Technical Specification
(TM03LNNATY1)

History

Ver.	Date	Contents	Written by	Checked by	Approved by	Note
1.0	2020.09.08					

Contents

1. Product Introuction

The **TM03LNNATY1** are designed for the automotive industry. They support LTE and WCDMA air Interface standards. The **TM03LNNATY1** are based on the Qualcomm MDM9628 wireless chipsets and support the following bands.

Table 1. Supported Band

Region		US
Band	LTE	B2/B4/B5/B12/B26
	WCDMA	B2/B4/B5

1.1 Environmental Specifications

The environmental specification for operating and storage of the **TM03LNNATY1** are defined in the the table below.

Table 2. Environmental Specifications

Parameter	Temperature Range
Operating Temperature	-40℃ to 85℃
Storage Temperature	-40℃ to +90℃
Humidity	95% or less

1.2 Electrical Specifications

This section provides details for some of the key electrical specifications of the **TM03LNNATY1** embedded modules.

1.2.1 Absolute Maximum Rating and ESD Ratings

This section defines the Absolute Maximum and Electrostatic Discharge (ESD) Ratings of the **TM03LNNATY1** embedded modules.

Warning: If these parameters are exceeded, even momentarily, damage may occur to the device.

Table 3. Absolute Maximum Ratings

Parameter		Min	Max	Units
+12.0_VPWR	Power Supply Input	-	16.0V	V
VIN	Voltage on any digital input or output pin	-	VREG_MDME+0.5	V
ESD Ratings				
ESD[1)]	Primary, Diversity antenna pads - Contact		10	kV

1) The ESD Simulator configured with 330pF, 2000Ω.

Caution: The TM03LNNATY1 embedded modules are sensitive to Electrostatic Discharge. ESD countermeasures and handling methods must be used when handling the TM03LNNATY1 devices.

1.2.2 Current Consumption

Table 4. **TM03LNNATY1** Current Consumption (TBD)

Mode	Parameter	Typical	Max	Units
LTE	Max TX Output /Full RB	600	650	mA
WCDMA	Max TX Output /Full RB	600	650	mA
LTE	Idle, Registered	3.6	4.0	mA
WCDMA	Idle, Registered	3.6	4.0	mA
LTE	Sleep Mode, Average Current	1.8	2.2	mA
WCDMA	Sleep Mode, Average Current	1.8	2.2	mA

1.3 Mechanical Specifications

1.3.1 Physical Dimensions and Connection Interface

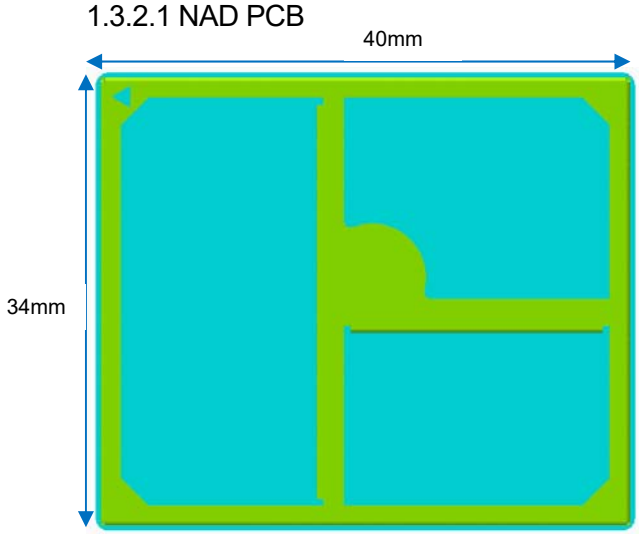
The **TM03LNNATY1** embedded modules are a Land Grid Array (LGA) form factor device. The device does not have a System or RF connectors. All electrical and mechanical connections are made via the 387 pad **TM03LNNATY1** on the underside of the PCB.

