COMPANY CONFIDENTIAL

LTE-Advanced Gigabit Class PCI Express M.2 Module (LTE, UMTS)

Engineering Requirements Specification

Project code: T77W968
Solution: SDX20+SDR845
SKU: WW-5-S3

Foxconn PN	Customer PN
T77W968.00	PH6K2
T77W968.01	59X27
T77W968.02	C0RVH
T77W968.03	K4DJ8
T77W968.04	HMGJ3

Reviewers

Department	Name	Signature	Review Dates	
			* Plan	** Results
Project Manager	Choro. Chung			
Project Leader	Michael. Xiao			
Hardware Engineer	Lynn. Liu			

Modification History

Rev	Date	Originator	Comment
R1.0	2017/9/18	Lynn. Liu	Initial release
R1.1	2017/9/20	Lynn. Liu	Update item 4.1 operating condition
R1.2	2017/10/25	Lynn. Liu	Update item 1.5.4 / 1.5.8 per Customer's requirement
R1.3	2017/12/08	Lynn. Liu	Update item 2.4& 3.3 per Customer's requirement
R1.4	2017/12/12	Lynn. Liu	Update item 1.5.1 for 4x4 and 2x2 antenna selection
R1.5	2017/12/22	Lynn. Liu	Update item 5 for draft RF performance Specification
R1.6	2017/12/26	Lynn. Liu	Update item 1.3/ 1.4.2/ 1.5.9 (System block diagram and USIM application note)
R1.7	2018/01/30	Lynn. Liu	Update item 1.4.2/ 1.5.2 base on Kick off update
R1.8	2018/04/25	Lynn. Liu	Add variant SKU by different platform PN requirement

CONTENTS

1. General Description

T77W968 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. T77W968 is the data card solution that delivers wireless wide-area network (WWAN) connectivity for the LTE, UMTS (HSDPA/HSUPA/HSPA+/DC-HSPA+) and GPS/Glonass/Beidou protocols in one hardware configuration.

SKU		WW-5-S3 / T77W968
Carrier Support		NA: AT&T, Verizon, Sprint WW: Vodafone, Orange, Telefonica-O2 EU: Deutsche Telekom, Swisscom APAC: Telstra, Optus, Docomo, KDDI China: CMCC/CUCC/CTCC * Carrier engagement based on real business agreement
QCT Solution		SDX20+SDR845+PMX20
4G	Mode	FDD / TDD
	Support Band	LB: B26(5/18/19)/8/12(17)/13/14/20/28/29/ MB: B1/2(25)/3/4(66)/32 HB: 7/30/38/39/40/41/42/43/48
	LAA	B46 (DL only)
	Carrier Aggregation	5xDL CA (Up to 100MHz, 256QAM); 2xUL CA (Up to 40MHz 64QAM)
	Cat (DL/UL Mbps)	ue-CategoryUL 13 (UL: 150Mbps) + ue-CategoryDL 16 (DL: 1.0Gbps) with 2X2 ue-CategoryUL 13 (UL: 150Mbps) + ue-CategoryDL 18 (DL: 1.2Gbps) with 4X4
3G	WCDMA	HSPA+ Rel8 (DL/UL: up to 42/11 Mbps)
	Support Band	B1/2/4/5(6/19)/8/9
GNSS		GPS/GLONASS/Beidou/Galileo
Tunable antenna		Reserve MiPi/GPIO at M.2 interface for external antenna tuner
Interface		USB2.0, USB3.0, PCIe (Enabled by Firmware)
Form factor		3042 PCIe M.2 Key.B Sigle side

