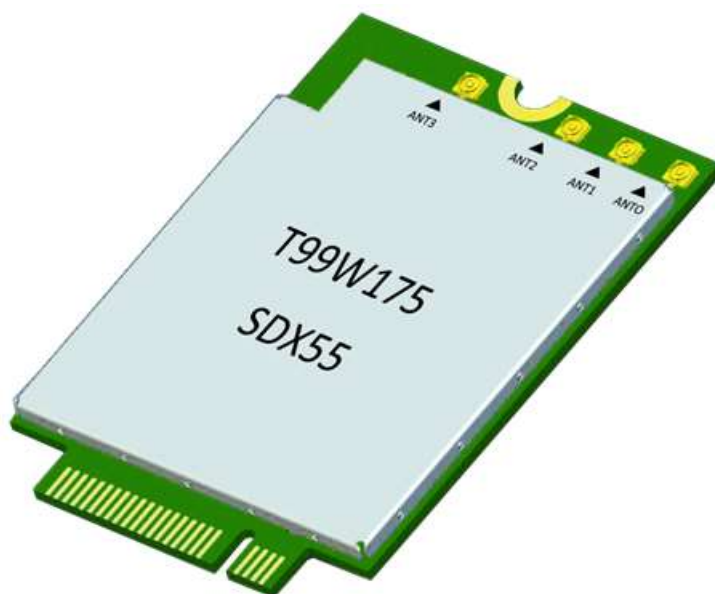


# 5GNR/ LTE-Advanced PCI Express M.2 Module (Sub 6G, LTE, UMTS)

## Engineering Requirements Specification



Project code: T99W175.0x

Solution: SDX55+SDR865+PMX55

SKU: WW-1-5G

| Foxconn PN | Customer PN |
|------------|-------------|
| T99W175.06 | K1YCW       |
| T99W175.08 | JP18Y       |
| T99W175.09 | FTY9X       |
| T99W175.30 | 1TFY5       |
| T99W175.31 | H75GC       |
| T99W175.32 | 01PCT       |



Reviewers

| Department        | Name          | Signature | Review Dates |            |
|-------------------|---------------|-----------|--------------|------------|
|                   |               |           | * Plan       | ** Results |
| Project Manager   | Ai-Ning Song  |           |              |            |
| Project Leader    | Michael. Xiao |           |              |            |
| Hardware Engineer | Lynn. Liu     |           |              |            |

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**Modification History**

| Rev  | Date       | Originator | Comment                                                                                                                                                                                                                                                                                                                       |
|------|------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R1.0 | 2019/5/9   | Lynn. Liu  | Initial release                                                                                                                                                                                                                                                                                                               |
| R1.1 | 2019/5/20  | Lynn. Liu  | Update base on the customer requirements                                                                                                                                                                                                                                                                                      |
| R1.2 | 2019/5/28  | Lynn. Liu  | Update item 2.4 for antenna requirements; item 1.4.2 for USIM2                                                                                                                                                                                                                                                                |
| R1.3 | 2019/5/30  | Lynn. Liu  | Update Pin38/60 description and item 1.5.12 for Coexistence                                                                                                                                                                                                                                                                   |
| R1.4 | 2019/7/9   | Lynn. Liu  | 1. Remove n25/38/40& B43 support due to Qualcomm update (item1.1); 2. Remove n71& GPS L5 due to not in POR and B48 as TBD; 3. Update mmWave IF connector pin definition (item 2.4.2); 4. Update ME drawing (item3.2                                                                                                           |
| R1.5 | 2019/7/25  | Lynn. Liu  | 1. Update PCIe connection guideline(item1.5.4); 2. Update ME drawing (item3.2); 3. Update antenna configuration (item 2.4.2); 4. Update LTE Rx sensitivity Spec; 5. Update W_Disable# (item1.5.5)                                                                                                                             |
| R1.6 | 2019/9/12  | Lynn. Liu  | 1. Update Pin29/31/35/37(USB3.0) to NC; 2. Need Platform side reserve USB2.0 for factory test (WinPE) (item1.4.2)                                                                                                                                                                                                             |
| R1.7 | 2019/10/08 | Lynn. Liu  | 1. Disable B48 for NA (item 1); 2. Update operating temperature (item 4.1); 3. Update antenna configuration (item 2.4.2 Figure2-2); 4. Update golden plating drawing; 5. Pin29/31/35/37 as NC and reserve with PCIe Lane 2                                                                                                    |
| R1.8 | 2020/2/24  | Lynn. Liu  | 1. Remove mmW for Sub6G only SKU; 2. Enable B48 for US& EU 3. Remove Reset (Pin67) requirement; 4. Update antenna configure (Item 2.4.2 Figure2-2); 5. Update HW feature (Item 2); 6. Update initial power consumption Spec (Item 4.2); 7. Update RF performance Spec (Item 5.1& 5.2) & support bandwidth; 8. Add DPS feature |
| R1.9 | 2020/3/27  | Lynn. Liu  | 1. Add PN for Olympic MLK& Andrews; 2. Disable B40 to meet FCC requirement; 3. Update Power on/off sequence requirement (Item 1.5.13); 4. Reserve 0.1uF on Pin6(Full card power off) & Pin50 (PERST#) Item 1.5.3& 1.5.4; 5. Add n71 for new Platform POR                                                                      |
|      |            |            |                                                                                                                                                                                                                                                                                                                               |
|      |            |            |                                                                                                                                                                                                                                                                                                                               |
|      |            |            |                                                                                                                                                                                                                                                                                                                               |
|      |            |            |                                                                                                                                                                                                                                                                                                                               |

