

FCC ID: A3LSMS906U

Part 0 Power Density Report  
Power Density Characterization  
Revision A

November 11, 2021

SAMSUNG ELECTRONICS

# Power Density Characterization

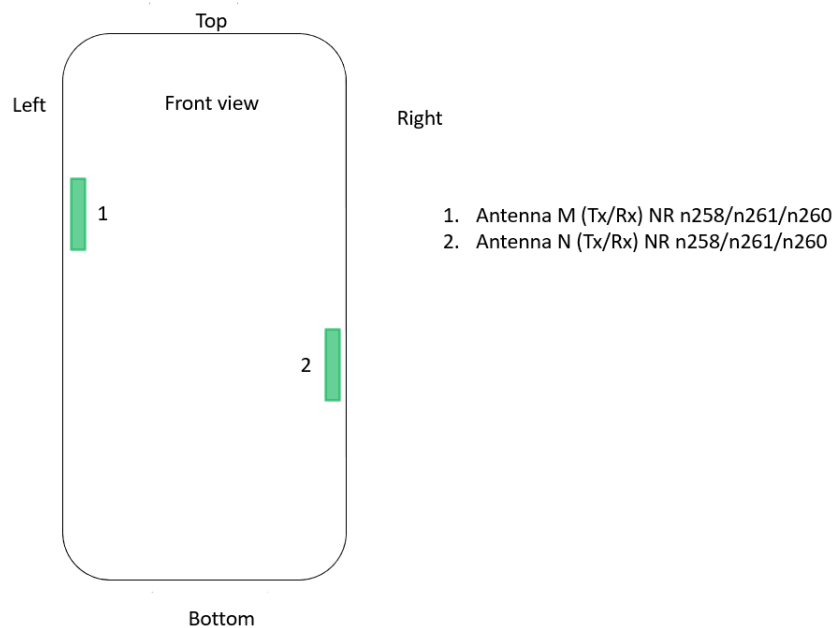
## 1 Exposure Scenarios

At frequencies > 6 GHz, the total peak spatial averaged power density (psPD) is required to be assessed for all antenna configurations (beams) from all mmW antenna modules installed inside the device. This device has 2 patch antenna arrays (M Patch, N Patch).

As showed in Figure 1, the surfaces near-by each mmW antenna module for PD characterization are identified and listed in Table 1.

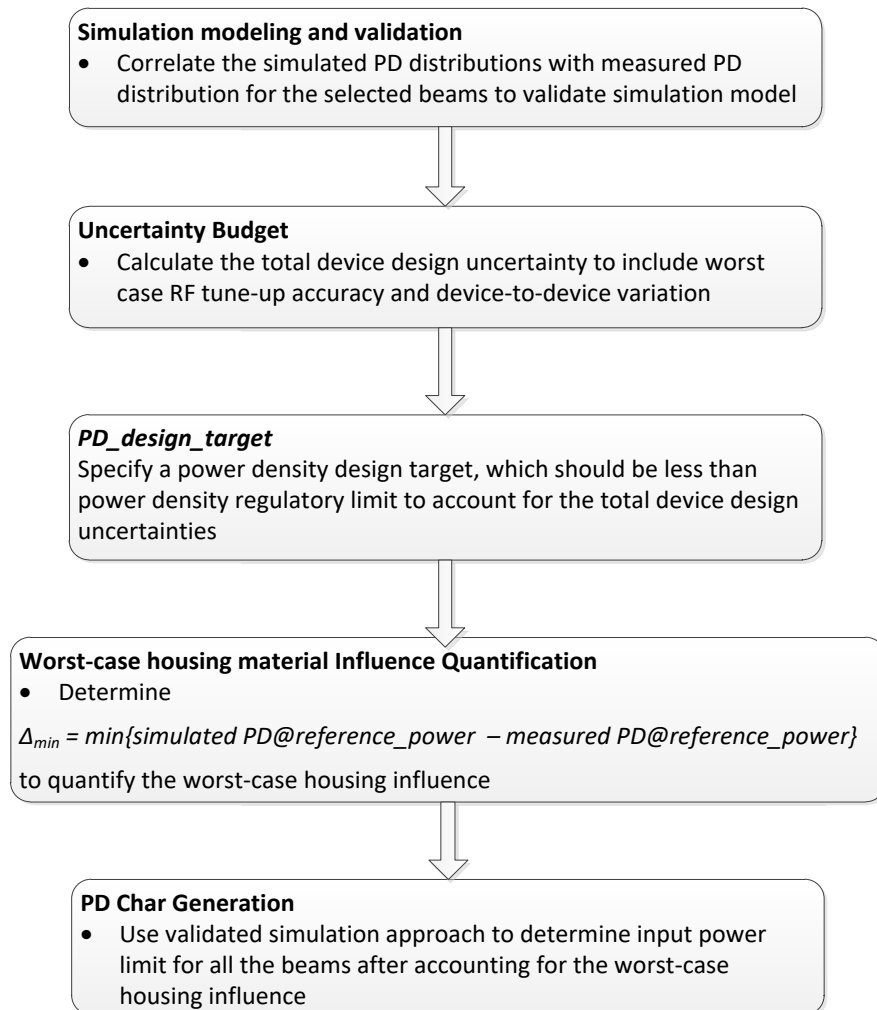
**Table 1**  
**Evaluation Surfaces for PD Characterization**

| Band/Mode | Antenna Module | Back | Front | Top | Bottom | Right | Left |
|-----------|----------------|------|-------|-----|--------|-------|------|
| NR n258   | M              | Yes  | Yes   | Yes | No     | No    | Yes  |
| NR n258   | N              | Yes  | Yes   | No  | No     | Yes   | No   |
| NR n261   | M              | Yes  | Yes   | Yes | No     | No    | Yes  |
| NR n261   | N              | Yes  | Yes   | No  | No     | Yes   | No   |
| NR n260   | M              | Yes  | Yes   | Yes | No     | No    | Yes  |
| NR n260   | N              | Yes  | Yes   | No  | No     | Yes   | No   |



**Figure 1: Location of mmW antenna modules looking from front of the DUT**

## 2 Power Density Characterization Method



### 3 Codebook for all supported beams

**Table 2**  
**5G mmW NR Band n258 Ant M Codebook**

| Band | Antenna Module | Antenna Type | Beam ID | Feed no. | Paired With |
|------|----------------|--------------|---------|----------|-------------|
| n258 | M              | Patch        | 0       | 1        | 128         |
| n258 | M              | Patch        | 2       | 1        | 130         |
| n258 | M              | Patch        | 4       | 1        | 132         |
| n258 | M              | Patch        | 6       | 1        | 134         |
| n258 | M              | Patch        | 8       | 1        | 136         |
| n258 | M              | Patch        | 10      | 2        | 138         |
| n258 | M              | Patch        | 11      | 2        | 139         |
| n258 | M              | Patch        | 12      | 2        | 140         |
| n258 | M              | Patch        | 13      | 2        | 141         |
| n258 | M              | Patch        | 18      | 2        | 146         |
| n258 | M              | Patch        | 19      | 2        | 147         |
| n258 | M              | Patch        | 20      | 2        | 148         |
| n258 | M              | Patch        | 24      | 5        | 152         |
| n258 | M              | Patch        | 25      | 5        | 153         |
| n258 | M              | Patch        | 26      | 5        | 154         |
| n258 | M              | Patch        | 27      | 5        | 155         |
| n258 | M              | Patch        | 28      | 5        | 156         |
| n258 | M              | Patch        | 34      | 5        | 162         |
| n258 | M              | Patch        | 35      | 5        | 163         |
| n258 | M              | Patch        | 36      | 5        | 164         |
| n258 | M              | Patch        | 37      | 5        | 165         |
| n258 | M              | Patch        | 128     | 1        | 0           |
| n258 | M              | Patch        | 130     | 1        | 2           |
| n258 | M              | Patch        | 132     | 1        | 4           |
| n258 | M              | Patch        | 134     | 1        | 6           |
| n258 | M              | Patch        | 136     | 1        | 8           |
| n258 | M              | Patch        | 138     | 2        | 10          |
| n258 | M              | Patch        | 139     | 2        | 11          |
| n258 | M              | Patch        | 140     | 2        | 12          |
| n258 | M              | Patch        | 141     | 2        | 13          |
| n258 | M              | Patch        | 146     | 2        | 18          |
| n258 | M              | Patch        | 147     | 2        | 19          |
| n258 | M              | Patch        | 148     | 2        | 20          |
| n258 | M              | Patch        | 152     | 5        | 24          |
| n258 | M              | Patch        | 153     | 5        | 25          |
| n258 | M              | Patch        | 154     | 5        | 26          |
| n258 | M              | Patch        | 155     | 5        | 27          |
| n258 | M              | Patch        | 156     | 5        | 28          |
| n258 | M              | Patch        | 162     | 5        | 34          |
| n258 | M              | Patch        | 163     | 5        | 35          |
| n258 | M              | Patch        | 164     | 5        | 36          |
| n258 | M              | Patch        | 165     | 5        | 37          |