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~4.4V follow M.2 standard)
Dimension	Dimensions (L × W × H): 42 mm × 30 mm × 2.3 mm, maximum height=2.38mm (add PCB tolerance=0.08mm)
Shielding design	Shield case on board design, no additional shielding requirement
Weight	Approximately ~6g
USIM	Off-board USIM connector supported
Operating Bands	WCDMA/HSDPA/HSUPA/HSPA+ operating bands: Band 2: 1850 to 1910 MHz (UL), 1930 to 1990 MHz (DL) Band 4: 1710 to 1755 MHz (UL), 2110 to 2155 MHz (DL) Band 5: 824 to 849 MHz (UL), 869 to 894 MHz (DL)
	LTE FDD/TDD operating bands: Band 2: 1850 to 1910 MHz (UL), 1930 to 1990 MHz (DL) Band 4: 1710 to 1755 MHz (UL), 2110 to 2155 MHz (DL) Band 5: 824 to 849 MHz (UL), 869 to 894 MHz (DL) Band 7: 2500 to 2570 MHz (UL), 2620 to 2690 MHz (DL) Band 12: 699 to 716 MHz (UL), 729 to 746 MHz (DL) Band 13: 777 to 787 MHz (UL), 746 to 756 MHz (DL) Band 14: 788 to 798 MHz (UL), 758 to 768 MHz (DL) Band 17: 704 to 716 MHz (UL), 734 to 746 MHz (DL) Band 25: 1850 to 1915 MHz (UL), 1930 to 1995 MHz (DL) Band 26: 814 to 849 MHz (UL), 859 to 894 MHz (DL) Band 29: 717 to 728 MHz (DL) Band 30: 2305 to 2315 MHz (UL) 2350 to 2360 MHz (DL) Band 32: 1452 to 1496 MHz (DL) Band 38: 2570 to 2620 MHz (UL/DL) Band 41: 2496 to 2690 MHz (UL/DL) Band 42: 3552.5 to 3597.5 MHz (UL/DL) Band 48: 3552.5 to 3597.5 MHz (UL/DL) Band 66: 1710 to 1800 MHz (UL), 2110 to 2200 MHz (DL)

Operating Bands	LAA Band 46: 5150 to 5925 (DL)
Diversity/2nd Rx	All UMTS operating bands All LTE operating bands
4x4 MIMO Rx	1/25(2)/3/66(4)/7/30/40/41(38)
GNSS	GPS: L1 (1575.42MHz) GLONASS: L1 (1602MHz) Beidou (1561.098MHz) Galileo E1 (1575.42)
USIM Voltage	Support 1.8V and 2.85V, and auto detects follow SIM card type
Antenna connectors	MAIN: Support all LTE& UMTS bands AUX: Supports all LTE& UMTS bands Diversity and GPS simultaneously MIMO1& MIMO2: Support 4x4 MIMO B1/2/3/4/7/30/40/41/66
Throughput	WCDMA CS: DL 64 kbps /UL 64 kbps WCDMA PS: DL 384 kbps /UL 384 kbps HSPA+: DL 21.6 Mbps /UL 5.76 Mbps DC-HSPA+: DL 42 Mbps/UL 5.76 Mbps LTE Cat4: DL:150 Mbps/UL 50 Mbps LTE Cat6: DL: 300 Mbps/UL 50 Mbps LTE Cat9: DL: 450 Mbps/UL 50 Mbps LTE Cat16: DL: 1.0 Gbps/UL 150 Mbps LTE Cat18: DL: 1.2 Gbps/UL 150 Mbps

LTE Air Interface

LTE Rel13

- DL – 1.2 Gbps / 12-layer / 100 MHz CA
- UL - 150 Mbps / 40 MHz CA
- 256 QAM DL / 64 QAM UL
- 4 × 2 MIMO 5x CA (R13)
- 4 × 4 MIMO 3x CA
- FDD + TDD CA
- 3.5 GHz and 600 MHz Bands
- LAA and LTE-U (up to 80 MHz of unlicens)
- Advance LTE IC + NAIC (with CRS only)

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
  Uplink 16 QAM: up to 5.76 Mbps
- R8 DC-HSPA+
  Downlink dual carrier with 64 QAM (SISO); up to 42 Mbps

GNSS

- Customizable tracking session
  - Automatic tracking session on startup
  - Concurrent standalone GPS, GLONASS , BeiDou and Galileo
  - gpsOneXTRA with GPS + GLONASS + BeiDou + Galileo support

5. RF performance specifications

Radio performance for T77W968. is given in the following sections, including RF receiver, RF transmitter.