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## 1. General Description

T99W175 is designed to enable wireless data connectivity for notebook computer or any other device compatible with the PCI Express M.2 Specification 3042 type Key B slot.

T99W175 is the data card solution that delivers wireless wide-area network (WWAN) connectivity for the 5G NR (Sub 6G), LTE, UMTS (HSDPA/HSUPA/HSPA+DC-HSPA+) and GPS/Glonass/ Beidou/ Galileo protocols in one hardware configuration.

| SKU             |               | WW-1-5G / T99W175                                                                                                                                          |
|-----------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Carrier Support |               | NA: AT&T, Verizon, Sprint<br>WW: Vodafone, Telefonica-O2<br>APAC: Telstra, Docomo, KDDI, Softbank<br>* Carrier engagement based on real business agreement |
| QCT Solution    |               | SDX55+SDR865+SMR526+PMX55                                                                                                                                  |
| 5G              | FR1 (Sub 6G)  | LB: n5/8/12/20/25/28/71; MB: n1/2/3/66;<br>HB: n7/38/41/77/78/79                                                                                           |
|                 | FR2 (mmWave)  | NA                                                                                                                                                         |
|                 | 4x4 MIMO      | n1/2/3/66/7/38/41/77/78/79                                                                                                                                 |
|                 | UE Capability | UL (TBD); DL(TBD)                                                                                                                                          |
| 4G              | Support Band  | LB: B26(5/18/19)/8/12(17)/13/14/20/28/29/71<br>MB: B1/2(25)/3/4(66)/32<br>HB: B7/30/34/38/39/40(Disable for FCC)/41/42/48                                  |
|                 | 4x4 MIMO      | B1/25(2)/3/66(4)/7/30/40/41(38)/42/48                                                                                                                      |
|                 | LAA           | B46 (DL only)                                                                                                                                              |
|                 | LTE Cat.      | ue-CategoryUL 13 (UL: 150Mbps) + ue-CategoryDL 20 (DL: 2Gbps);<br>7xDL CA, 2xUL CA (Intra-band), 5xDL CA+4X4 MIMO (Up to Cat20)                            |
| 3G              | WCDMA         | HSPA+ Rel8 (DL/UL: up to 42/11 Mbps)                                                                                                                       |
|                 | Support Band  | B1/2/4/5(6/19)/8/9                                                                                                                                         |
| GNSS            |               | Dual-Frequency GNSS: L1 GPS/Glonass/Beidou/Galileo,                                                                                                        |
| USIM            |               | Dual SIM interface, Dual SIM Single Active (DSSA)                                                                                                          |
| eSIM            |               | eSIM Dual SIM with eSIM on board (eSIM is option), Dual SIM Single Active (DSSA)                                                                           |
| Interface       |               | PCIe3.0; Reserve USB2.0 for factory test (WinPE)                                                                                                           |
| Form factor     |               | 3042 PCIe M.2 Key.B                                                                                                                                        |