**Table 3**  
**5G mmW NR Band n258 Ant N Codebook**

| Band | Antenna Module | Antenna Type | Beam ID | Feed no. | Paired With |
|------|----------------|--------------|---------|----------|-------------|
| n258 | N              | Patch        | 1       | 1        | 129         |
| n258 | N              | Patch        | 3       | 1        | 131         |
| n258 | N              | Patch        | 5       | 1        | 133         |
| n258 | N              | Patch        | 7       | 1        | 135         |
| n258 | N              | Patch        | 9       | 1        | 137         |
| n258 | N              | Patch        | 14      | 2        | 142         |
| n258 | N              | Patch        | 15      | 2        | 143         |
| n258 | N              | Patch        | 16      | 2        | 144         |
| n258 | N              | Patch        | 17      | 2        | 145         |
| n258 | N              | Patch        | 21      | 2        | 149         |
| n258 | N              | Patch        | 22      | 2        | 150         |
| n258 | N              | Patch        | 23      | 2        | 151         |
| n258 | N              | Patch        | 29      | 5        | 157         |
| n258 | N              | Patch        | 30      | 5        | 158         |
| n258 | N              | Patch        | 31      | 5        | 159         |
| n258 | N              | Patch        | 32      | 5        | 160         |
| n258 | N              | Patch        | 33      | 5        | 161         |
| n258 | N              | Patch        | 38      | 5        | 166         |
| n258 | N              | Patch        | 39      | 5        | 167         |
| n258 | N              | Patch        | 40      | 5        | 168         |
| n258 | N              | Patch        | 41      | 5        | 169         |
| n258 | N              | Patch        | 129     | 1        | 1           |
| n258 | N              | Patch        | 131     | 1        | 3           |
| n258 | N              | Patch        | 133     | 1        | 5           |
| n258 | N              | Patch        | 135     | 1        | 7           |
| n258 | N              | Patch        | 137     | 1        | 9           |
| n258 | N              | Patch        | 142     | 2        | 14          |
| n258 | N              | Patch        | 143     | 2        | 15          |
| n258 | N              | Patch        | 144     | 2        | 16          |
| n258 | N              | Patch        | 145     | 2        | 17          |
| n258 | N              | Patch        | 149     | 2        | 21          |
| n258 | N              | Patch        | 150     | 2        | 22          |
| n258 | N              | Patch        | 151     | 2        | 23          |
| n258 | N              | Patch        | 157     | 5        | 29          |
| n258 | N              | Patch        | 158     | 5        | 30          |
| n258 | N              | Patch        | 159     | 5        | 31          |
| n258 | N              | Patch        | 160     | 5        | 32          |
| n258 | N              | Patch        | 161     | 5        | 33          |
| n258 | N              | Patch        | 166     | 5        | 38          |
| n258 | N              | Patch        | 167     | 5        | 39          |
| n258 | N              | Patch        | 168     | 5        | 40          |
| n258 | N              | Patch        | 169     | 5        | 41          |

**Table 4**  
**5G mmW NR Band n261 Ant M Codebook**

| Band | Antenna Module | Antenna Type | Beam ID | Feed no. | Paired With |
|------|----------------|--------------|---------|----------|-------------|
| n261 | M              | Patch        | 0       | 1        | 128         |
| n261 | M              | Patch        | 2       | 1        | 130         |
| n261 | M              | Patch        | 4       | 1        | 132         |
| n261 | M              | Patch        | 6       | 1        | 134         |
| n261 | M              | Patch        | 8       | 1        | 136         |
| n261 | M              | Patch        | 10      | 2        | 138         |
| n261 | M              | Patch        | 11      | 2        | 139         |
| n261 | M              | Patch        | 12      | 2        | 140         |
| n261 | M              | Patch        | 13      | 2        | 141         |
| n261 | M              | Patch        | 18      | 2        | 146         |
| n261 | M              | Patch        | 19      | 2        | 147         |
| n261 | M              | Patch        | 20      | 2        | 148         |
| n261 | M              | Patch        | 24      | 5        | 152         |
| n261 | M              | Patch        | 25      | 5        | 153         |
| n261 | M              | Patch        | 26      | 5        | 154         |
| n261 | M              | Patch        | 27      | 5        | 155         |
| n261 | M              | Patch        | 28      | 5        | 156         |
| n261 | M              | Patch        | 34      | 5        | 162         |
| n261 | M              | Patch        | 35      | 5        | 163         |
| n261 | M              | Patch        | 36      | 5        | 164         |
| n261 | M              | Patch        | 37      | 5        | 165         |
| n261 | M              | Patch        | 128     | 1        | 0           |
| n261 | M              | Patch        | 130     | 1        | 2           |
| n261 | M              | Patch        | 132     | 1        | 4           |
| n261 | M              | Patch        | 134     | 1        | 6           |
| n261 | M              | Patch        | 136     | 1        | 8           |
| n261 | M              | Patch        | 138     | 2        | 10          |
| n261 | M              | Patch        | 139     | 2        | 11          |
| n261 | M              | Patch        | 140     | 2        | 12          |
| n261 | M              | Patch        | 141     | 2        | 13          |
| n261 | M              | Patch        | 146     | 2        | 18          |
| n261 | M              | Patch        | 147     | 2        | 19          |
| n261 | M              | Patch        | 148     | 2        | 20          |
| n261 | M              | Patch        | 152     | 5        | 24          |
| n261 | M              | Patch        | 153     | 5        | 25          |
| n261 | M              | Patch        | 154     | 5        | 26          |
| n261 | M              | Patch        | 155     | 5        | 27          |
| n261 | M              | Patch        | 156     | 5        | 28          |
| n261 | M              | Patch        | 162     | 5        | 34          |
| n261 | M              | Patch        | 163     | 5        | 35          |
| n261 | M              | Patch        | 164     | 5        | 36          |
| n261 | M              | Patch        | 165     | 5        | 37          |

**Table 5**  
**5G mmW NR Band n261 Ant N Codebook**

| Band | Antenna Module | Antenna Type | Beam ID | Feed no. | Paired With |
|------|----------------|--------------|---------|----------|-------------|
| n261 | N              | Patch        | 1       | 1        | 129         |
| n261 | N              | Patch        | 3       | 1        | 131         |
| n261 | N              | Patch        | 5       | 1        | 133         |
| n261 | N              | Patch        | 7       | 1        | 135         |
| n261 | N              | Patch        | 9       | 1        | 137         |
| n261 | N              | Patch        | 14      | 2        | 142         |
| n261 | N              | Patch        | 15      | 2        | 143         |
| n261 | N              | Patch        | 16      | 2        | 144         |
| n261 | N              | Patch        | 17      | 2        | 145         |
| n261 | N              | Patch        | 21      | 2        | 149         |
| n261 | N              | Patch        | 22      | 2        | 150         |
| n261 | N              | Patch        | 23      | 2        | 151         |
| n261 | N              | Patch        | 29      | 5        | 157         |
| n261 | N              | Patch        | 30      | 5        | 158         |
| n261 | N              | Patch        | 31      | 5        | 159         |
| n261 | N              | Patch        | 32      | 5        | 160         |
| n261 | N              | Patch        | 33      | 5        | 161         |
| n261 | N              | Patch        | 38      | 5        | 166         |
| n261 | N              | Patch        | 39      | 5        | 167         |
| n261 | N              | Patch        | 40      | 5        | 168         |
| n261 | N              | Patch        | 41      | 5        | 169         |
| n261 | N              | Patch        | 129     | 1        | 1           |
| n261 | N              | Patch        | 131     | 1        | 3           |
| n261 | N              | Patch        | 133     | 1        | 5           |
| n261 | N              | Patch        | 135     | 1        | 7           |
| n261 | N              | Patch        | 137     | 1        | 9           |
| n261 | N              | Patch        | 142     | 2        | 14          |
| n261 | N              | Patch        | 143     | 2        | 15          |
| n261 | N              | Patch        | 144     | 2        | 16          |
| n261 | N              | Patch        | 145     | 2        | 17          |
| n261 | N              | Patch        | 149     | 2        | 21          |
| n261 | N              | Patch        | 150     | 2        | 22          |
| n261 | N              | Patch        | 151     | 2        | 23          |
| n261 | N              | Patch        | 157     | 5        | 29          |
| n261 | N              | Patch        | 158     | 5        | 30          |
| n261 | N              | Patch        | 159     | 5        | 31          |
| n261 | N              | Patch        | 160     | 5        | 32          |
| n261 | N              | Patch        | 161     | 5        | 33          |
| n261 | N              | Patch        | 166     | 5        | 38          |
| n261 | N              | Patch        | 167     | 5        | 39          |
| n261 | N              | Patch        | 168     | 5        | 40          |
| n261 | N              | Patch        | 169     | 5        | 41          |

**Table 6**  
**5G mmW NR Band n260 Ant M Codebook**

| Band | Antenna Module | Antenna Type | Beam ID | Feed no. | Paired With |
|------|----------------|--------------|---------|----------|-------------|
| n260 | M              | Patch        | 0       | 1        | 128         |
| n260 | M              | Patch        | 2       | 1        | 130         |
| n260 | M              | Patch        | 4       | 1        | 132         |
| n260 | M              | Patch        | 6       | 1        | 134         |
| n260 | M              | Patch        | 8       | 1        | 136         |
| n260 | M              | Patch        | 10      | 2        | 138         |
| n260 | M              | Patch        | 11      | 2        | 139         |
| n260 | M              | Patch        | 12      | 2        | 140         |
| n260 | M              | Patch        | 13      | 2        | 141         |
| n260 | M              | Patch        | 18      | 2        | 146         |
| n260 | M              | Patch        | 19      | 2        | 147         |
| n260 | M              | Patch        | 20      | 2        | 148         |
| n260 | M              | Patch        | 24      | 5        | 152         |
| n260 | M              | Patch        | 25      | 5        | 153         |
| n260 | M              | Patch        | 26      | 5        | 154         |
| n260 | M              | Patch        | 27      | 5        | 155         |
| n260 | M              | Patch        | 28      | 5        | 156         |
| n260 | M              | Patch        | 34      | 5        | 162         |
| n260 | M              | Patch        | 35      | 5        | 163         |
| n260 | M              | Patch        | 36      | 5        | 164         |
| n260 | M              | Patch        | 37      | 5        | 165         |
| n260 | M              | Patch        | 128     | 1        | 0           |
| n260 | M              | Patch        | 130     | 1        | 2           |
| n260 | M              | Patch        | 132     | 1        | 4           |
| n260 | M              | Patch        | 134     | 1        | 6           |
| n260 | M              | Patch        | 136     | 1        | 8           |
| n260 | M              | Patch        | 138     | 2        | 10          |
| n260 | M              | Patch        | 139     | 2        | 11          |
| n260 | M              | Patch        | 140     | 2        | 12          |
| n260 | M              | Patch        | 141     | 2        | 13          |
| n260 | M              | Patch        | 146     | 2        | 18          |
| n260 | M              | Patch        | 147     | 2        | 19          |
| n260 | M              | Patch        | 148     | 2        | 20          |
| n260 | M              | Patch        | 152     | 5        | 24          |
| n260 | M              | Patch        | 153     | 5        | 25          |
| n260 | M              | Patch        | 154     | 5        | 26          |
| n260 | M              | Patch        | 155     | 5        | 27          |
| n260 | M              | Patch        | 156     | 5        | 28          |
| n260 | M              | Patch        | 162     | 5        | 34          |
| n260 | M              | Patch        | 163     | 5        | 35          |
| n260 | M              | Patch        | 164     | 5        | 36          |
| n260 | M              | Patch        | 165     | 5        | 37          |