Table5. **TM03LNNATY1** Embedded Module Dimensions

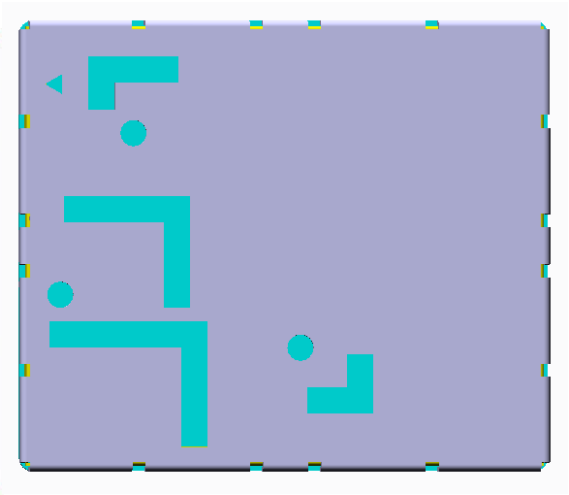
Parameter	Nominal	Max	Units
Overall Dimension	34 x 40	34.35 x 40.35	mm
Overall Module Height	3.8	4.0	mm
PCB Thickness	1.0	1.1	mm
Flatness Specification		0.1	mm
Weight	TBD		g

1.3.2 Mechanical Drawing

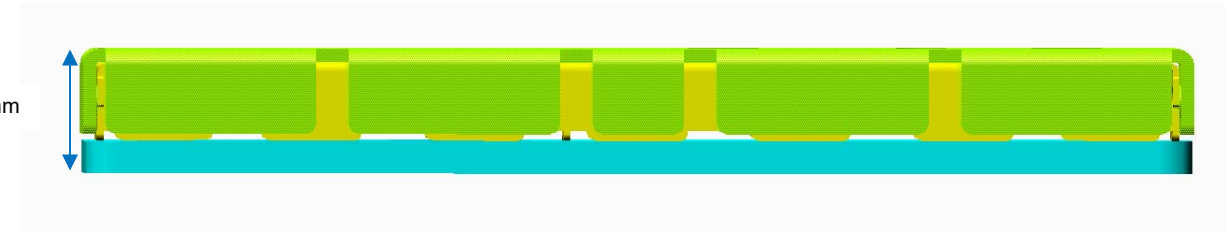
1.3.2.1 NAD PCB



[TOP View_Without shield Can cover]



[TOP View_With shield Can cover]



[SIDE View_With shield Can cover]

2. RF Specification

The specifications for the LTE and WCDMA interfaces are defined.
TM03LNNATY1 is designed to be compliant with the standard shown in the table below.

Table6. Standards Compliance

Technology	Standards
LTE	• 3GPP Release 8
WCDMA	• 3GPP Release 9

2.1 LTE Specification

2.1.1 LTE RX Sensitivity

The Receiver Sensitivity of the **TM03LNNATY1** are specified in the following table.

Table7. Conducted RX (Receive) Sensitivity – LTE Bands

BAND	**Method (DL CH)**	**Specification**
BAND 2 Reference sensitivity level(DUAL)	Measure BLER of Mid Channel (900) in Band2	sensitivity : ≤-95 BLER : ≤ 5%
BAND 4 Reference sensitivity level(DUAL)	Measure BLER of Mid Channel (2175) in Band4	sensitivity : ≤-97 BLER : ≤ 5%
BAND 5 Reference sensitivity level(DUAL)	Measure BLER of Mid Channel (2525) in Band5	sensitivity : ≤-95 BLER : ≤ 5%
BAND 12 Reference sensitivity level(DUAL)	Measure BLER of Mid Channel (5095) in Band12	sensitivity : ≤-94 BLER : ≤ 5%
BAND 26 Reference sensitivity level(DUAL)	Measure BLER of Mid Channel (8865) in Band26	sensitivity : ≤-94.5 BLER : ≤ 5%

2.2 WCDMA Specification

2.2.1 WCDMA RX Sensitivity

The Receiver Sensitivity of the **TM03LNNATY1** are specified in the following table.