## 1.1 System Main Feature

| Feature          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physical         | PCI express M.2 module, size 3042, Key.B, 75Pin golden finger                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Electrical       | Single VCC supply (3.135V~3.63V)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Dimension        | Dimensions (L × W × H): 42 mm × 30 mm × 2.5 mm, maximum height=2.6mm (add PCB tolerance=0.1mm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Shielding design | Shield case on board design, no additional shielding requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Weight           | Approximately ~8g                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| USIM             | Off-board USIM connector supported on Host through USIM1/USIM2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Operating Bands  | <p>WCDMA/HSDPA/HSUPA/HSPA+ operating bands:</p> <p>Band 1: 1920 to 1980 MHz (UL), 2110 to 2170 MHz (DL)</p> <p>Band 2: 1850 to 1910 MHz (UL), 1930 to 1990 MHz (DL)</p> <p>Band 4: 1710 to 1755 MHz (UL), 2110 to 2155 MHz (DL)</p> <p>Band 5: 824 to 849 MHz (UL), 869 to 894 MHz (DL)</p> <p>Band 6: 830 to 840 MHz (UL), 875 to 885 MHz (DL)</p> <p>Band 8: 880 to 915 MHz (UL), 925 to 960 MHz (DL)</p> <p>Band 9: 1750 to 1785 MHz (UL), 1845 to 1880 MHz (DL)</p> <p>Band 19: 830 to 845 MHz (UL), 875 to 890 MHz (DL)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                  | <p>LTE FDD/TDD operating bands:</p> <p>Band 1: 1920 to 1980 MHz (UL), 2110 to 2170 MHz (DL)</p> <p>Band 2: 1850 to 1910 MHz (UL), 1930 to 1990 MHz (DL)</p> <p>Band 3: 1710 to 1785 MHz (UL), 1805 to 1880 MHz (DL)</p> <p>Band 4: 1710 to 1755 MHz (UL), 2110 to 2155 MHz (DL)</p> <p>Band 5: 824 to 849 MHz (UL), 869 to 894 MHz (DL)</p> <p>Band 7: 2500 to 2570 MHz (UL), 2620 to 2690 MHz (DL)</p> <p>Band 8: 880 to 915 MHz (UL), 925 to 960 MHz (DL)</p> <p>Band 12: 699 to 716 MHz (UL), 729 to 746 MHz (DL)</p> <p>Band 13: 777 to 787 MHz (UL), 746 to 756 MHz (DL)</p> <p>Band 14: 788 to 798 MHz (UL), 758 to 768 MHz (DL)</p> <p>Band 17: 704 to 716 MHz (UL), 734 to 746 MHz (DL)</p> <p>Band 18: 815 to 830 MHz (UL), 860 to 875 MHz (DL)</p> <p>Band 19: 830 to 845 MHz (UL), 875 to 890 MHz (DL)</p> <p>Band 20: 832 to 862 MHz (UL), 791 to 821 MHz (DL)</p> <p>Band 25: 1850 to 1915 MHz (UL), 1930 to 1995 MHz (DL)</p> <p>Band 26: 814 to 849 MHz (UL), 859 to 894 MHz (DL)</p> <p>Band 28: 703 to 748 MHz (UL), 758 to 803 MHz (DL)</p> <p>Band 29: 717 to 728 MHz (DL)</p> <p>Band 30: 2305 to 2315 MHz (UL) 2350 to 2360 MHz (DL)</p> <p>Band 32: 1452 to 1496 MHz (DL)</p> <p>Band 34: 2010 to 2025 MHz (UL/DL)</p> <p>Band 38: 2570 to 2620 MHz (UL/DL)</p> <p>Band 39: 1880 to 1920 MHz (UL/DL)</p> <p>Band 40: 2300 to 2400 MHz (UL/DL)</p> <p>Band 41: 2496 to 2690 MHz (UL/DL)</p> <p>Band 66: 1710 to 1800 MHz (UL), 2110 to 2200 MHz (DL)</p> <p>Band 71: 663 to 698 MHz (UL), 617 to 652 MHz (DL)</p> |

