Cable and antenna solution

with cutting edge technology

RF MORECOM

COREA

MORECOM COREA Company Introduction

1. Overview for business application

2. mmWave/5G low loss & Flexible cables

3. mmWave/5G Antenna

4. mmWave/5G Antenna for CPE

Overview for business application(Antenna & RF Coax)

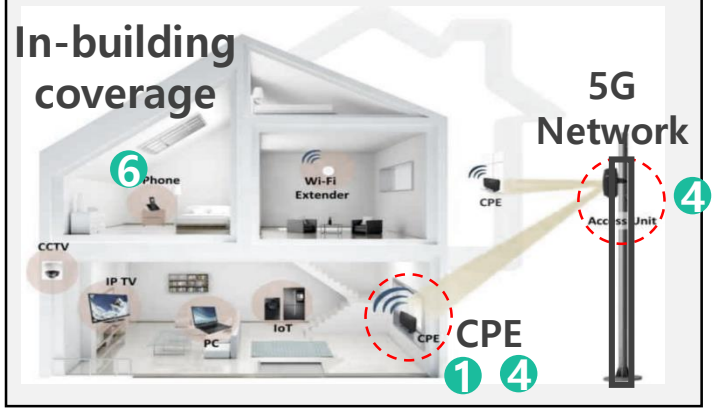
Product list

1. Multiline cable [MConflon®]
2. TLIA®
3. Flex-S®
4. mmWave Array antenna
6. In-building Antenna
7. Low-loss phase-matched microwave cable

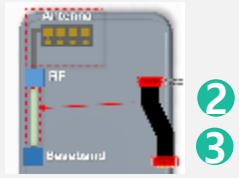
*The indicated each numbers explain which application is belonging to.

Application list

5G Infra Solution



5G Wireless Devices



5G Smartphone

Smart TV

5G Laptop

Connected Car based on 5G

Autonomous vehicles
(Light weight, EMI shield)

Overview for business application(Antenna & RF Coax)

Product list

④ mmWave Array antenna

⑤ mmWave Probe Antenna

⑦ Low-loss phase-matched microwave cable

⑧ Phase-matched adapter

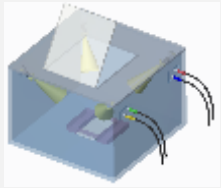
⑨ Precision RF connector

***The indicated each numbers explain which application is belonging to.**

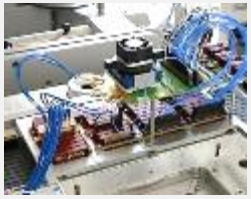
Application list

RF T&M/ 5G(mmWave) T&M

⑦ ⑧ Network Analyzer



⑤ ⑦ ⑧ 5G OTA Solution



⑤ ⑦ ⑧ ⑨ Semiconductor Test Equipment

Aerospace & Defense

Aircraft

⑦ EMI shield

⑦ Light weight cables

AESA radar system

④ ⑦ ⑧ ⑨

Ant. array RF Cables

⑦ **LOGIR** (Low-cOst Guided Imaging Rocket)

mmWave/5G low loss & Flexible cables

RF MORECOM
COREA

High-end mmWave/5G cable technology – In Production

Conflon®

EMI shielded
Light weight

- Element Tech.

- Application

➢ **World's 1st technology**

➢ **200% better performance**

Zenild®

Light weight / EMI shielded
Highly tensile

- Element Technology
  - Plating on fiber
  - Stronger than steel
  - Same electrical conductivity as silver

- Application

■ 60% less weight in same size

➢ **World's 2nd in production after NASA**

➢ **130% better performance**

Aeroflon®

Low loss for 5G (up to 67GHz)
Phase stable / low weight / highly flexible

- Element Tech

Aeroflon® PTFE

- Material
- Low dielectric constant

- Application

5G Infra

➢ **In global top 10**

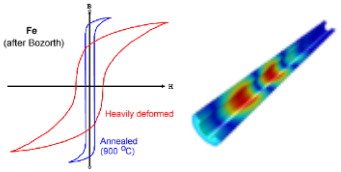
➢ **More than 130% better performance**

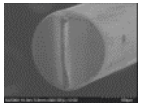
High-end mmWave/5G cable technology –Under development