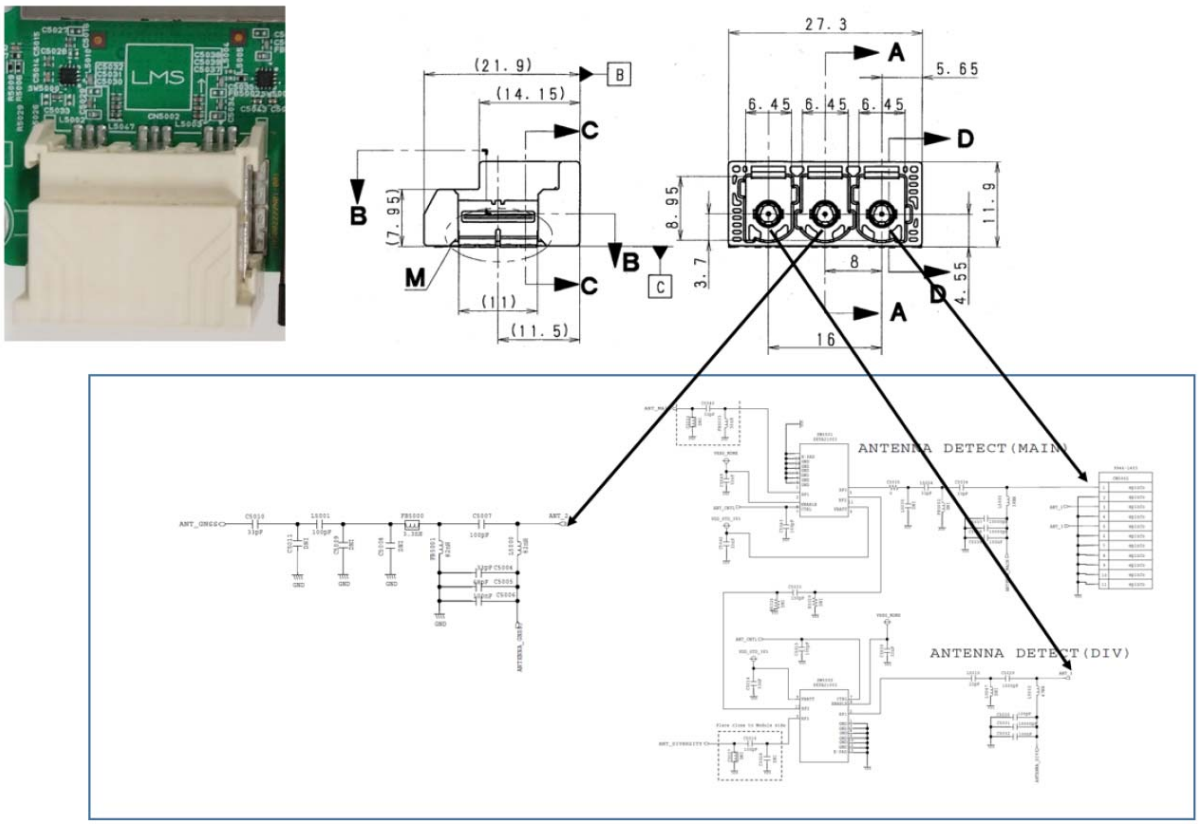
Table8. Conducted RX (Receive) Sensitivity – WCDMA Bands

Item	Method (DL CH)	Specification
BAND2 BER(Bit Error Rate)	Measure BER of Middle Channel (CH=9800) in Band2	0.1% @≤-106.7dBm
BAND4 BER(Bit Error Rate)	Measure BER of Middle Channel (CH=1675) in Band4.	0.1% @≤-106.7dBm
BAND5 BER(Bit Error Rate)	Measure BER of Middle Channel (CH=4400) in Band5	0.1% @≤-106.7dBm