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Operating Bands    | LTE 3.5G<br>Band 42: 3400 to 3600 MHz (UL/DL)<br>Band 48: 3550 to 3700 MHz (UL/DL)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                    | LAA<br>Band 46: 5150 to 5925 MHz (DL)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                    | 5G NR Sub 6GHz<br>n1: 1920 to 1980 MHz (UL), 2110 to 2170 MHz (DL)<br>n2: 1850 to 1910 MHz (UL), 1930 to 1990 MHz (DL)<br>n3: 1710 to 1785 MHz (UL), 1805 to 1880 MHz (DL)<br>n5: 824 to 849 MHz (UL), 869 to 894 MHz (DL)<br>n7: 2500 to 2570 MHz (UL), 2620 to 2690 MHz (DL)<br>n8: 880 to 915 MHz (UL), 925 to 960 MHz (DL)<br>n12: 699 to 716 MHz (UL), 729 to 746 MHz (DL)<br>n20: 832 to 862 MHz (UL), 791 to 821 MHz (DL)<br>n25: 1850 to 1915 MHz (UL), 1930 to 1995 MHz (DL)<br>n28: 703 to 748 MHz (UL), 758 to 803 MHz (DL)<br>n38: 2570 to 2620 MHz (UL/DL)<br>n41: 2496 to 2690 MHz (UL/DL)<br>n66: 1710 to 1800 MHz (UL), 2110 to 2200 MHz (DL)<br>n71: 663 to 698 MHz (UL), 617 to 652 MHz (DL)<br>n77: 3300 to 4200 MHz (UL/DL)<br>n78: 3300 to 3800 MHz (UL/DL)<br>n79: 4400 to 5000 MHz (UL/DL) |
|                    | 5G NR mmWave<br>NA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Diversity/2nd Rx   | All UMTS operating bands<br>All LTE operating bands                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 4x4 MIMO Rx        | LTE-B1/25(2)/3/66(4)/7/30/40/41(38)/42/48<br>5G NR-n1/2/3/66/7/41/77/78/79                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| GNSS               | GPS: L1 (1575.42MHz);<br>GLONASS: L1 (1602MHz)<br>BeidouB1(1561.098MHz)<br>Galileo E1 (1575.42);                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| USIM Voltage       | Support 1.8V and 2.85V, and auto detects follow SIM card type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Antenna connectors | ANT0: Support all 5G NR Sub 6G& LTE& UMTS bands<br>ANT1: Support 5G NR Sub 6G& LTE M/H/UHB& UMTS bands<br>ANT2: Support 5G NR Sub 6G& LTE M/H/UHB& UMTS bands<br>ANT3: Support all 5G NR Sub 6G& LTE& UMTS bands and GPS L1 simultaneously<br>ANT4/5/6: NA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

|            |                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Throughput | WCDMA CS: DL 64 kbps /UL 64 kbps<br>WCDMA PS: DL 384 kbps /UL 384 kbps<br>HSPA+:DL 21.6 Mbps /UL 5.76 Mbps<br>DC-HSPA+: DL 42 Mbps/UL 5.76 Mbps<br>LTE Cat20: DL:2Gbps/UL 150 Mbps<br>5G NR Sub 6G: DL: TBD/UL (TBD)<br>5G NR mmWave: NA |
| ENDC DPS   | Support NSA mode ENDC Dynamic Power Sharing feature                                                                                                                                                                                      |

#### 5G NR Air Interface

- 3GPP Rel15 5G NR Sub-6  
Sub-6G
- Modulation UL: 256 QAM; DL: 256 QAM
- Waveform UL: CP-OFDM and DFT-S-OFDM; DL: CP-OFDM
- Sub-Carrier Spacing (SCS): 15 KHz, 30 KHz
- Duplex mode: FDD and TDD
- Operation mode: Standalone mode (SA) and Non-Standalone mode (NSA)
- CA capability: DLCA
- MIMO DL: 4 × 4 MIMO;
- EN-DC: LTE and NR sub-6 GHz dual connectivity

#### LTE Air Interface

##### LTE Rel15

- 20 layers and 2 Gbps downlink (DL) throughput – 4 × 4 MIMO across 5x CA
- 150 Mbps uplink (UL) throughput – 40 MHz ULCA and 256 QAM
- LAA (Licensed assist access) across 80 MHz
- CA capability:
  - DLCA
    - Inter-band DLCA
    - Intra band contiguous CA
    - Intra band non contiguous
  - ULCA
    - Inter band ULCA (Depend on Customer requirements)
    - Intra band contiguous CA
- Modulation UL: 256 QAM; DL: 256 QAM
- 4 × 2 MIMO 7x CA (R15)
- 4 × 4 MIMO 5x CA (R15)
- FDD + TDD CA