5.1 RF maximum TX power specifications

Table 5-1 Conductive Maximum transmits power (LTE BW: 10MHz)

Notes: The below test result is for reference only, we will update the final Spec. after DVT build before April. of 2018

Band	3GPP Standard (dBm)	Design Spec.(dBm)		
		Max.	Typ.	Min.
2	23 +/-2	24.5	23.5	22.0
4	23 +/-2	24.5	23.5	22.0
5	23 +/-2	24.5	23.5	22.0
7	23 +/-2	24.5	23.5	22.0
12	23 +/-2	24.5	23.5	22.0
13	23 +/-2	24.5	23.5	22.0
14	23 +/-2	24.5	23.5	22.0
17	23 +/-2	24.5	23.5	22.0
25	23 +/-2	24.5	23.5	22.0
26	23 +/-2	24.5	23.5	22.0
29	23 +/-2	24.5	23.5	22.0
30	23 +/-2	24.0	23.0	22.0
38	23 +/-2	24.5	23.5	22.0
41	23 +/-2	24.5	23.5	22.0
66	23 +/-2	24.5	23.5	22.0
WCDMA	3GPP Standard (dBm)	Design Spec.(dBm)		
		Max.	Typ.	Min.
2	24+1.7/-3.7	24.5	23.5	22.5
4	24+1.7/-3.7	24.5	23.5	22.5
5(6/19)	24+1.7/-3.7	24.5	23.5	22.5

		Design Spec.(dBm)		
Band	3GPP Standard(dBm)	Max.	Typ.	Min.
42	23 +/-2	24.5	23.5	22
48	23 +/-2	24.5	23.5	22

8	24+1.7/-3.7	24.5	23.5	22.5
9	24+1.7/-3.7	24.5	23.5	22.5

5.2 RF min. Rx sensitivity specifications

Table 5-2 Conductive Minimum Sensitivity (LTE BW: 10MHz)

Notes: The below test result is for reference only, we will update the final Spec. after DVT build before April. of 2018

Band	3GPP MIMO Combined (dBm)	Design Spec.(dBm)				
		PRx	DRx	HORx_1	HORx_2	MIMO Combined
1	-95	-98	-98	-97.5	-97.5	TBD
2	-95	-98	-98	-97.5	-97.5	TBD
3	-94	-98	-98	-97.5	-97.5	TBD
4	-97	-98	-98	-97.5	-97.5	TBD
5	-95	-99	-99	NA	NA	-102
7	-95	-97.5	-97.5	-97.5	-97.5	TBD
8	-94	-99	-99	NA	NA	-102
12	-94	-99	-99	NA	NA	-102
13	-94	-99	-99	NA	NA	-102
14	-94	-99	-99	NA	NA	-102
17	-94	-99	-99	NA	NA	-102
18	-97	-99	-99	NA	NA	-102
19	-97	-99	-99	NA	NA	-102
20	-94	-99	-99	NA	NA	-102
25	-93.5	-98	-98	-97.5	-97.5	TBD
26	-94.5	-99	-99	NA	NA	-102
28	-95.5	-99	-99	NA	NA	-102
29	-94	-99	-99	NA	NA	-102
30	-97	-97.5	-97.5	-97.5	-97.5	TBD
32	-97	-99	-99	NA	NA	-102
38	-97	-97.5	-97.5	-97.5	-97.5	TBD
39	-97	-98.5	-98.5	NA	NA	-101
40	-97	-97.5	-97.5	-97.5	-97.5	TBD
41	-96	-97.5	-97.5	-97.5	-97.5	TBD
42	-96	-98	-98	NA	NA	-101
43	-96	-98	-98	NA	NA	-101
48	-96	-98	-98	NA	NA	-101
66	-96.5	-98	-98	NA	NA	-101
46	-93	-98	-98	NA	NA	-101
WCDMA	3GPP MIMO Combined (dBm)	Design Spec.(dBm)				
		PRx	DRx	HORx_1	HORx_1	MIMO Combined
1	-106.7	-109	-109	NA	NA	-112
2	-104.7	-109	-109	NA	NA	-112
4	-106.7	-109	-109	NA	NA	-112