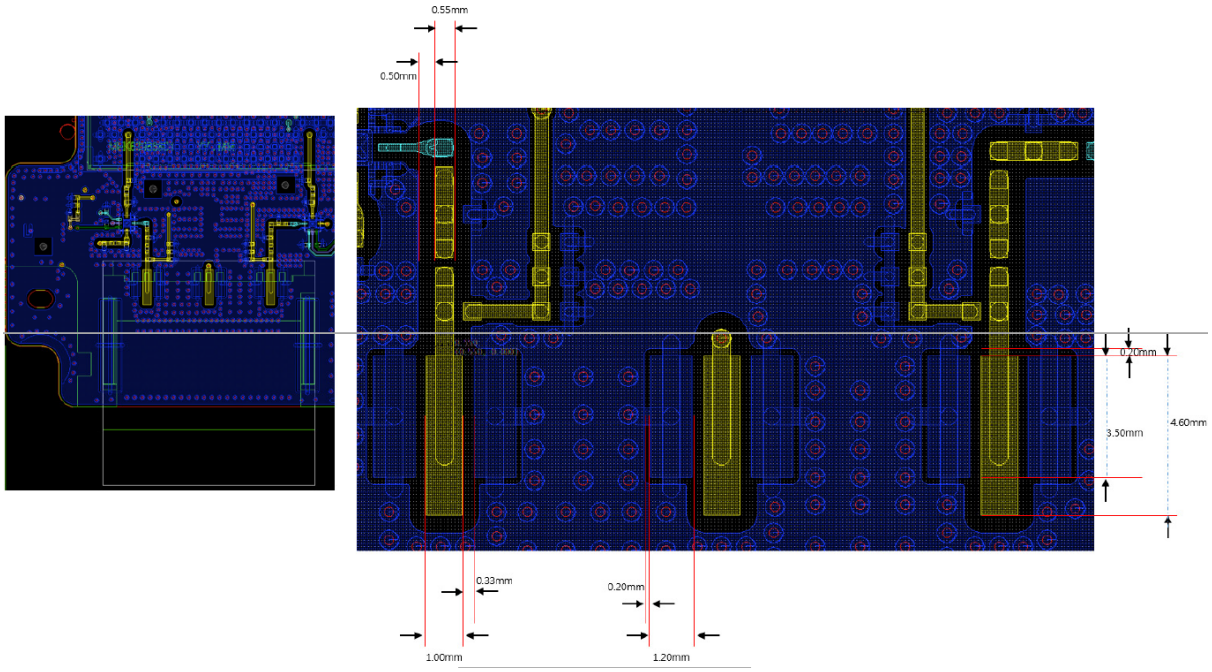
3. NAD Module installation guide

- TM03LNNATY0 Module is mounted with solder ball on the main TCU board. - TM03LNNATY0 Module is the Limited single-modular transmitter and is used only on the Toyota TCU board.

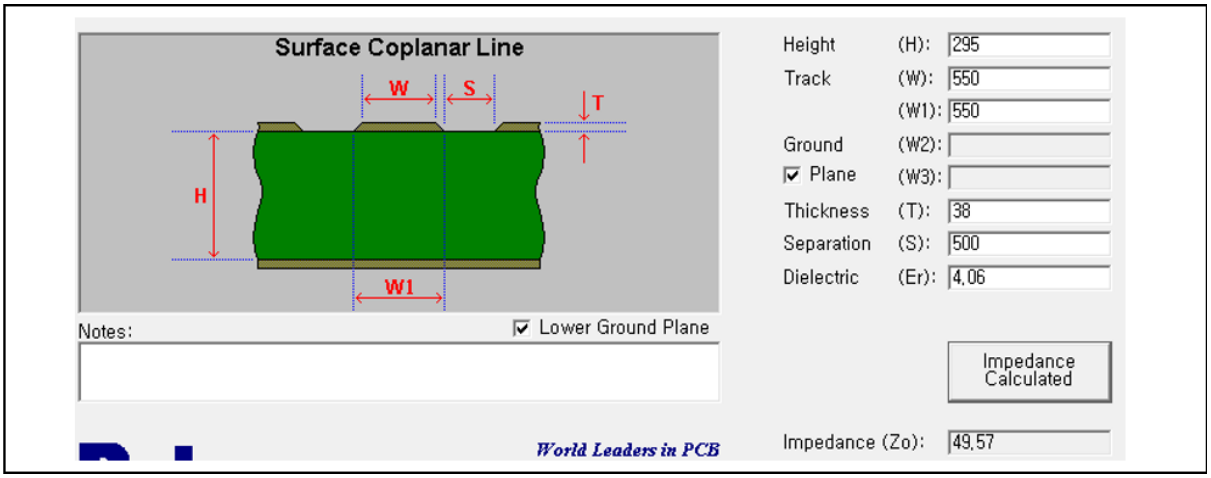
3.1 Antenna connector configuration and Circuit design



[Figure 1. Schematic and Antenna Configuration]



[Figure 2. Trace Layout]



[Figure 3. 50ohms calculatoin(mm) trace width : 0.55mm, Copper clearance : 0.5mm]