**Table 7**  
**5G mmW NR Band n260 Ant N Codebook**

| Band | Antenna Module | Antenna Type | Beam ID | Feed no. | Paired With |
|------|----------------|--------------|---------|----------|-------------|
| n260 | N              | Patch        | 1       | 1        | 129         |
| n260 | N              | Patch        | 3       | 1        | 131         |
| n260 | N              | Patch        | 5       | 1        | 133         |
| n260 | N              | Patch        | 7       | 1        | 135         |
| n260 | N              | Patch        | 9       | 1        | 137         |
| n260 | N              | Patch        | 14      | 2        | 142         |
| n260 | N              | Patch        | 15      | 2        | 143         |
| n260 | N              | Patch        | 16      | 2        | 144         |
| n260 | N              | Patch        | 17      | 2        | 145         |
| n260 | N              | Patch        | 21      | 2        | 149         |
| n260 | N              | Patch        | 22      | 2        | 150         |
| n260 | N              | Patch        | 23      | 2        | 151         |
| n260 | N              | Patch        | 29      | 5        | 157         |
| n260 | N              | Patch        | 30      | 5        | 158         |
| n260 | N              | Patch        | 31      | 5        | 159         |
| n260 | N              | Patch        | 32      | 5        | 160         |
| n260 | N              | Patch        | 33      | 5        | 161         |
| n260 | N              | Patch        | 38      | 5        | 166         |
| n260 | N              | Patch        | 39      | 5        | 167         |
| n260 | N              | Patch        | 40      | 5        | 168         |
| n260 | N              | Patch        | 41      | 5        | 169         |
| n260 | N              | Patch        | 129     | 1        | 1           |
| n260 | N              | Patch        | 131     | 1        | 3           |
| n260 | N              | Patch        | 133     | 1        | 5           |
| n260 | N              | Patch        | 135     | 1        | 7           |
| n260 | N              | Patch        | 137     | 1        | 9           |
| n260 | N              | Patch        | 142     | 2        | 14          |
| n260 | N              | Patch        | 143     | 2        | 15          |
| n260 | N              | Patch        | 144     | 2        | 16          |
| n260 | N              | Patch        | 145     | 2        | 17          |
| n260 | N              | Patch        | 149     | 2        | 21          |
| n260 | N              | Patch        | 150     | 2        | 22          |
| n260 | N              | Patch        | 151     | 2        | 23          |
| n260 | N              | Patch        | 157     | 5        | 29          |
| n260 | N              | Patch        | 158     | 5        | 30          |
| n260 | N              | Patch        | 159     | 5        | 31          |
| n260 | N              | Patch        | 160     | 5        | 32          |
| n260 | N              | Patch        | 161     | 5        | 33          |
| n260 | N              | Patch        | 166     | 5        | 38          |
| n260 | N              | Patch        | 167     | 5        | 39          |
| n260 | N              | Patch        | 168     | 5        | 40          |
| n260 | N              | Patch        | 169     | 5        | 41          |

#### 4 Simulation and Modeling Validation

Power density simulations of all beams and surfaces were performed. Details of these simulations and modeling validation can be found in the Power Density Simulation Report. Table below includes a summary of the validation results to support worst-case housing influence quantification in power density characterization for this model.

With an input power of 6 dBm for n258 band, 6 dBm for n261 band, and 6 dBm for n260 band, PD measurements are conducted for at least one single beam per antenna module on worst-surface(s). PD measurements are performed at mid channel of each mmW band and with CW modulation. All measured PD values are listed in table below along with corresponding simulated PD values for the same configuration.

PD value will be used to determine worst-case housing influence for conservative assessment.

**Table 8**

| Band | Antenna | Beam ID | Surface | 4cm <sup>2</sup> psPD |           | Delta = Simulated - Measured |
|------|---------|---------|---------|-----------------------|-----------|------------------------------|
|      |         |         |         | Measured              | Simulated |                              |
|      |         |         |         | (mW/cm <sup>2</sup> ) |           | (dB)                         |
| n258 | M       | 34      | Back    | 0.663                 | 1.502     | 3.55                         |
|      |         | 26      | Left    | 0.379                 | 0.581     | <b>1.86</b>                  |
|      |         | 156     | Back    | 0.997                 | 2.075     | 3.18                         |
|      |         | 152     | Left    | 0.389                 | 0.689     | 2.48                         |
|      | N       | 33      | Back    | 0.312                 | 0.756     | 3.84                         |
|      |         | 32      | Right   | 0.733                 | 1.119     | 1.84                         |
|      |         | 40      | Front   | 0.352                 | 0.478     | <b>1.33</b>                  |
|      |         | 167     | Back    | 0.275                 | 0.591     | 3.32                         |
|      |         |         | Right   | 0.67                  | 1.151     | 2.35                         |
|      |         | 159     | Front   | 0.283                 | 0.651     | 3.62                         |
| n261 | M       | 27      | Back    | 0.793                 | 1.479     | 2.71                         |
|      |         | 26      | Left    | 0.457                 | 0.700     | <b>1.85</b>                  |
|      |         | 156     | Back    | 1.040                 | 2.184     | 3.22                         |
|      |         | 153     | Left    | 0.661                 | 1.042     | 1.98                         |
|      | N       | 31      | Back    | 0.338                 | 0.639     | 2.77                         |
|      |         |         | Right   | 0.814                 | 1.435     | 2.46                         |
|      |         |         | Front   | 0.437                 | 0.722     | 2.18                         |
|      |         | 160     | Back    | 0.279                 | 0.616     | 3.44                         |
|      |         |         | Right   | 1.170                 | 1.284     | <b>0.40</b>                  |
|      |         | 167     | Front   | 0.548                 | 0.857     | 1.94                         |
| n260 | M       | 24      | Back    | 0.401                 | 0.722     | 2.55                         |
|      |         | 37      | Left    | 0.257                 | 0.386     | 1.77                         |
|      |         | 154     | Back    | 0.583                 | 1.018     | 2.42                         |
|      |         | 156     | Left    | 0.355                 | 0.482     | <b>1.33</b>                  |
|      | N       | 39      | Back    | 0.526                 | 0.603     | <b>0.59</b>                  |
|      |         | 32      | Right   | 0.616                 | 1.599     | 4.14                         |
|      |         |         | Front   | 0.196                 | 1.028     | 7.20                         |
|      |         |         | Back    | 0.477                 | 0.921     | 2.86                         |
|      |         | 167     | Right   | 0.724                 | 1.648     | 3.57                         |
|      |         |         | Front   | 0.274                 | 0.824     | 4.78                         |

## 5 $PD_{design\_target}$

**Table 9**

| <b><math>PD_{design\_target}</math></b>                                                   |                          |
|-------------------------------------------------------------------------------------------|--------------------------|
| $PD_{design\_target} < PD_{regulatory\_limit} \times 10^{\frac{-Total\ Uncertainty}{10}}$ |                          |
| <b>psPD over 4 cm<sup>2</sup> Averaging Area (mW/cm<sup>2</sup>)</b>                      |                          |
| <i>Total Uncertainty</i>                                                                  | 2.0 dB                   |
| <i>PD<sub>regulatory_limit</sub></i>                                                      | 1.0 mW/cm <sup>2</sup>   |
| <i>PD<sub>design_target</sub></i>                                                         | 0.631 mW/cm <sup>2</sup> |

## 6 $\Delta_{min}$

For non-metal material, the material property cannot be accurately characterized at mmW frequencies to date. The estimated material property for the device housing is used in the simulation model, which could influence the accuracy in simulation for PD amplitude quantification. Since the housing influence on PD could vary from surface to surface where the EM field propagates through, the most underestimated surface is used to quantify the worst-case housing influence for conservative assessment.

Since the mmW antenna modules are placed at different locations, only surrounding material/housing has impact on EM field propagation, and in turn power density. Furthermore, depending on the type of antenna array, i.e., dipole antenna array or patch antenna array, the nature of EM field propagation in the near field is different. Therefore, the worst-case housing influence is determined per antenna module and per antenna type.

For this DUT, the below procedure was used to determine worst-case housing influence,  $\Delta_{min}$ :

1. Based on PD simulation, for each module and antenna type, determine one or more worst-surface(s) that has highest 4cm<sup>2</sup> PD for all the single beams per antenna module and per antenna type in the mid channel of each band.
2. For identified worst surface(s) per antenna module and per antenna type group,
  - a. First determine  $\Delta_{min}$  based on identified worst surface(s), and derive input.power.limit
  - b. Then prove all other near-by surface(s), i.e., non-selected surface(s), is not required for housing material loss quantification (in other words, these non-evaluated surfaces have no influence on the determined input.power.limit) by:

- i. re-scale all simulated 4cm2 PD values to input.power.limit to identify the worst-PD beam per each non-evaluated surface
  - ii. Measure 4cm2 PD at input.power.limit on identified worst-PD beam per each non-evaluated surface
  - iii. Demonstrate all measured 4cm2 PD values are below PD\_design\_target
3. If any of the above surface(s) in Step (2.b.iii) have measured 4cm2 PD  $\geq$  PD\_design\_target, then those surfaces must be included in the  $\Delta_{min}$  determination in Step (2.a), and re-evaluate input.power.limit with these added surfaces.