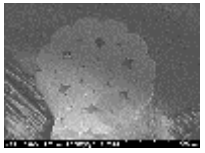
Coolductor®

Super low loss
High power rating

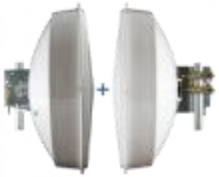
• Element Technology





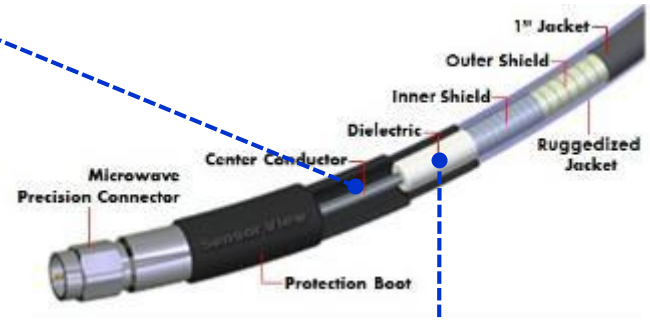


• Application



5G Antenna

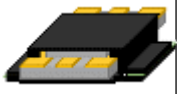
- **World's 1st technology**
- **More than 300% better performance**



Nanoflon®

Super low loss flexible dielectric material

• Element Tech



Low permittivity material

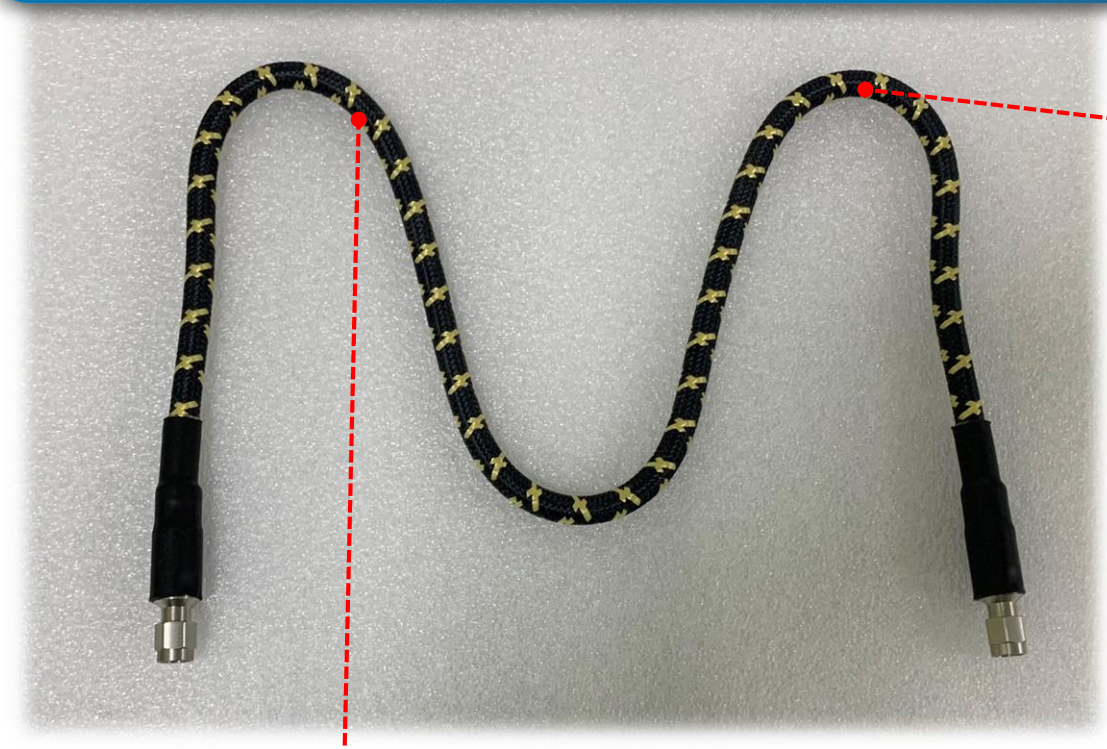
• Application

100% used in 5G smart phones

- **World's 1st technology**

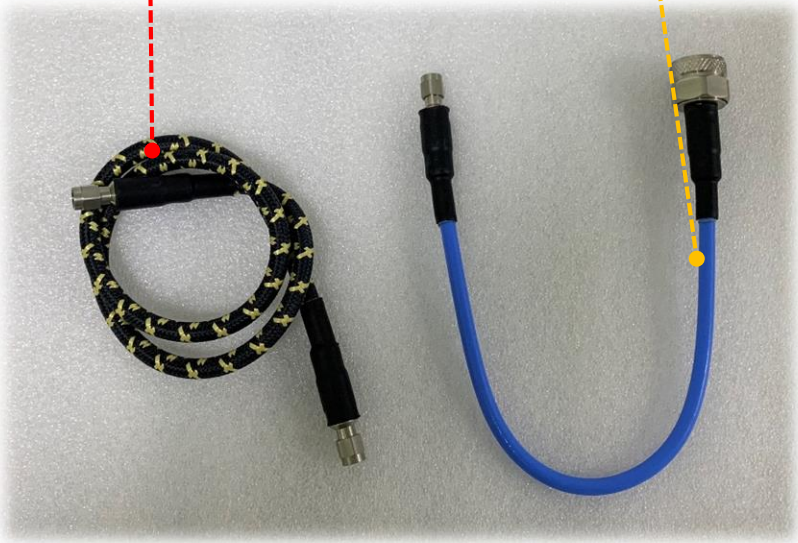
Big advantage for mmWave cable solution

Very Flexible cable - MORECOM GEN2 cable



20mm
Bend Radius
MORECOM's

30mm
Bend Radius
Competitor's



ARAMID YARN

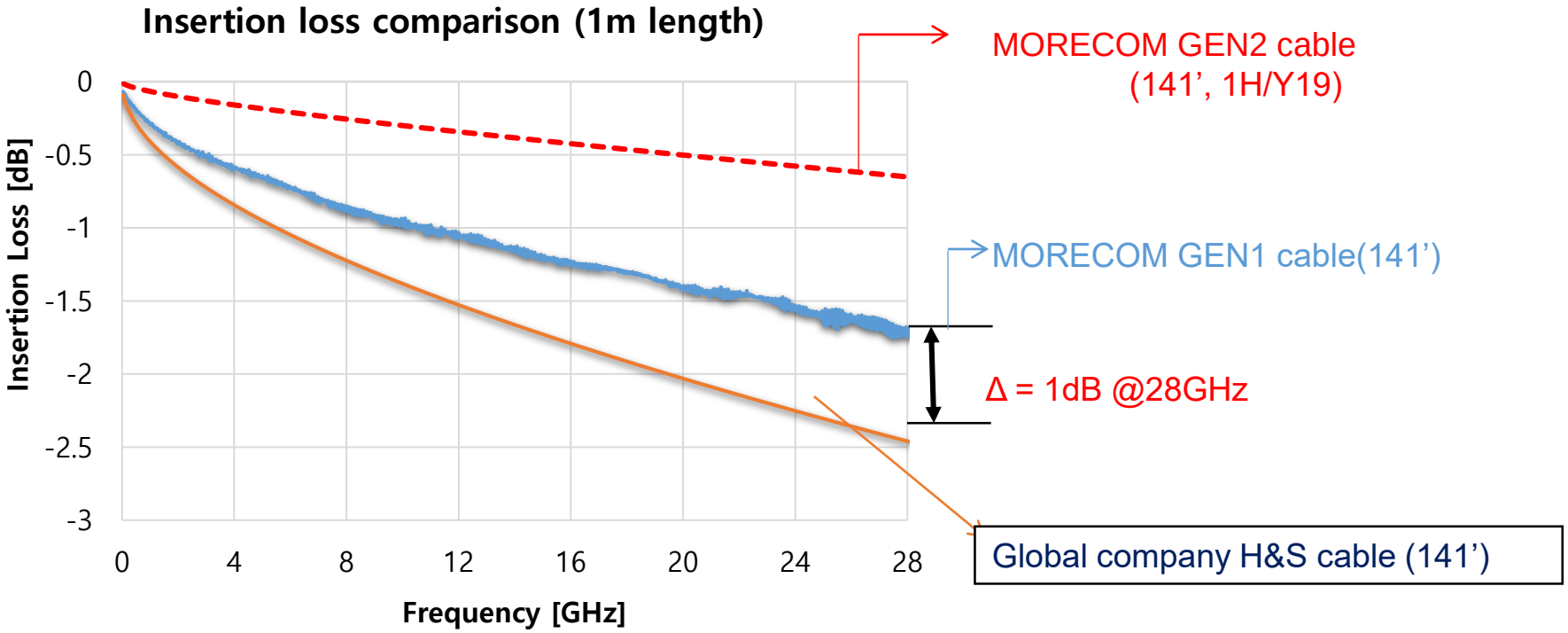
High