#### WCDMA/HSPA Air Interface

- R99:  
All modes and data rates for WCDMA FDD
- R5 HSDPA  
PS data speeds up to 7.2 Mbps on the downlink
- R6 HSUPA  
E-DCH data rates of up to 5.76 Mbps for 2 ms TTI (UE category 6) uplink
- R7 HSPA+  
Downlink 64 QAM SISO: up to 21 Mbps  
Downlink 16 QAM 2X2 MIMO: up to 28 Mbps
- R8 DC-HSPA+  
Downlink dual carrier with 64 QAM (SISO); up to 42 Mbps

#### GNSS

- GPS, GLONASS, Galileo, and BeiDou support
- Two GNSS paths to support simultaneous L1
- Customizable tracking session
  - Automatic tracking session on startup
  - Concurrent standalone GPS, GLONASS, BeiDou and Galileo
  - gpsOneXTRA with GPS + GLONASS + BeiDou+ Galileo support

## 1.2 EUTRA -NR- Dual Connectivity & Carrier Aggregation Combination

TBD

For US SKU Spec.

| Feature          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Physical         | PCI express M.2 module, size 3042,Key.B,75Pin golden finger                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Electrical       | 5Vdc ( Host Equipment )<br>3.135Vdc~3.63Vdc ( Module )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Shielding design | Shield case on board design, no additional shielding requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Operating Bands  | WCDMA/HSDPA/HSUPA/HSPA+ operating bands:<br>Band 2: 1850 to 1910 MHz (UL), 1930 to 1990 MHz (DL)<br>Band 4: 1710 to 1755 MHz (UL), 2110 to 2155 MHz (DL)<br>Band 5: 824 to 849 MHz (UL), 869 to 894 MHz (DL)<br>Band 6 (cover by B5): 830 to 840 MHz (UL), 875 to 885 MHz (DL)<br>Band 19 (cover by B5): 830 to 845 MHz (UL), 875 to 890 MHz (DL)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                  | LTE FDD/TDD operating bands:<br>Band 2: 1850 to 1910 MHz (UL), 1930 to 1990 MHz (DL)<br>Band 4: 1710 to 1755 MHz (UL), 2110 to 2155 MHz (DL)<br>Band 5: 824 to 849 MHz (UL), 869 to 894 MHz (DL)<br>Band 7: 2500 to 2570 MHz (UL), 2620 to 2690 MHz (DL)<br>Band 12: 699 to 716 MHz (UL), 729 to 746 MHz (DL)<br>Band 13: 777 to 787 MHz (UL), 746 to 756 MHz (DL)<br>Band 14: 788 to 798 MHz (UL), 758 to 768 MHz (DL)<br>Band 17: 704 to 716 MHz (UL), 734 to 746 MHz (DL)<br>Band 25: 1850 to 1915 MHz (UL), 1930 to 1995 MHz (DL)<br>Band 26: 814 to 849 MHz (UL), 859 to 894 MHz (DL)<br>Band 30: 2305 to 2315 MHz (UL) 2350 to 2360 MHz (DL)<br>Band 38: 2570 to 2620 MHz (UL/DL)<br>Band 41: 2496 to 2690 MHz (UL/DL)<br>Band 66: 1710 to 1800 MHz (UL), 2110 to 2200 MHz (DL)<br>Band 71: 663 to 698 MHz (UL), 617 to 652 MHz (DL) |
| Operating Bands  | LTE 3.5G<br>Band 48: 3550 to 3700 MHz (UL/DL)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |                       |                              |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------------|------------------------------|-----------------------|------|------|-----|-----------------|----|-------|------------|-----------------------|----|-------|------------|-------------------|----|-------|------------|-----------|-----|-------|---------|-----------|-----|-------|-----------------------|--------------------|-----|-------|------------|-----------------------|-----|-------|------------|-------------|-------|------------|--|--|------|------|-----|-----------------|-----|-------|------------|---------|-----|-------|-----------------------|------------------------------|
|                  | <div>5G NR Sub 6GHz ( STA Mode )<br/>n38: 2570 to 2620 MHz (UL/DL)</div> <div>5G NR FR1 EN_DC</div> <table><tr><td rowspan="8">5G NR</td><td colspan="3">FCC 5G FR1</td><td rowspan="2">ENDC</td></tr><tr><td>Band</td><td>SCS</td><td>Bandwidth (MHz)</td></tr><tr><td>n2</td><td>15kHz</td><td>5/10/15/20</td><td>Band 5/12/13/30/48/66</td></tr><tr><td>n5</td><td>15kHz</td><td>5/10/15/20</td><td>Band 2/7/12/48/66</td></tr><tr><td>n7</td><td>15kHz</td><td>5/10/15/20</td><td>Band 5/12</td></tr><tr><td>n12</td><td>15kHz</td><td>5/10/15</td><td>Band 2/66</td></tr><tr><td>n41</td><td>30kHz</td><td>20/40/50/60/80/90/100</td><td>Band 2/25/26/66/41</td></tr><tr><td>n66</td><td>15kHz</td><td>5/10/15/20</td><td>Band 5/12/13/30/48/71</td></tr><tr><td>n71</td><td>15kHz</td><td>5/10/15/20</td><td>Band 2/7/66</td></tr><tr><td rowspan="4">5G NR</td><td colspan="3">FCC 5G FR1</td><td rowspan="2">ENDC</td></tr><tr><td>Band</td><td>SCS</td><td>Bandwidth (MHz)</td></tr><tr><td>n25</td><td>15kHz</td><td>5/10/15/20</td><td>Band 12</td></tr><tr><td>n77</td><td>30kHz</td><td>20/40/50/60/80/90/100</td><td>Band 2/5/7/12/13/14/30/41/66</td></tr></table> | 5G NR      | FCC 5G FR1            |                              |                       | ENDC | Band | SCS | Bandwidth (MHz) | n2 | 15kHz | 5/10/15/20 | Band 5/12/13/30/48/66 | n5 | 15kHz | 5/10/15/20 | Band 2/7/12/48/66 | n7 | 15kHz | 5/10/15/20 | Band 5/12 | n12 | 15kHz | 5/10/15 | Band 2/66 | n41 | 30kHz | 20/40/50/60/80/90/100 | Band 2/25/26/66/41 | n66 | 15kHz | 5/10/15/20 | Band 5/12/13/30/48/71 | n71 | 15kHz | 5/10/15/20 | Band 2/7/66 | 5G NR | FCC 5G FR1 |  |  | ENDC | Band | SCS | Bandwidth (MHz) | n25 | 15kHz | 5/10/15/20 | Band 12 | n77 | 30kHz | 20/40/50/60/80/90/100 | Band 2/5/7/12/13/14/30/41/66 |