Following above procedure, based on the Samsung PD simulation report, the worst-surface(s) having highest 4cm2 PD for all the single beams per each antenna type and each antenna module group in the mid channel of n258, n261, and n260 bands are identified in the following table:

**Table 10**  
**Worst-surface(s) for Ant M, Ant N**

| Antenna Module | Antenna Type | Back (S2) | Front (S1) | Top (S5) | Bottom (S6) | Right (S4) | Left (S3) |
|----------------|--------------|-----------|------------|----------|-------------|------------|-----------|
| <b>M</b>       | <b>Patch</b> | Yes       | No         | No       | No          | No         | Yes       |
| <b>N</b>       | <b>Patch</b> | Yes       | Yes        | No       | No          | Yes        | No        |

Thus, when comparing a simulated 4cm2-averaged PD and measured 4 cm2-averaged PD for the identified worst surface(s), the worst error introduced for each antenna type and each antenna module group when using the estimated material property in the simulation is highlighted in bold numbers in the table below. Thus, the worst-case housing influence, denoted as  $\Delta_{min} = \text{Sim. PD} - \text{Meas. PD}$ , is determined as

**Table 11**  
 **$\Delta_{min}$  for Ant M, Ant N**

| Band | Antenna | $\Delta_{min}$ |
|------|---------|----------------|
|      |         | (dB)           |
| n258 | M       | <b>1.86</b>    |
|      | N       | <b>1.33</b>    |
| n261 | M       | <b>1.85</b>    |
|      | N       | <b>0.40</b>    |
| n260 | M       | <b>1.33</b>    |
|      | N       | <b>0.59</b>    |

$\Delta_{min}$  represents the worst case where RF exposure is underestimated the most in simulation when using the estimated material property of the housing. For conservative assessment, the  $\Delta_{min}$  is used as the worst-case factor and applied to all the beams in the corresponding antenna type and antenna module group to determine input power limits in PD char for compliance.

The detail input.power.limit derivation is described in Section 7.

Simulated 4cm<sup>2</sup> PD values in the Power Density Simulation Report are scaled to input.power.limit and are listed in the tables below for all single beams for all identified surfaces, when assuming the simulation is performed with correct housing influence.

Determine the worst beam for each of non-selected surface(s), identified in the table below:

**Table 12**  
**Non-Selected Surface(s) for Ant M, Ant N**

| Antenna Module | Antenna Type | Back (S2) | Front (S1) | Top (S5) | Bottom (S6) | Right (S4) | Left (S3) |
|----------------|--------------|-----------|------------|----------|-------------|------------|-----------|
| <b>M</b>       | <b>Patch</b> | No        | Yes        | Yes      | No          | No         | No        |
| <b>N</b>       | <b>Patch</b> | No        | No         | No       | No          | No         | No        |

Then perform PD measurement for all determined worst-case beams, highlighted in orange in the tables below, on the corresponding surface. Measurement is performed in the mid channel of each band with CW modulation. The evaluation distance is at 2 mm.

**Table 13**  
**n258/mid channel, Antenna M Patch simulated 4cm2 PD at PD\_Design\_Target**  
**(if simulation performed with correct housing material properties) ( $\Delta_{min}$ )**

| Antenna | Beam ID_1 | Simulated 4cm <sup>2</sup> PD (mW/cm <sup>2</sup> ) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties |          |         |            |           |          |
|---------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|------------|-----------|----------|
|         |           | S4(Right)                                                                                                                                                                      | S3(Left) | S5(Top) | S6(Bottom) | S1(Front) | S2(Back) |
| M       | 0         | 0.015                                                                                                                                                                          | 0.165    | 0.022   | 0.005      | 0.090     | 0.529    |
| M       | 2         | 0.013                                                                                                                                                                          | 0.214    | 0.029   | 0.006      | 0.036     | 0.558    |
| M       | 4         | 0.011                                                                                                                                                                          | 0.107    | 0.030   | 0.006      | 0.024     | 0.584    |
| M       | 6         | 0.018                                                                                                                                                                          | 0.146    | 0.032   | 0.005      | 0.060     | 0.548    |
| M       | 8         | 0.006                                                                                                                                                                          | 0.203    | 0.071   | 0.002      | 0.065     | 0.501    |
| M       | 10        | 0.007                                                                                                                                                                          | 0.128    | 0.041   | 0.008      | 0.025     | 0.531    |
| M       | 11        | 0.006                                                                                                                                                                          | 0.145    | 0.034   | 0.001      | 0.022     | 0.560    |
| M       | 12        | 0.016                                                                                                                                                                          | 0.113    | 0.021   | 0.006      | 0.035     | 0.593    |
| M       | 13        | 0.023                                                                                                                                                                          | 0.143    | 0.026   | 0.008      | 0.101     | 0.511    |
| M       | 18        | 0.011                                                                                                                                                                          | 0.238    | 0.030   | 0.001      | 0.030     | 0.580    |
| M       | 19        | 0.010                                                                                                                                                                          | 0.267    | 0.023   | 0.001      | 0.037     | 0.579    |
| M       | 20        | 0.029                                                                                                                                                                          | 0.097    | 0.063   | 0.004      | 0.100     | 0.555    |
| M       | 24        | 0.009                                                                                                                                                                          | 0.157    | 0.079   | 0.002      | 0.041     | 0.519    |
| M       | 25        | 0.017                                                                                                                                                                          | 0.225    | 0.034   | 0.001      | 0.031     | 0.584    |
| M       | 26        | 0.016                                                                                                                                                                          | 0.233    | 0.029   | 0.001      | 0.036     | 0.557    |
| M       | 27        | 0.014                                                                                                                                                                          | 0.159    | 0.024   | 0.003      | 0.051     | 0.528    |
| M       | 28        | 0.031                                                                                                                                                                          | 0.166    | 0.018   | 0.007      | 0.081     | 0.554    |
| M       | 34        | 0.013                                                                                                                                                                          | 0.190    | 0.057   | 0.001      | 0.035     | 0.558    |
| M       | 35        | 0.013                                                                                                                                                                          | 0.227    | 0.022   | 0.000      | 0.035     | 0.568    |
| M       | 36        | 0.019                                                                                                                                                                          | 0.210    | 0.021   | 0.001      | 0.041     | 0.538    |
| M       | 37        | 0.025                                                                                                                                                                          | 0.159    | 0.029   | 0.003      | 0.074     | 0.572    |
| M       | 128       | 0.009                                                                                                                                                                          | 0.165    | 0.019   | 0.009      | 0.027     | 0.588    |
| M       | 130       | 0.006                                                                                                                                                                          | 0.227    | 0.026   | 0.010      | 0.026     | 0.554    |
| M       | 132       | 0.009                                                                                                                                                                          | 0.187    | 0.038   | 0.009      | 0.018     | 0.593    |
| M       | 134       | 0.012                                                                                                                                                                          | 0.173    | 0.044   | 0.006      | 0.028     | 0.564    |
| M       | 136       | 0.010                                                                                                                                                                          | 0.212    | 0.043   | 0.004      | 0.035     | 0.588    |
| M       | 138       | 0.005                                                                                                                                                                          | 0.306    | 0.062   | 0.017      | 0.028     | 0.590    |
| M       | 139       | 0.005                                                                                                                                                                          | 0.256    | 0.028   | 0.003      | 0.018     | 0.582    |
| M       | 140       | 0.010                                                                                                                                                                          | 0.181    | 0.012   | 0.008      | 0.020     | 0.582    |
| M       | 141       | 0.019                                                                                                                                                                          | 0.160    | 0.035   | 0.012      | 0.025     | 0.600    |
| M       | 146       | 0.005                                                                                                                                                                          | 0.268    | 0.035   | 0.004      | 0.020     | 0.582    |
| M       | 147       | 0.007                                                                                                                                                                          | 0.243    | 0.022   | 0.003      | 0.019     | 0.580    |
| M       | 148       | 0.007                                                                                                                                                                          | 0.151    | 0.014   | 0.011      | 0.031     | 0.584    |
| M       | 152       | 0.004                                                                                                                                                                          | 0.289    | 0.085   | 0.004      | 0.024     | 0.566    |
| M       | 153       | 0.010                                                                                                                                                                          | 0.295    | 0.031   | 0.003      | 0.023     | 0.559    |
| M       | 154       | 0.015                                                                                                                                                                          | 0.240    | 0.018   | 0.003      | 0.018     | 0.588    |
| M       | 155       | 0.014                                                                                                                                                                          | 0.206    | 0.013   | 0.003      | 0.030     | 0.598    |
| M       | 156       | 0.022                                                                                                                                                                          | 0.124    | 0.013   | 0.007      | 0.027     | 0.605    |
| M       | 162       | 0.006                                                                                                                                                                          | 0.299    | 0.080   | 0.005      | 0.019     | 0.573    |
| M       | 163       | 0.017                                                                                                                                                                          | 0.271    | 0.012   | 0.002      | 0.022     | 0.563    |
| M       | 164       | 0.016                                                                                                                                                                          | 0.206    | 0.020   | 0.004      | 0.021     | 0.586    |
| M       | 165       | 0.016                                                                                                                                                                          | 0.173    | 0.009   | 0.002      | 0.029     | 0.594    |