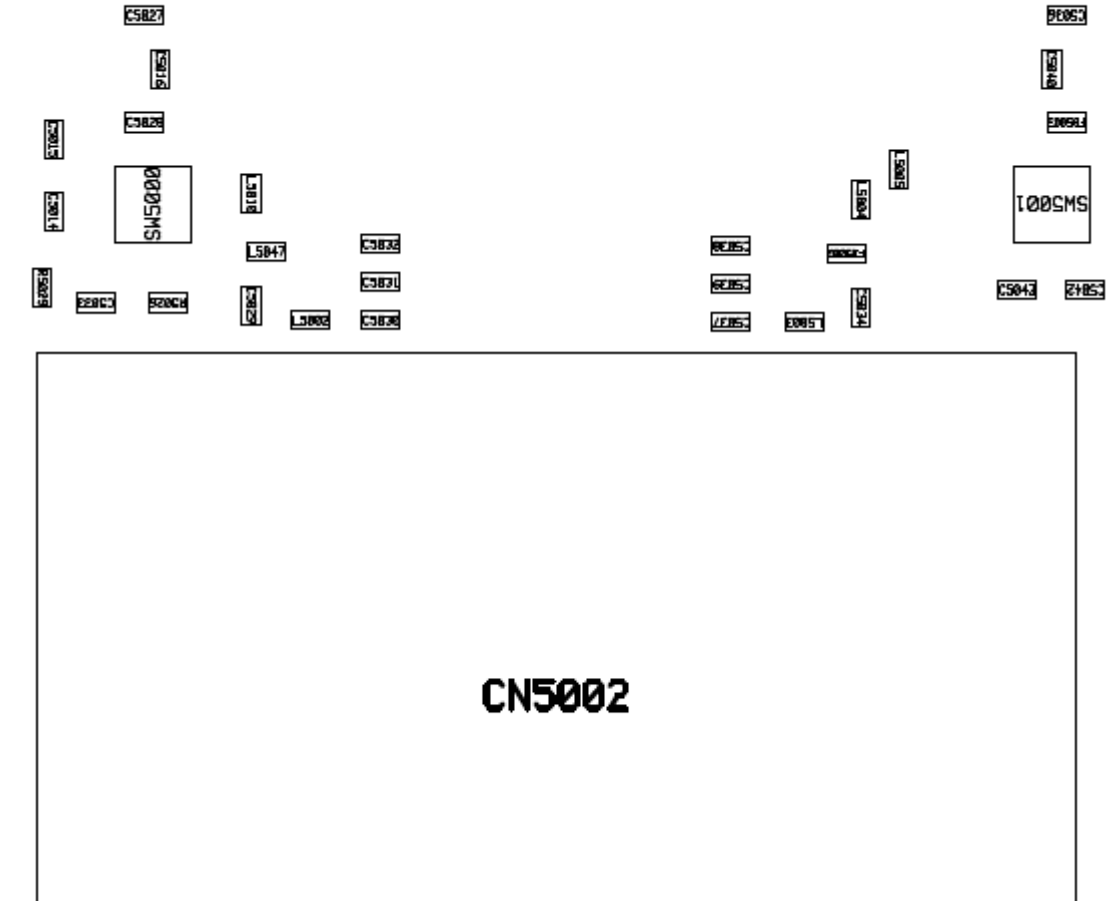
3.2 Design validation & production procedures

To verify compliance of the reference trace, a coupon must be requested with every manufacturing panel form and for which the characteristics are described in the Gerber files. Part of these characteristic are shown in Figure 3. Then a network analyzer is used to measure the impedance of this coupon in order to validate the antenna trace.

FR4-6L 1.6T				Single Impedance					
				50ohm		50ohm		50ohm	
				Width	Ref.	Width	Ref.	Width	Ref.
Layer	Type		Code						
	S/M	0.020							
1	TOP	0.038		0.195	2L	0.195	2L	0.55	3L
	prepreg	0.110	2116						
2	SIG	0.035							
	CORE	0.150	0.15T						
3	SIG	0.035		0.212	2L/4L	0.208	2L/5L	0.208	2L/4L
	prepreg	0.740	7628*4						
4	SIG	0.035		0.212	3L/5L	0.208	2L/5L	0.208	3L/5L
	CORE	0.150	0.15T						
5	SIG	0.035							
	prepreg	0.110	2116						
6	BOT	0.038		0.195	5L	0.195	5L	0.555	4L
	S/M	0.020							
	Total T	1.516							

Note1. Measurement results delivered with boards. Controlled impedance shall be 50 Ohms +/- 15% on layer TOP 0.55mm microstrip traces referenced to layer 3 plane and with a copper clearance of 0.50mm.