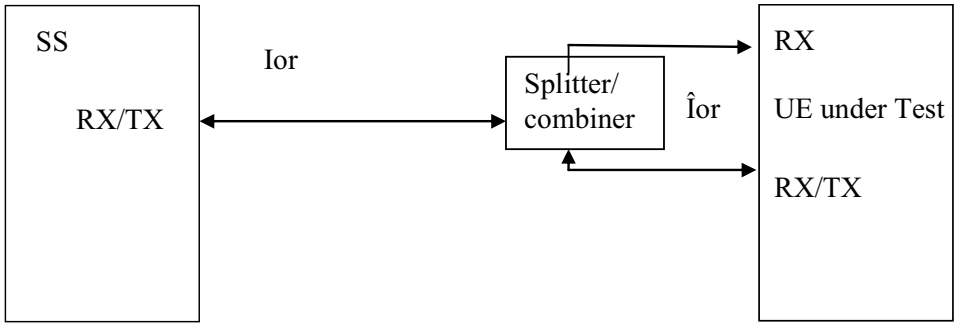
5(6/19)	-104.7	-110	-110	NA	NA	-113
8	-103.7	-110	-110	NA	NA	-113
9	-105.7	-110	-110	NA	NA	-113
GNSS tracking sensitivity	Design target (dBm)	Spec (dBm)				
	-159	-152				

Remark:

a. It has 3dB margin at least refer to 3GPP standard.

b. The typical value of LTE was measured as combine Rx sensitivity which was follow test setup of 3GPP standard (TS36.521 charter 7.2 and charter 7.3.5), the test setup is follow TS36.508 Annex A Figure A.3.

c. Above table is for general application, please inform us if you have any specific requirement.



6. Software Features

------ Will update the data later

7. Label Plan

------ Will update the data later

8. Host integration instructions

Install module through golden finger.

Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

2.2 List of applicable FCC rules

This module has been tested for compliance to FCC Part 15, 22, 24, 27, 90, 96.

2.3 Summarize the specific operational use conditions

The module is tested for standalone mobile RF exposure use condition. Any other usage conditions such as co-location with other transmitter(s) or being used in a portable condition will need a separate reassessment through a class II permissive change application or new certification.

2.4 Limited module procedures
Not applicable.

2.5 Trace antenna designs
Not applicable.

2.6 RF exposure considerations

This equipment complies with FCC mobile radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body. If the module is installed in a portable host, a separate SAR evaluation is required to confirm compliance with relevant FCC portable RF exposure rules.

2.7 Antennas

The following antennas have been certified for use with this module; antennas of the same type with equal or lower gain may also be used with this module. The antenna must be installed such that 20 cm can be maintained between the antenna and users.

Antenna Type	PIFA, Dipole, PCB
Antenna connector	i-pex

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following: "Contains FCC ID: MCLT77W968". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

2.9 Information on test modes and additional testing requirements

This transmitter is tested in a standalone mobile RF exposure condition and any co-located or simultaneous transmission with other transmitter(s) or portable use will require a separate class II permissive change re-evaluation or new certification.

2.10 Additional testing, Part 15 Subpart B disclaimer

This transmitter module is tested as a subsystem and its certification does not cover the FCC Part 15 Subpart B (unintentional radiator) rule requirement applicable to the final host. The final host will still need to be reassessed for compliance to this portion of rule requirements if applicable.
As long as all conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC

authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

OEM/Host manufacturer responsibilities

OEM/Host manufacturers are ultimately responsible for the compliance of the Host and Module. The final product must be reassessed against all the essential requirements of the FCC rule such as FCC Part 15 Subpart B before it can be placed on the US market. This includes reassessing the transmitter module for compliance with the Radio and EMF essential requirements of the FCC rules. This module must not be incorporated into any other device or system without retesting for compliance as multi-radio and combined equipment.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs, et

2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains IC: **2878D-T77W968**”.

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: **2878D-T77W968**".

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.

Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

低功率電波輻射性電機管理辦法

本模組於取得認證後將依規定於模組本體標示審驗合格標籤。

2. 系統廠商應於平台上標示「本產品內含射頻模組：CCXXXyyyLPDzzzz-x」字樣。

電磁波警語標示：「減少電磁波影響，請妥適使用」。

標示方式：必須標示於設備本體適當位置及設備外包裝及使用說明書上。

「電