**Table 14**  
**n261/mid channel, Antenna M Patch simulated 4cm2 PD at PD\_Design\_Target**  
**(if simulation performed with correct housing material properties) ( $\Delta_{min}$ )**

| Antenna | Beam ID_1 | Simulated 4cm <sup>2</sup> PD (mW/cm <sup>2</sup> ) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties |          |         |            |           |          |
|---------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|------------|-----------|----------|
|         |           | S4(Right)                                                                                                                                                                      | S3(Left) | S5(Top) | S6(Bottom) | S1(Front) | S2(Back) |
| M       | 0         | 0.007                                                                                                                                                                          | 0.291    | 0.022   | 0.005      | 0.049     | 0.624    |
| M       | 2         | 0.011                                                                                                                                                                          | 0.175    | 0.040   | 0.003      | 0.052     | 0.551    |
| M       | 4         | 0.019                                                                                                                                                                          | 0.195    | 0.044   | 0.002      | 0.049     | 0.622    |
| M       | 6         | 0.013                                                                                                                                                                          | 0.239    | 0.034   | 0.002      | 0.029     | 0.609    |
| M       | 8         | 0.007                                                                                                                                                                          | 0.191    | 0.049   | 0.002      | 0.028     | 0.591    |
| M       | 10        | 0.018                                                                                                                                                                          | 0.166    | 0.083   | 0.004      | 0.049     | 0.631    |
| M       | 11        | 0.012                                                                                                                                                                          | 0.244    | 0.037   | 0.004      | 0.045     | 0.623    |
| M       | 12        | 0.013                                                                                                                                                                          | 0.306    | 0.021   | 0.004      | 0.043     | 0.605    |
| M       | 13        | 0.015                                                                                                                                                                          | 0.225    | 0.023   | 0.004      | 0.076     | 0.555    |
| M       | 18        | 0.009                                                                                                                                                                          | 0.206    | 0.037   | 0.005      | 0.049     | 0.591    |
| M       | 19        | 0.012                                                                                                                                                                          | 0.299    | 0.027   | 0.004      | 0.040     | 0.627    |
| M       | 20        | 0.011                                                                                                                                                                          | 0.303    | 0.017   | 0.004      | 0.057     | 0.587    |
| M       | 24        | 0.011                                                                                                                                                                          | 0.144    | 0.100   | 0.004      | 0.053     | 0.631    |
| M       | 25        | 0.019                                                                                                                                                                          | 0.219    | 0.090   | 0.002      | 0.022     | 0.631    |
| M       | 26        | 0.021                                                                                                                                                                          | 0.320    | 0.028   | 0.003      | 0.038     | 0.620    |
| M       | 27        | 0.019                                                                                                                                                                          | 0.241    | 0.017   | 0.003      | 0.031     | 0.586    |
| M       | 28        | 0.016                                                                                                                                                                          | 0.205    | 0.040   | 0.003      | 0.044     | 0.615    |
| M       | 34        | 0.016                                                                                                                                                                          | 0.164    | 0.106   | 0.003      | 0.028     | 0.631    |
| M       | 35        | 0.019                                                                                                                                                                          | 0.285    | 0.046   | 0.002      | 0.027     | 0.631    |
| M       | 36        | 0.025                                                                                                                                                                          | 0.280    | 0.031   | 0.001      | 0.039     | 0.589    |
| M       | 37        | 0.015                                                                                                                                                                          | 0.216    | 0.029   | 0.003      | 0.035     | 0.613    |
| M       | 128       | 0.008                                                                                                                                                                          | 0.150    | 0.017   | 0.007      | 0.023     | 0.614    |
| M       | 130       | 0.005                                                                                                                                                                          | 0.214    | 0.021   | 0.003      | 0.016     | 0.620    |
| M       | 132       | 0.005                                                                                                                                                                          | 0.244    | 0.026   | 0.003      | 0.016     | 0.631    |
| M       | 134       | 0.003                                                                                                                                                                          | 0.261    | 0.033   | 0.003      | 0.008     | 0.629    |
| M       | 136       | 0.007                                                                                                                                                                          | 0.251    | 0.045   | 0.002      | 0.013     | 0.617    |
| M       | 138       | 0.006                                                                                                                                                                          | 0.268    | 0.077   | 0.003      | 0.013     | 0.631    |
| M       | 139       | 0.004                                                                                                                                                                          | 0.266    | 0.028   | 0.002      | 0.013     | 0.631    |
| M       | 140       | 0.006                                                                                                                                                                          | 0.185    | 0.007   | 0.004      | 0.020     | 0.619    |
| M       | 141       | 0.010                                                                                                                                                                          | 0.181    | 0.020   | 0.009      | 0.026     | 0.603    |
| M       | 146       | 0.003                                                                                                                                                                          | 0.274    | 0.029   | 0.003      | 0.013     | 0.631    |
| M       | 147       | 0.005                                                                                                                                                                          | 0.222    | 0.020   | 0.001      | 0.015     | 0.631    |
| M       | 148       | 0.007                                                                                                                                                                          | 0.182    | 0.009   | 0.005      | 0.023     | 0.612    |
| M       | 152       | 0.002                                                                                                                                                                          | 0.285    | 0.107   | 0.002      | 0.019     | 0.621    |
| M       | 153       | 0.007                                                                                                                                                                          | 0.336    | 0.052   | 0.001      | 0.009     | 0.631    |
| M       | 154       | 0.012                                                                                                                                                                          | 0.328    | 0.009   | 0.001      | 0.010     | 0.627    |
| M       | 155       | 0.009                                                                                                                                                                          | 0.308    | 0.009   | 0.001      | 0.020     | 0.624    |
| M       | 156       | 0.009                                                                                                                                                                          | 0.267    | 0.010   | 0.005      | 0.034     | 0.631    |
| M       | 162       | 0.004                                                                                                                                                                          | 0.287    | 0.080   | 0.001      | 0.014     | 0.631    |
| M       | 163       | 0.009                                                                                                                                                                          | 0.334    | 0.020   | 0.001      | 0.009     | 0.630    |
| M       | 164       | 0.010                                                                                                                                                                          | 0.332    | 0.008   | 0.001      | 0.014     | 0.619    |
| M       | 165       | 0.008                                                                                                                                                                          | 0.307    | 0.008   | 0.002      | 0.025     | 0.628    |

**Table 15**  
**n260/mid channel, Antenna M Patch simulated 4cm2 PD at PD\_Design\_Target**  
**(if simulation performed with correct housing material properties) ( $\Delta_{min}$ )**

| Antenna | Beam ID_1 | Simulated 4cm <sup>2</sup> PD (mW/cm <sup>2</sup> ) Corresponding to PD_design_target if the simulation was performed with correct No. Module Type housing material properties |          |         |            |           |          |
|---------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------|------------|-----------|----------|
|         |           | S4(Right)                                                                                                                                                                      | S3(Left) | S5(Top) | S6(Bottom) | S1(Front) | S2(Back) |
| M       | 0         | 0.009                                                                                                                                                                          | 0.211    | 0.026   | 0.003      | 0.023     | 0.587    |
| M       | 2         | 0.008                                                                                                                                                                          | 0.299    | 0.044   | 0.004      | 0.049     | 0.631    |
| M       | 4         | 0.007                                                                                                                                                                          | 0.289    | 0.045   | 0.004      | 0.026     | 0.631    |
| M       | 6         | 0.008                                                                                                                                                                          | 0.233    | 0.038   | 0.004      | 0.031     | 0.505    |
| M       | 8         | 0.007                                                                                                                                                                          | 0.196    | 0.067   | 0.003      | 0.017     | 0.466    |
| M       | 10        | 0.010                                                                                                                                                                          | 0.230    | 0.042   | 0.005      | 0.044     | 0.619    |
| M       | 11        | 0.009                                                                                                                                                                          | 0.320    | 0.036   | 0.002      | 0.032     | 0.595    |
| M       | 12        | 0.006                                                                                                                                                                          | 0.238    | 0.091   | 0.002      | 0.022     | 0.575    |
| M       | 13        | 0.008                                                                                                                                                                          | 0.207    | 0.047   | 0.005      | 0.049     | 0.616    |
| M       | 18        | 0.007                                                                                                                                                                          | 0.307    | 0.052   | 0.003      | 0.040     | 0.580    |
| M       | 19        | 0.009                                                                                                                                                                          | 0.230    | 0.051   | 0.002      | 0.019     | 0.478    |
| M       | 20        | 0.008                                                                                                                                                                          | 0.291    | 0.068   | 0.004      | 0.038     | 0.629    |
| M       | 24        | 0.007                                                                                                                                                                          | 0.305    | 0.131   | 0.011      | 0.041     | 0.631    |
| M       | 25        | 0.012                                                                                                                                                                          | 0.268    | 0.025   | 0.003      | 0.041     | 0.455    |
| M       | 26        | 0.014                                                                                                                                                                          | 0.306    | 0.046   | 0.003      | 0.027     | 0.631    |
| M       | 27        | 0.010                                                                                                                                                                          | 0.308    | 0.101   | 0.004      | 0.046     | 0.547    |
| M       | 28        | 0.006                                                                                                                                                                          | 0.316    | 0.136   | 0.007      | 0.046     | 0.607    |
| M       | 34        | 0.010                                                                                                                                                                          | 0.338    | 0.082   | 0.009      | 0.057     | 0.631    |
| M       | 35        | 0.011                                                                                                                                                                          | 0.304    | 0.030   | 0.001      | 0.018     | 0.586    |
| M       | 36        | 0.013                                                                                                                                                                          | 0.259    | 0.032   | 0.005      | 0.032     | 0.521    |
| M       | 37        | 0.007                                                                                                                                                                          | 0.320    | 0.148   | 0.002      | 0.053     | 0.593    |
| M       | 128       | 0.006                                                                                                                                                                          | 0.261    | 0.013   | 0.006      | 0.048     | 0.631    |
| M       | 130       | 0.013                                                                                                                                                                          | 0.202    | 0.017   | 0.003      | 0.033     | 0.558    |
| M       | 132       | 0.008                                                                                                                                                                          | 0.242    | 0.031   | 0.003      | 0.025     | 0.506    |
| M       | 134       | 0.012                                                                                                                                                                          | 0.354    | 0.057   | 0.003      | 0.030     | 0.598    |
| M       | 136       | 0.006                                                                                                                                                                          | 0.301    | 0.048   | 0.003      | 0.033     | 0.604    |
| M       | 138       | 0.008                                                                                                                                                                          | 0.307    | 0.088   | 0.004      | 0.036     | 0.537    |
| M       | 139       | 0.013                                                                                                                                                                          | 0.377    | 0.065   | 0.002      | 0.027     | 0.631    |
| M       | 140       | 0.011                                                                                                                                                                          | 0.342    | 0.040   | 0.002      | 0.047     | 0.576    |
| M       | 141       | 0.007                                                                                                                                                                          | 0.203    | 0.024   | 0.007      | 0.048     | 0.554    |
| M       | 146       | 0.015                                                                                                                                                                          | 0.236    | 0.058   | 0.003      | 0.024     | 0.542    |
| M       | 147       | 0.010                                                                                                                                                                          | 0.372    | 0.026   | 0.002      | 0.040     | 0.631    |
| M       | 148       | 0.010                                                                                                                                                                          | 0.271    | 0.022   | 0.005      | 0.036     | 0.631    |
| M       | 152       | 0.009                                                                                                                                                                          | 0.266    | 0.075   | 0.008      | 0.046     | 0.457    |
| M       | 153       | 0.017                                                                                                                                                                          | 0.261    | 0.051   | 0.002      | 0.036     | 0.546    |
| M       | 154       | 0.015                                                                                                                                                                          | 0.287    | 0.014   | 0.002      | 0.029     | 0.631    |
| M       | 155       | 0.011                                                                                                                                                                          | 0.308    | 0.040   | 0.001      | 0.050     | 0.519    |
| M       | 156       | 0.005                                                                                                                                                                          | 0.317    | 0.088   | 0.005      | 0.056     | 0.469    |
| M       | 162       | 0.019                                                                                                                                                                          | 0.224    | 0.068   | 0.005      | 0.044     | 0.483    |
| M       | 163       | 0.015                                                                                                                                                                          | 0.275    | 0.025   | 0.002      | 0.022     | 0.631    |
| M       | 164       | 0.017                                                                                                                                                                          | 0.346    | 0.036   | 0.002      | 0.050     | 0.631    |
| M       | 165       | 0.005                                                                                                                                                                          | 0.307    | 0.077   | 0.003      | 0.050     | 0.480    |