| 5G NR            | FCC 5G FR1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |                       | ENDC                         |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | Band                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            | SCS                   |                              | Bandwidth (MHz)       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | n2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            | 15kHz                 | 5/10/15/20                   | Band 5/12/13/30/48/66 |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | n5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            | 15kHz                 | 5/10/15/20                   | Band 2/7/12/48/66     |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | n7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            | 15kHz                 | 5/10/15/20                   | Band 5/12             |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | n12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            | 15kHz                 | 5/10/15                      | Band 2/66             |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | n41                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |            | 30kHz                 | 20/40/50/60/80/90/100        | Band 2/25/26/66/41    |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | n66                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 15kHz      | 5/10/15/20            | Band 5/12/13/30/48/71        |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
| n71              | 15kHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 5/10/15/20 | Band 2/7/66           |                              |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
| 5G NR            | FCC 5G FR1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |                       | ENDC                         |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | Band                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | SCS        | Bandwidth (MHz)       |                              |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | n25                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 15kHz      | 5/10/15/20            | Band 12                      |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
|                  | n77                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 30kHz      | 20/40/50/60/80/90/100 | Band 2/5/7/12/13/14/30/41/66 |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
| Diversity/2nd Rx | <div>All UMTS operating bands</div> <div>All LTE operating bands</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |                       |                              |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
| MIMO 4 Rx        | <div>LTE-B1/25(2)/3/66(4)/7/30/40/41(38)/42/48</div> <div>5G NR-n1/2/3/66/7/41/77/78/79</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |                       |                              |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
| GNSS             | <div>GPS: L1 (1575.42MHz); L5 (1176MHz)</div> <div>GLONASS: L1 (1602MHz)</div> <div>BeidouB1(1561.098MHz)</div> <div>Galileo E1 (1575.42); E5a (1176MHz)</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |                       |                              |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |
| Throughput       | <div>WCDMA CS: DL 64 kbps /UL 64 kbps</div> <div>WCDMA PS: DL 384 kbps /UL 384 kbps</div> <div>HSPA+:DL 21.6 Mbps /UL 5.76 Mbps</div> <div>DC-HSPA+: DL 42 Mbps/UL 5.76 Mbps</div> <div>LTE Cat20: DL:2Gbps/UL 150 Mbps</div> <div>5G NR Sub 6G: DL:TBD/UL (TBD)</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |                       |                              |                       |      |      |     |                 |    |       |            |                       |    |       |            |                   |    |       |            |           |     |       |         |           |     |       |                       |                    |     |       |            |                       |     |       |            |             |       |            |  |  |      |      |     |                 |     |       |            |         |     |       |                       |                              |