*** Temperature**
*** Abrasion Resistance**
*** Tensile Strength**

Big advantage for mmWave cable solution

- mmWave(5G) cable Issue : Serious performance degradation of loss & phase characteristics

Super low loss cable for mmWave



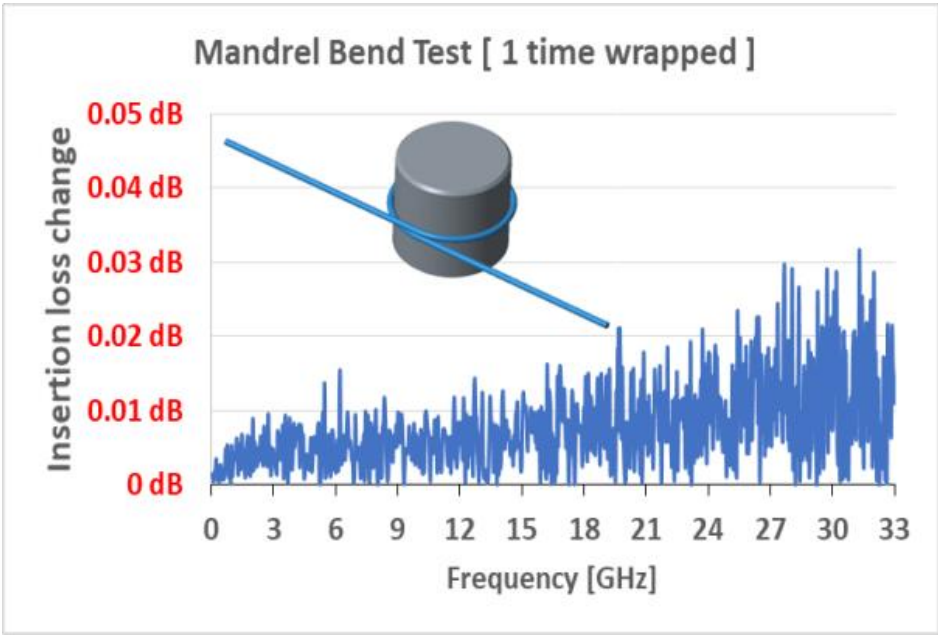
✓ **Performance comparison for 1m test cables**
- General PTFE (Teflon) 141" cable
- MORECOM 141 cable for 5G (SSV-32-141)