The test results in the table below shows that the all measured 4cm<sup>2</sup> PD values are less than PD\_design\_target of 0.631 mW/cm<sup>2</sup>, thus, the non-selected surfaces have no influence on the determined  $\Delta_{min}$  and input.power.limit in Section 7.

**Table 16**  
**4cm<sup>2</sup> PD of the selected beams measured on the corresponding surfaces**  
**that are not selected for  $\Delta_{min}$  determination**

| Band | Antenna | Beam ID | Surface | Tested Power Level (dBm) | input.power.limit (dBm) | Meas. 4cm <sup>2</sup> PD (mW/cm <sup>2</sup> ) |
|------|---------|---------|---------|--------------------------|-------------------------|-------------------------------------------------|
| n258 | M       | 13      | Front   | 7.8                      | 7.0                     | 0.015                                           |
|      |         | 152     | Top     | 3.4                      | 2.6                     | 0.057                                           |
| n261 | M       | 13      | Front   | 8.9                      | 8.0                     | 0.015                                           |
|      |         | 152     | Top     | 2.6                      | 1.7                     | 0.084                                           |
| n260 | M       | 34      | Front   | 6.4                      | 5.6                     | 0.034                                           |
|      |         | 37      | Top     | 5.9                      | 5.0                     | 0.145                                           |

## 7 PD Char

### 7.1 Single Beams

To determine the input power limit at each antenna port, simulation was performed at low, mid, and high channel for each mmW band supported, with 6 dBm input power per active port for n258 band, 6 dBm input power per active port for n261 band, and 6 dBm input power per active port for n260 band:

1. Obtained PDsurface value (the worst PD among all identified surfaces of the DUT) at all three channels for all single beams specified in the codebook.
2. Derived a scaling factor at low, mid and high channel,  $s(i)_{low\_or\_mid\_or\_high}$ , by:

$$s(i)_{low\_or\_mid\_or\_high} = \frac{PD\ design\ target}{sim.PD_{surface}(i)}, \quad i \in single\ beams \quad (1)$$

3. Determined the worst-case scaling factor,  $s(i)$ , among low, mid and high channels:

$$s(i) = \min\{s_{low}(i), s_{mid}(i), s_{high}(i)\}, \quad i \in single\ beams \quad (2)$$

and this scaling factor applies to the input power at each antenna port.

For 2<sup>nd</sup> generation of Smart Transmit, "Qualcomm MG Script" prints the  $sim.power_{limit}$  for all three channels, denoted as  $sim.power_{limit\_L}$ ,  $sim.power_{limit\_M}$ , and  $sim.power_{limit\_H}$ . The  $sim.power_{limit}$  is determined by:

$$sim.power_{limit} = \min\{sim.power_{limit\_L}, sim.power_{limit\_M}, sim.power_{limit\_H}\}$$

## 7.2 Beam Pairs

Per the manufacturer, the relative phase between beam pair is not controlled in the chipset design and could vary from run to run. Therefore, for each beam pair, based on the simulation results, the worst-case scaling factor was determined mathematically to ensure the compliance. The worst-case PD for MIMO operations was found by sweeping the relative phase for all possible angles to ensure a conservative assessment. The power density simulation report contains the worst-case power density for each surface after sweeping through all relative phases between beams.

Once the power density was determined for the worst-case  $\emptyset$ , the scaling factor was obtained by the below equation for low, mid and high channels:

$$s(i)_{low\_or\_mid\_or\_high} = \frac{PD\ design\ target}{total\ PD\ (\emptyset(i)_{worstcase})}, i \in beam\ pairs \quad (3)$$

The *total PD* ( $\emptyset_{worstcase}$ ) varies with channel and beam pair, the lowest scaling factor among all three channels,  $s(i)$ , is determined for the beam pair  $i$ :

$$s(i) = \min\{s_{low}(i), s_{mid}(i), s_{high}(i)\}, i \in beam\ pairs \quad (4)$$

For 2<sup>nd</sup> generation of Smart Transmit, "Qualcomm MG Script" prints the `sim.power_limit` for all three channels, denoted as `sim.power_limit_L`, `sim.power_limit_M`, and `sim.power_limit_H`. The `sim.power_limit` is determined by:

$$sim.\ power\_limit = \min\{sim.\ power\_limit\_L, sim.\ power\_limit\_M, sim.\ power\_limit\_H\}$$

### 7.3 Input.Power.Limit Calculations

The PD Char specifies the limit of input power at antenna port that corresponds to PD\_design\_target for all the beams.

Ideally, if there is no uncertainty associated with hardware design, the input power limit, denoted as *input.power.limit(i)*, for beam *i* can be obtained after accounting for the housing influence ( $\Delta_{min}$ ), given by:

- For n258, n261, and n260

$$input.power.limit(i) = sim.power_{limit} + 10 * \log(s(i)) + \Delta_{min}, i \in all\ beams \quad (5)$$

where 6 dBm is the input power used in simulation for n258, n261 and n260, respectively;  $s(i)$  is the scaling factor obtained from Eq. (2) or Eq. (4) for beam *i*;  $\Delta_{min}$  is the worst-case housing influence factor for beam *i*.

If simulation overestimates the housing influence, then  $\Delta_{min}$  (= simulated PD – measured PD) is negative, which means that the measured PD would be higher than the simulated PD. The input power to antenna elements determined via simulation must be decreased for compliance.

Similarly, if simulation underestimates the loss, then  $\Delta_{min}$  is positive (measured PD would be lower than the simulated value). Input power to antenna elements determined via simulation can be increased and still be PD compliant.

In reality the hardware design has uncertainty which must be properly considered. The device design related uncertainty is embedded in the process of  $\Delta_{min}$  determination. Since the device uncertainty is already accounted for in PD\_design\_target, it needs to be removed to avoid double counting this uncertainty.

Thus, Equation 5 is modified to:

**If** -TxAGC uncertainty <  $\Delta_{min}$  < TxAGC uncertainty,

$$input.power.limit(i) = sim.power_{limit}(i), i \in all\ beams, \text{ for n258, n261, and n260} \quad (6)$$

**else if**  $\Delta_{min}$  < -TxAGC uncertainty,

$$input.power.limit(i) = sim.power_{limit}(i) + (\Delta_{min} + TxAGC\ uncertainty), \\ i \in all\ beams, \text{ for n258, n261, and n260} \quad (7)$$

**else if**  $\Delta_{min}$  > TxAGC uncertainty,

$$input.power.limit(i) = sim.power_{limit}(i) + (\Delta_{min} - TxAGC\ uncertainty), \\ i \in all\ beams, \text{ for n258, n261, and n260} \quad (8)$$

Following above logic, the `input.power.limit` for this DUT can be calculated using Equations (6), (7), and (8), i.e.,

**Table 17**  
***input.power.limit* Calculation**

| Band | Antenna | $\Delta_{min}$ | TxAGC<br>Uncertainty | <i>input.power.limit</i>                         | Notes      |
|------|---------|----------------|----------------------|--------------------------------------------------|------------|
|      |         | (dB)           | (dB)                 | (dBm)                                            |            |
| n258 | M       | 1.86           | 0.63                 | $input.power.limit(i) = sim.power\_limit + 1.23$ | Using Eq.8 |
|      | N       | 1.33           | 0.63                 | $input.power.limit(i) = sim.power\_limit + 0.7$  | Using Eq.8 |
| n261 | M       | 1.85           | 0.63                 | $input.power.limit(i) = sim.power\_limit + 1.22$ | Using Eq.8 |
|      | N       | 0.40           | 0.63                 | $input.power.limit(i) = sim.power\_limit$        | Using Eq.6 |
| n260 | M       | 1.33           | 0.63                 | $input.power.limit(i) = sim.power\_limit + 0.7$  | Using Eq.8 |
|      | N       | 0.59           | 0.63                 | $input.power.limit(i) = sim.power\_limit$        | Using Eq.6 |

**Table 18**  
***Permanent backoff applied to calculated input.power.limit***

| Band | Antenna | backoff (dB) |
|------|---------|--------------|
| n258 | M       | 0.8          |
| n258 | N       | 0.5          |
| n261 | M       | 0.8          |
| n261 | N       | 0.5          |
| n260 | M       | 0.8          |
| n260 | N       | 0.5          |

Note: The above backoff values have been permanently applied to the `input.power.limits` calculated from the equations above. The final `input.power.limits` implemented in the EFS are in the tables below.