#### 5G NR Air Interface

- 3GPP Rel15 5G NR sub-6  
Sub-6G
- Modulation UL: 256 QAM; DL: 256 QAM
- Waveform UL: CP-OFDM and DFT-S-OFDM; DL: CP-OFDM
- Sub-Carrier Spacing (SCS): 15 KHz, 30 KHz
- Duplex mode: FDD and TDD
- Operation mode: Standalone mode (SA) and Non-Standalone mode (NSA)
- CA capability: DLCA
- EN-DC: LTE and NR sub-6 GHz dual connectivity
- **MIMO: 1 TX × 4 RX**

#### LTE Air Interface

##### LTE Rel14

- 20 layers and 2 Gbps downlink (DL) throughput – **4 RX MIMO** across 5x CA
- 200 Mbps uplink (UL) throughput – 40 MHz ULCA and 256 QAM

- LAA (Licensed assist access) across 80 MHz
- CA capability:
  - DLCA
    - Inter-band DLCA
    - Intra band contiguous CA
    - Intra band non contiguous
  - ULCA
    - Intra band contiguous CA
- Modulation UL: 256 QAM; DL: 1024 QAM
- FDD + TDD CA
- **MIMO: 1 TX × 4 RX**

#### WCDMA/HSPA Air Interface

- R99:
  - All modes and data rates for WCDMA FDD
- R5 HSDPA
  - PS data speeds up to 7.2 Mbps on the downlink
- R6 HSUPA
  - E-DCH data rates of up to 5.76 Mbps for 2 ms TTI (UE category 6) uplink
- R7 HSPA+
  - Downlink 64 QAM SISO: up to 21 Mbps
  - Downlink 16 QAM 2X2 MIMO: up to 28 Mbps
- R8 DC-HSPA+
  - Downlink dual carrier with 64 QAM (SISO); up to 42 Mbps
- **MIMO: 1 TX × 4 RX**

#### GNSS

- GPS, GLONASS, Galileo, and BeiDou support
- Two GNSS paths to support simultaneous L1 and /L5
- Customizable tracking session
  - Automatic tracking session on startup
  - Concurrent standalone GPS, GLONASS , BeiDou and Galileo
  - gpsOneXTRA with GPS + GLONASS + BeiDou+ Galileo support

### 1.3 Host integration instructions

Install module through golden finger.

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#### 1.4 Antenna information