[Figure 4. PCB stack-up]



[Figure 5. Placement]

Reference Designator	Part Name	Component_Type	Maker	Value	Spec.
L5002	EAP62807121	Coil	TDK CORPORATION	47NH	MLG1005S47NJ-TD25 47NH 5% - 250mA - - 1.2OHM 1.1GHZ 8 SHIELD 1 1.0X0.5X0.5MM R/TP TDK CORPORATION
L5003	EAP62807127	Coil	TDK Electronics KOREA CORPORATION	39NH	MLG1005S39NJTD25 39NH 5% - 250mA - - 0.65OHM 1.2GHZ - SHIELD 2 1.0X0.5X0.5MM R/TP TDK Electronics KOREA CORPORATION
L5004	EAE63461925	Capacitor	KOREA MURATA ELECTRONICS CO. LTD.	33pF	GCM1555C1H330FA16D 33pF +-1% 50V C0G -55TO+125C 1005 R/TP - AEC-Q200 KOREA MURATA ELECTRONICS CO. LTD.
L5005	DNI	DNI	DNI	DNI	DNI
L5010	EAE63461910	Capacitor	MURATA MANUFACTURING CO.,LTD.	22pF	GCM1555C1H220J 22pF 5% 50V C0G -55TO+125C 1005 R/TP 0.5mm Automotive Type GM Gen10 NAD MURATA MANUFACTURING CO.,LTD.
L5047	DNI	DNI	DNI	DNI	DNI
C5014	EAE64382902	Capacitor	SAMWHA CAPACITOR CO. LTD.	33nF	CQ1005X7R333K160NR 33nF 10% 16V X7R -55TO+125C 1005 R/TP - - SAMWHA CAPACITOR CO. LTD.
C5015	EAE64361601	Capacitor	KOREA TAIYO YUDEN.CO., LTD.	100pF	RM UMK105 CG101JVHF 100pF 5% 50V C0G -55TO+125C 1005 R/TP - - KOREA TAIYO YUDEN.CO., LTD.
C5016	EAE64361601	Capacitor	KOREA TAIYO YUDEN.CO., LTD.	100pF	RM UMK105 CG101JVHF 100pF 5% 50V C0G -55TO+125C 1005 R/TP - - KOREA TAIYO YUDEN.CO., LTD.
C5027	DNI	DNI	DNI	DNI	DNI
C5028	DNI	DNI	DNI	DNI	DNI
C5029	EAE63422301	Capacitor	MURATA MANUFACTURING CO.,LTD.	1000pF	GCM155R71H102K AEC-Q200(1) 1000pF 10% 50V X7R -55TO+125C 1005 R/TP - - MURATA MANUFACTURING CO.,LTD.
C5030	EAE64361601	Capacitor	KOREA TAIYO YUDEN.CO., LTD.	100pF	RM UMK105 CG101JVHF 100pF 5% 50V C0G -55TO+125C 1005 R/TP - - KOREA TAIYO YUDEN.CO., LTD.
C5031	EAE63422302	Capacitor	MURATA MANUFACTURING CO.,LTD.	10000pF	GCM155R71H103K AEC-Q200(Grade1) 10000pF 10% 50V X7R -55TO+125C 1005 R/TP - - MURATA MANUFACTURING CO.,LTD.
C5032	EAE64984501	Capacitor	SAMWHA CAPACITOR CO. LTD.	100nF	CQ1005X7R104K250NR AEC-Q200(1) 100nF 10% 25V X7R -55TO+125C 1005 R/TP - - SAMWHA CAPACITOR CO. LTD.
C5033	EAE64361601	Capacitor	KOREA TAIYO YUDEN.CO., LTD.	100pF	RM UMK105 CG101JVHF 100pF 5% 50V C0G -55TO+125C 1005 R/TP - - KOREA TAIYO YUDEN.CO., LTD.
C5034	EAE63461925	Capacitor	KOREA MURATA ELECTRONICS CO. LTD.	33pF	GCM1555C1H330FA16D 33pF +-1% 50V C0G -55TO+125C 1005 R/TP - AEC-Q200 KOREA MURATA ELECTRONICS CO. LTD.
C5035	0RJ0000C678	Resistor	ABCO ELECTRONICS CO.,LTD	0	ACR0402T000J 0OHM 5% 1/16W 1005 R/TP - ABCO ELECTRONICS CO.,LTD
C5036	DNI	DNI	DNI	DNI	DNI
C5037	EAE63422302	Capacitor	MURATA MANUFACTURING CO.,LTD.	10000pF	GCM155R71H103K AEC-Q200(Grade1) 10000pF 10% 50V X7R -55TO+125C 1005 R/TP - - MURATA MANUFACTURING CO.,LTD.
C5038	EAE63422302	Capacitor	MURATA MANUFACTURING CO.,LTD.	10000pF	GCM155R71H103K AEC-Q200(Grade1) 10000pF 10% 50V X7R -55TO+125C 1005 R/TP - - MURATA MANUFACTURING CO.,LTD.
C5039	EAE64984501	Capacitor	SAMWHA CAPACITOR CO. LTD.	100nF	CQ1005X7R104K250NR AEC-Q200(1) 100nF 10% 25V X7R -55TO+125C 1005 R/TP - - SAMWHA CAPACITOR CO. LTD.
C5040	EAE63461925	Capacitor	KOREA MURATA ELECTRONICS CO. LTD.	33pF	GCM1555C1H330FA16D 33pF +-1% 50V C0G -55TO+125C 1005 R/TP - AEC-Q200 KOREA MURATA ELECTRONICS CO. LTD.
C5042	EAE64382902	Capacitor	SAMWHA CAPACITOR CO. LTD.	33nF	CQ1005X7R333K160NR 33nF 10% 16V X7R -55TO+125C 1005 R/TP - - SAMWHA CAPACITOR CO. LTD.
C5043	EAE64361601	Capacitor	KOREA TAIYO YUDEN.CO., LTD.	100pF	RM UMK105 CG101JVHF 100pF 5% 50V C0G -55TO+125C 1005 R/TP - - KOREA TAIYO YUDEN.CO., LTD.
R5026	DNI	DNI	DNI	DNI	DNI
R5029	DNI	DNI	DNI	DNI	DNI
CN5002	EAG65871301	Connector	TAEYANG 3C CO.,LTD	6098-8777	6098-8777 NONE ANGLE FAKRA SMD R/TP AU 0OHM 0DB TAEYANG 3C CO.,LTD
FB5002	DNI	DNI	DNI	DNI	DNI
FB5003	EAP62887206	Coil	TAIYO YUDEN CO.,LTD	56nH	HK100556NJ-TV AEC 56NH 5% - 200mA - - 1OOHM 800MHZ - SHIELD 1 1.0X0.5X0.5MM R/TP TAIYO YUDEN CO.,LTD
SW5000	EAM64650301	Switch	SKYWORKS SOLUTIONS INC.	SKYA21003	SKYA21003 +0.5 dBm at 2.5 GHz 40~42dB 0.01 to 6.0 GHz SPDT 70dBm QFN12L 2x2x0.55 SKYWORKS SOLUTIONS INC.
SW5001	EAM64650301	Switch	SKYWORKS SOLUTIONS INC.	SKYA21003	SKYA21003 +0.5 dBm at 2.5 GHz 40~42dB 0.01 to 6.0 GHz SPDT 70dBm QFN12L 2x2x0.55 SKYWORKS SOLUTIONS INC.