**Table 19**  
***Permanent backoff applied to specific beams***

| Band | Antenna | Beam ID | backoff (dB) |
|------|---------|---------|--------------|
| n258 | N       | 33      | 0.3          |

Note: The above backoff values have been permanently applied to the `input.power.limits` calculated from the equations above. The final `input.power.limits` implemented in the EFS are in the tables below.

**Table 20**  
**5G NR n258 M Patch *input.power.limit***

| Band | Beam ID 1 | Beam ID 2 | input.power.limit |
|------|-----------|-----------|-------------------|
| n258 | 0         | -         | 10.3              |
| n258 | 2         | -         | 9.2               |
| n258 | 4         | -         | 9.7               |
| n258 | 6         | -         | 10.0              |
| n258 | 8         | -         | 9.4               |
| n258 | 10        | -         | 7.0               |
| n258 | 11        | -         | 5.5               |
| n258 | 12        | -         | 7.0               |
| n258 | 13        | -         | 7.0               |
| n258 | 18        | -         | 6.6               |
| n258 | 19        | -         | 6.6               |
| n258 | 20        | -         | 8.0               |
| n258 | 24        | -         | 2.2               |
| n258 | 25        | -         | 2.7               |
| n258 | 26        | -         | 2.4               |
| n258 | 27        | -         | 2.9               |
| n258 | 28        | -         | 2.7               |
| n258 | 34        | -         | 2.1               |
| n258 | 35        | -         | 2.4               |
| n258 | 36        | -         | 2.7               |
| n258 | 37        | -         | 3.0               |
| n258 | -         | 128       | 8.7               |
| n258 | -         | 130       | 9.3               |
| n258 | -         | 132       | 9.0               |
| n258 | -         | 134       | 9.4               |
| n258 | -         | 136       | 9.5               |
| n258 | -         | 138       | 7.0               |
| n258 | -         | 139       | 6.1               |
| n258 | -         | 140       | 5.6               |
| n258 | -         | 141       | 5.9               |
| n258 | -         | 146       | 6.2               |
| n258 | -         | 147       | 6.2               |
| n258 | -         | 148       | 5.2               |
| n258 | -         | 152       | 2.6               |
| n258 | -         | 153       | 3.0               |
| n258 | -         | 154       | 2.6               |
| n258 | -         | 155       | 1.9               |
| n258 | -         | 156       | 1.0               |
| n258 | -         | 162       | 2.9               |
| n258 | -         | 163       | 2.9               |
| n258 | -         | 164       | 2.6               |
| n258 | -         | 165       | 1.4               |
| n258 | 0         | 128       | 5.7               |
| n258 | 2         | 130       | 6.1               |
| n258 | 4         | 132       | 6.2               |
| n258 | 6         | 134       | 6.3               |
| n258 | 8         | 136       | 6.1               |
| n258 | 10        | 138       | 3.6               |
| n258 | 11        | 139       | 2.8               |
| n258 | 12        | 140       | 3.3               |
| n258 | 13        | 141       | 3.0               |
| n258 | 18        | 146       | 3.3               |
| n258 | 19        | 147       | 3.0               |
| n258 | 20        | 148       | 4.0               |
| n258 | 24        | 152       | -1.1              |
| n258 | 25        | 153       | -0.6              |
| n258 | 26        | 154       | -0.7              |
| n258 | 27        | 155       | -1.0              |
| n258 | 28        | 156       | -1.9              |
| n258 | 34        | 162       | -1.0              |
| n258 | 35        | 163       | -0.8              |
| n258 | 36        | 164       | -0.7              |
| n258 | 37        | 165       | -1.4              |

**Table 21**

**5G mmWave NR n258 N Patch *input.power.limit***

| Band | Beam ID 1 | Beam ID 2 | input.power.limit |
|------|-----------|-----------|-------------------|
| n258 | 1         | -         | 10.0              |
| n258 | 3         | -         | 11.9              |
| n258 | 5         | -         | 11.9              |
| n258 | 7         | -         | 11.6              |
| n258 | 9         | -         | 11.4              |
| n258 | 14        | -         | 7.6               |
| n258 | 15        | -         | 7.1               |
| n258 | 16        | -         | 7.5               |
| n258 | 17        | -         | 8.0               |
| n258 | 21        | -         | 7.8               |
| n258 | 22        | -         | 7.5               |
| n258 | 23        | -         | 7.5               |
| n258 | 29        | -         | 4.3               |
| n258 | 30        | -         | 4.2               |
| n258 | 31        | -         | 4.3               |
| n258 | 32        | -         | 3.0               |
| n258 | 33        | -         | 3.6               |
| n258 | 38        | -         | 4.0               |
| n258 | 39        | -         | 3.8               |
| n258 | 40        | -         | 3.4               |
| n258 | 41        | -         | 3.6               |
| n258 | -         | 129       | 10.0              |
| n258 | -         | 131       | 10.4              |
| n258 | -         | 133       | 10.5              |
| n258 | -         | 135       | 10.3              |
| n258 | -         | 137       | 11.8              |
| n258 | -         | 142       | 7.8               |
| n258 | -         | 143       | 6.6               |
| n258 | -         | 144       | 7.1               |
| n258 | -         | 145       | 9.1               |
| n258 | -         | 149       | 7.3               |
| n258 | -         | 150       | 6.4               |
| n258 | -         | 151       | 8.6               |
| n258 | -         | 157       | 3.6               |
| n258 | -         | 158       | 2.8               |
| n258 | -         | 159       | 2.5               |
| n258 | -         | 160       | 3.1               |
| n258 | -         | 161       | 3.3               |
| n258 | -         | 166       | 2.8               |
| n258 | -         | 167       | 2.6               |
| n258 | -         | 168       | 2.9               |
| n258 | -         | 169       | 2.9               |
| n258 | 1         | 129       | 6.5               |
| n258 | 3         | 131       | 7.5               |
| n258 | 5         | 133       | 7.2               |
| n258 | 7         | 135       | 7.3               |
| n258 | 9         | 137       | 7.9               |
| n258 | 14        | 142       | 4.1               |
| n258 | 15        | 143       | 4.0               |
| n258 | 16        | 144       | 4.2               |
| n258 | 17        | 145       | 6.0               |
| n258 | 21        | 149       | 4.0               |
| n258 | 22        | 150       | 3.4               |
| n258 | 23        | 151       | 4.4               |
| n258 | 29        | 157       | -0.3              |
| n258 | 30        | 158       | -0.8              |
| n258 | 31        | 159       | -0.3              |
| n258 | 32        | 160       | -0.4              |
| n258 | 33        | 161       | -0.2              |
| n258 | 38        | 166       | -0.5              |
| n258 | 39        | 167       | -0.7              |
| n258 | 40        | 168       | -0.3              |
| n258 | 41        | 169       | -0.4              |

**Table 22**

**5G mmWave NR n261 M Patch *input.power.limit***

| Band | Beam ID 1 | Beam ID 2 | input.power.limit |
|------|-----------|-----------|-------------------|
| n261 | 0         | -         | 10.3              |
| n261 | 2         | -         | 10.9              |
| n261 | 4         | -         | 10.0              |
| n261 | 6         | -         | 9.9               |
| n261 | 8         | -         | 10.1              |
| n261 | 10        | -         | 8.8               |
| n261 | 11        | -         | 7.5               |
| n261 | 12        | -         | 7.2               |
| n261 | 13        | -         | 8.0               |
| n261 | 18        | -         | 7.6               |
| n261 | 19        | -         | 7.3               |
| n261 | 20        | -         | 7.3               |
| n261 | 24        | -         | 4.6               |
| n261 | 25        | -         | 3.1               |
| n261 | 26        | -         | 3.0               |
| n261 | 27        | -         | 2.4               |
| n261 | 28        | -         | 4.0               |
| n261 | 34        | -         | 3.7               |
| n261 | 35        | -         | 2.7               |
| n261 | 36        | -         | 2.7               |
| n261 | 37        | -         | 2.9               |
| n261 | -         | 128       | 8.6               |
| n261 | -         | 130       | 8.5               |
| n261 | -         | 132       | 8.5               |
| n261 | -         | 134       | 8.6               |
| n261 | -         | 136       | 8.9               |
| n261 | -         | 138       | 6.4               |
| n261 | -         | 139       | 5.5               |
| n261 | -         | 140       | 5.0               |
| n261 | -         | 141       | 5.3               |
| n261 | -         | 146       | 5.6               |
| n261 | -         | 147       | 5.1               |
| n261 | -         | 148       | 5.0               |
| n261 | -         | 152       | 1.7               |
| n261 | -         | 153       | 1.5               |
| n261 | -         | 154       | 1.8               |
| n261 | -         | 155       | 1.5               |
| n261 | -         | 156       | 1.0               |
| n261 | -         | 162       | 1.2               |
| n261 | -         | 163       | 1.8               |
| n261 | -         | 164       | 1.9               |
| n261 | -         | 165       | 1.4               |
| n261 | 0         | 128       | 5.8               |
| n261 | 2         | 130       | 6.2               |
| n261 | 4         | 132       | 6.1               |
| n261 | 6         | 134       | 5.8               |
| n261 | 8         | 136       | 6.0               |
| n261 | 10        | 138       | 3.9               |
| n261 | 11        | 139       | 3.2               |
| n261 | 12        | 140       | 2.4               |
| n261 | 13        | 141       | 2.7               |
| n261 | 18        | 146       | 3.2               |
| n261 | 19        | 147       | 2.9               |
| n261 | 20        | 148       | 2.3               |
| n261 | 24        | 152       | -1.0              |
| n261 | 25        | 153       | -1.0              |
| n261 | 26        | 154       | -0.8              |
| n261 | 27        | 155       | -1.2              |
| n261 | 28        | 156       | -1.4              |
| n261 | 34        | 162       | -1.1              |
| n261 | 35        | 163       | -1.0              |
| n261 | 36        | 164       | -0.8              |
| n261 | 37        | 165       | -1.3              |