| Antenna No. | RF Chain No. | Brand        | Model          | Antenna Net Gain(dBi)                                           | Frequency range (MHz)                                                                            | Antenna Type | Connector Type |
|-------------|--------------|--------------|----------------|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------|----------------|
| 1           |              | WHA YU       | C107-511720-A  | 4.41                                                            | 660~803                                                                                          | PCB          | I-PEX          |
| 2           |              | WHA YU       | C107-511721-A  | 3.81<br>4.03                                                    | 791~960<br>1447.9~1606                                                                           | PCB          | I-PEX          |
| 3           |              | WHA YU       | C107-511722-A  | 4.27<br>5.31                                                    | 1710~2170<br>2500~2690                                                                           | PCB          | I-PEX          |
| 4           |              | WHA YU       | C107-511723-A  | 2.99<br>0.92                                                    | 2300~2400<br>3500~3700                                                                           | PCB          | I-PEX          |
| 5           |              | WHA YU       | C107-511724-A  | 6.45                                                            | 5150~5925                                                                                        | PCB          | I-PEX          |
| 6           |              | WHA YU       | C107-511725-A  | 4.89                                                            | 3400~3700                                                                                        | PCB          | I-PEX          |
| 7           |              | AVX          | 5000106-R1-X01 | 2.91                                                            | 699~803                                                                                          | Monopole     | I-PEX          |
| 8           |              | AVX          | 5000107-R1-X01 | 2.59                                                            | 791~960                                                                                          | Monopole     | I-PEX          |
| 9           |              | AVX          | 5000108-R1-X01 | 2.85                                                            | 1427~1610                                                                                        | Monopole     | I-PEX          |
| 10          |              | AVX          | 5000109-R1-X01 | 2.23<br>2.94                                                    | 1710~2200<br>5150~5925                                                                           | Monopole     | I-PEX          |
| 11          |              | AVX          | 5000110-R1-X01 | 0.9                                                             | 2300~2690                                                                                        | Monopole     | I-PEX          |
| 12          |              | AVX          | 5000111-R1-X01 | 0.87                                                            | 3300~5000                                                                                        | Monopole     | I-PEX          |
| Antenna No. | RF Chain No. | Brand        | Model          | Antenna Net Gain(dBi)                                           | Frequency range (MHz)                                                                            | Antenna Type | Connector Type |
| 13          | Tx1/<br>Rx1  | Ethertronics | 5003806        | 0.4<br>-1.61<br>0.39<br>2.95<br>1.98<br>0.38<br>0.83<br>2.31    | 698-821<br>824-960<br>1425-1515<br>1710-2200<br>2300-2690<br>3300-4200<br>4400-5000<br>5150-5925 | PIFA         | I-PEX          |
|             | Rx2          | Ethertronics | 5003807        | -2.24<br>-4.52<br>2.87<br>2.99<br>2.93<br>2.91<br>2.23<br>-0.85 | 716-821<br>824-960<br>1425-1515<br>1557-1610<br>1805-2200<br>2300-2690<br>3300-4200<br>4400-5000 | PIFA         | I-PEX          |

|    |                       |                  |         |                                        |                                                                    |      |       |
|----|-----------------------|------------------|---------|----------------------------------------|--------------------------------------------------------------------|------|-------|
|    |                       |                  |         | -3.04                                  | 5150-5925                                                          |      |       |
|    | Tx2/<br>Rx3           | Ethertronic<br>s | 5003806 | 2.21<br>2.25<br>-0.45<br>2.6           | 1710-2200<br>2300-2690<br>3300-4200<br>4400-5000                   | PIFA | I-PEX |
|    | Rx4                   | Ethertronic<br>s | 5003700 | 1.38<br>2.87<br>0.6<br>-2.09           | 1805-2200<br>2300-2690<br>3300-4200<br>4400-5000                   | PIFA | I-PEX |
| 14 | Ant. 0<br>(TX/R<br>X) | Master<br>Wave   | NA      | 2.4<br>2.2<br>2.9<br>2.9<br>2.9<br>NA  | 880~960<br>1020~2170<br>2545~2595<br>3565~3600<br>3900~4000<br>GPS | PCB  | I-PEX |
|    | Ant. 2<br>(TX/R<br>X) | Master<br>Wave   | NA      | NA<br>2.2<br>2.8<br>2.9<br>2.8<br>NA   | 880~960<br>1020~2170<br>2545~2595<br>3565~3600<br>3900~4000<br>GPS | PCB  | I-PEX |
|    | Ant. 1<br>(RX)        | Master<br>Wave   | NA      | NA<br>5.3<br>5.1<br>4.3<br>4.5<br>NA   | 880~960<br>1020~2170<br>2545~2595<br>3565~3600<br>3900~4000<br>GPS | PCB  | I-PEX |
|    | Ant. 3<br>(RX)        | Master<br>Wave   | NA      | 1.3<br>6.8<br>3.7<br>6.4<br>6.2<br>3.7 | 880~960<br>1020~2170<br>2545~2595<br>3565~3600<br>3900~4000<br>GPS | PCB  | I-PEX |

## 1.5 Host product testing guidance

HOST must follow section 3 of KDB 996369 D04 Module Integration Guide v01, to verify that the host product meets all the applicable FCC rules.

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