[Figure 6. Part List]

Notice

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 device complies with FCC radiation exposure limits set forth for an uncontrolled environment. This device should be installed and operated with minimum distance 20cm between the radiating element of this device and the user.

Integration instructions
The module complies with Part 22/24/27 of the FCC rules.
The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.
This module is limited to be installed in the specific final product(Model: TL19BNN2, TL19BNN1).
The host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.
The module is authorized with trace antenna design type.
The trace antenna design must be performed as specified in the manual.
The use of any changes to the reference trace design is subject to additional testing and authorization through a Class II permissive change
The maximum antenna gain including cable loss must not exceed the table below;

Band	Frequency Range[MHz]	Maximum antenna gain (including cable loss)[dBi]	
		Main	Sub
B2	1850 ~ 1910	-3.5	-7.5
B4	1710 ~ 1755	-2.9	-9.1
B26(5)	814 ~ 849	0.35	-6.25
B12	699 ~ 716	-0.35	-7.95

The module is limited to installation in mobile or fixed applications. At least 20 cm of separation distance between the transmitting antenna device and the user's body must be maintained at all times.
The OEM integrator will be responsible to satisfy SAR/ RF Exposure requirements, when the module integrated into the host device.
The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC multi-transmitter product procedures.
Separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations.
The module is labeled with its own FCC ID. If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following:
"Contains FCC ID: BEJTM03LNNATY1"

Host User Manual
The host manual shall include the following regulatory statement;

Part 15.19: 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.

The antenna(s) must be installed such that a minimum separation distance of at least 20 cm is maintained between the radiator (antenna) and all persons at all times.