**Table 23**

**5G mmWave NR n261 N Patch *input.power.limit***

| Band | Beam ID 1 | Beam ID 2 | input.power.limit |
|------|-----------|-----------|-------------------|
| n261 | 1         | -         | 9.1               |
| n261 | 3         | -         | 8.9               |
| n261 | 5         | -         | 9.0               |
| n261 | 7         | -         | 8.9               |
| n261 | 9         | -         | 9.7               |
| n261 | 14        | -         | 7.8               |
| n261 | 15        | -         | 5.9               |
| n261 | 16        | -         | 5.7               |
| n261 | 17        | -         | 6.5               |
| n261 | 21        | -         | 7.0               |
| n261 | 22        | -         | 5.2               |
| n261 | 23        | -         | 5.7               |
| n261 | 29        | -         | 2.7               |
| n261 | 30        | -         | 2.0               |
| n261 | 31        | -         | 1.4               |
| n261 | 32        | -         | 1.7               |
| n261 | 33        | -         | 2.9               |
| n261 | 38        | -         | 2.5               |
| n261 | 39        | -         | 1.7               |
| n261 | 40        | -         | 1.6               |
| n261 | 41        | -         | 2.0               |
| n261 | -         | 129       | 9.2               |
| n261 | -         | 131       | 9.2               |
| n261 | -         | 133       | 9.8               |
| n261 | -         | 135       | 9.2               |
| n261 | -         | 137       | 8.8               |
| n261 | -         | 142       | 6.6               |
| n261 | -         | 143       | 6.6               |
| n261 | -         | 144       | 5.7               |
| n261 | -         | 145       | 6.0               |
| n261 | -         | 149       | 7.0               |
| n261 | -         | 150       | 6.0               |
| n261 | -         | 151       | 5.7               |
| n261 | -         | 157       | 4.3               |
| n261 | -         | 158       | 2.1               |
| n261 | -         | 159       | 2.2               |
| n261 | -         | 160       | 2.0               |
| n261 | -         | 161       | 2.9               |
| n261 | -         | 166       | 3.3               |
| n261 | -         | 167       | 2.0               |
| n261 | -         | 168       | 2.1               |
| n261 | -         | 169       | 2.3               |
| n261 | 1         | 129       | 5.7               |
| n261 | 3         | 131       | 5.5               |
| n261 | 5         | 133       | 5.9               |
| n261 | 7         | 135       | 5.8               |
| n261 | 9         | 137       | 5.8               |
| n261 | 14        | 142       | 3.7               |
| n261 | 15        | 143       | 2.4               |
| n261 | 16        | 144       | 2.2               |
| n261 | 17        | 145       | 2.9               |
| n261 | 21        | 149       | 4.2               |
| n261 | 22        | 150       | 2.5               |
| n261 | 23        | 151       | 2.4               |
| n261 | 29        | 157       | -0.7              |
| n261 | 30        | 158       | -1.3              |
| n261 | 31        | 159       | -1.7              |
| n261 | 32        | 160       | -1.7              |
| n261 | 33        | 161       | -0.7              |
| n261 | 38        | 166       | -0.7              |
| n261 | 39        | 167       | -1.8              |
| n261 | 40        | 168       | -1.6              |
| n261 | 41        | 169       | -1.1              |

**Table 24**

**5G mmWave NR n260 M Patch *input.power.limit***

| Band | Beam ID 1 | Beam ID 2 | input.power.limit |
|------|-----------|-----------|-------------------|
| n260 | 0         | -         | 10.5              |
| n260 | 2         | -         | 11.9              |
| n260 | 4         | -         | 11.5              |
| n260 | 6         | -         | 11.7              |
| n260 | 8         | -         | 11.1              |
| n260 | 10        | -         | 8.1               |
| n260 | 11        | -         | 9.1               |
| n260 | 12        | -         | 8.9               |
| n260 | 13        | -         | 8.1               |
| n260 | 18        | -         | 8.1               |
| n260 | 19        | -         | 8.3               |
| n260 | 20        | -         | 8.9               |
| n260 | 24        | -         | 5.3               |
| n260 | 25        | -         | 4.8               |
| n260 | 26        | -         | 5.8               |
| n260 | 27        | -         | 5.6               |
| n260 | 28        | -         | 5.1               |
| n260 | 34        | -         | 5.6               |
| n260 | 35        | -         | 5.3               |
| n260 | 36        | -         | 5.7               |
| n260 | 37        | -         | 5.0               |
| n260 | -         | 128       | 10.9              |
| n260 | -         | 130       | 11.0              |
| n260 | -         | 132       | 10.3              |
| n260 | -         | 134       | 10.6              |
| n260 | -         | 136       | 10.6              |
| n260 | -         | 138       | 7.2               |
| n260 | -         | 139       | 8.1               |
| n260 | -         | 140       | 7.7               |
| n260 | -         | 141       | 8.2               |
| n260 | -         | 146       | 7.5               |
| n260 | -         | 147       | 8.0               |
| n260 | -         | 148       | 8.2               |
| n260 | -         | 152       | 4.1               |
| n260 | -         | 153       | 4.6               |
| n260 | -         | 154       | 3.8               |
| n260 | -         | 155       | 4.5               |
| n260 | -         | 156       | 4.0               |
| n260 | -         | 162       | 4.1               |
| n260 | -         | 163       | 4.2               |
| n260 | -         | 164       | 4.6               |
| n260 | -         | 165       | 4.0               |
| n260 | 0         | 128       | 6.8               |
| n260 | 2         | 130       | 7.6               |
| n260 | 4         | 132       | 7.4               |
| n260 | 6         | 134       | 7.3               |
| n260 | 8         | 136       | 6.8               |
| n260 | 10        | 138       | 5.8               |
| n260 | 11        | 139       | 5.4               |
| n260 | 12        | 140       | 3.9               |
| n260 | 13        | 141       | 4.2               |
| n260 | 18        | 146       | 4.2               |
| n260 | 19        | 147       | 4.4               |
| n260 | 20        | 148       | 5.9               |
| n260 | 24        | 152       | 0.8               |
| n260 | 25        | 153       | 1.1               |
| n260 | 26        | 154       | 0.1               |
| n260 | 27        | 155       | 0.6               |
| n260 | 28        | 156       | 0.4               |
| n260 | 34        | 162       | 0.9               |
| n260 | 35        | 163       | 0.9               |
| n260 | 36        | 164       | 0.8               |
| n260 | 37        | 165       | 0.3               |

Table 25

**5G mmWave NR n260 N Patch *input.power.limit***

| Band | Beam ID 1 | Beam ID 2 | input.power.limit |
|------|-----------|-----------|-------------------|
| n260 | 1         | -         | 9.2               |
| n260 | 3         | -         | 8.3               |
| n260 | 5         | -         | 8.6               |
| n260 | 7         | -         | 8.2               |
| n260 | 9         | -         | 8.5               |
| n260 | 14        | -         | 5.5               |
| n260 | 15        | -         | 6.1               |
| n260 | 16        | -         | 4.9               |
| n260 | 17        | -         | 5.8               |
| n260 | 21        | -         | 5.8               |
| n260 | 22        | -         | 5.8               |
| n260 | 23        | -         | 5.1               |
| n260 | 29        | -         | 1.6               |
| n260 | 30        | -         | 2.5               |
| n260 | 31        | -         | 2.4               |
| n260 | 32        | -         | 1.0               |
| n260 | 33        | -         | 2.4               |
| n260 | 38        | -         | 2.5               |
| n260 | 39        | -         | 2.2               |
| n260 | 40        | -         | 1.6               |
| n260 | 41        | -         | 2.0               |
| n260 | -         | 129       | 6.9               |
| n260 | -         | 131       | 8.2               |
| n260 | -         | 133       | 7.9               |
| n260 | -         | 135       | 7.6               |
| n260 | -         | 137       | 7.9               |
| n260 | -         | 142       | 4.8               |
| n260 | -         | 143       | 5.2               |
| n260 | -         | 144       | 4.9               |
| n260 | -         | 145       | 4.7               |
| n260 | -         | 149       | 4.3               |
| n260 | -         | 150       | 5.1               |
| n260 | -         | 151       | 4.8               |
| n260 | -         | 157       | 1.3               |
| n260 | -         | 158       | 1.2               |
| n260 | -         | 159       | 1.1               |
| n260 | -         | 160       | 1.4               |
| n260 | -         | 161       | 1.5               |
| n260 | -         | 166       | 1.2               |
| n260 | -         | 167       | 1.0               |
| n260 | -         | 168       | 2.0               |
| n260 | -         | 169       | 1.4               |
| n260 | 1         | 129       | 4.2               |
| n260 | 3         | 131       | 4.8               |
| n260 | 5         | 133       | 5.0               |
| n260 | 7         | 135       | 4.7               |
| n260 | 9         | 137       | 4.6               |
| n260 | 14        | 142       | 1.8               |
| n260 | 15        | 143       | 1.9               |
| n260 | 16        | 144       | 2.4               |
| n260 | 17        | 145       | 2.0               |
| n260 | 21        | 149       | 2.4               |
| n260 | 22        | 150       | 1.7               |
| n260 | 23        | 151       | 2.1               |
| n260 | 29        | 157       | -2.8              |
| n260 | 30        | 158       | -1.9              |
| n260 | 31        | 159       | -2.3              |
| n260 | 32        | 160       | -2.6              |
| n260 | 33        | 161       | -2.7              |
| n260 | 38        | 166       | -2.4              |
| n260 | 39        | 167       | -2.1              |
| n260 | 40        | 168       | -2.4              |
| n260 | 41        | 169       | -2.4              |