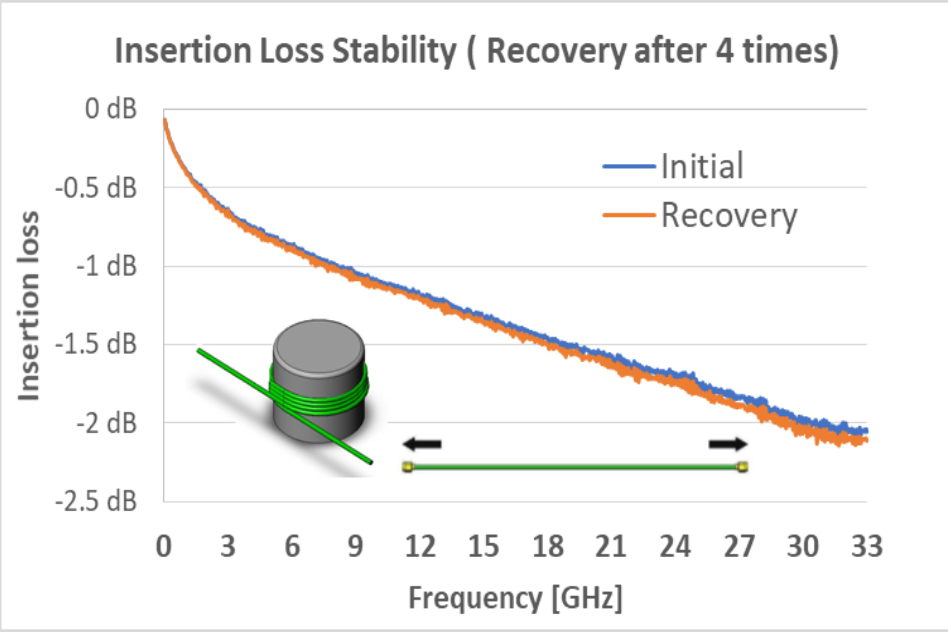
Big advantage for mmWave cable solution

- mmWave(5G) cable Issue : Serious performance degradation of loss & phase characteristics
- Target : **Low loss, High Phase stability, Phase matching, Light weight**

Loss & phase stability of cable

Loss & structure stability vs. bending

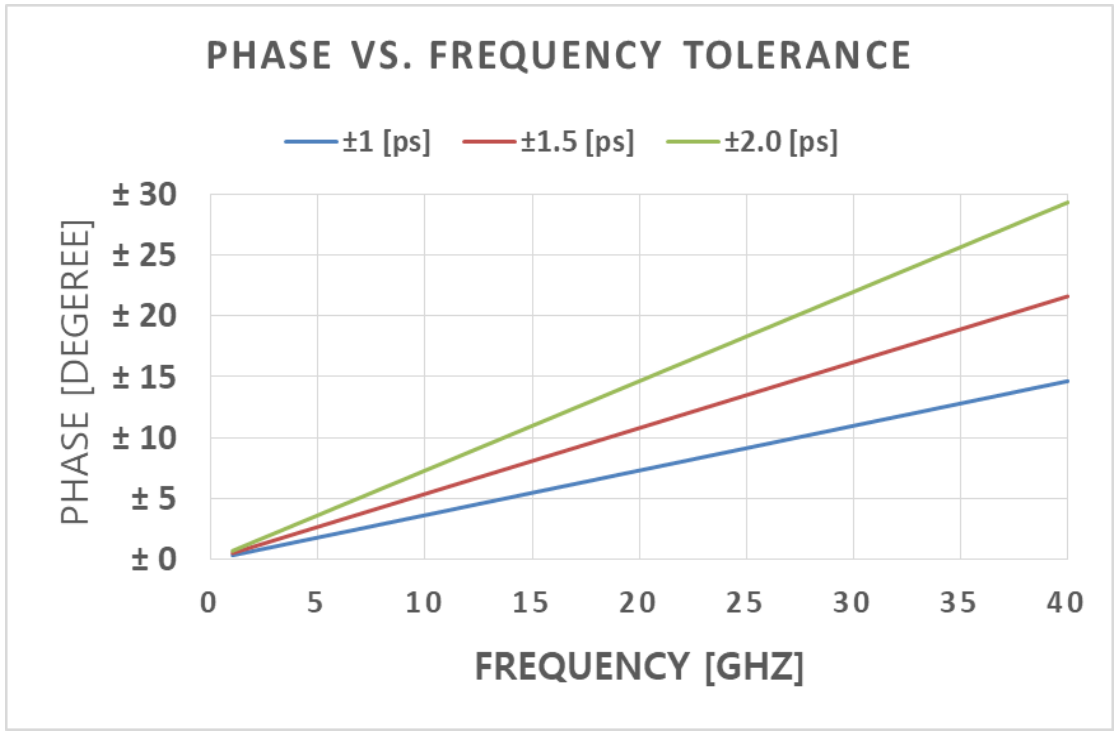


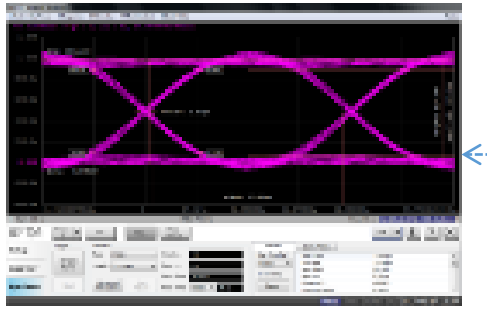


Big advantage for mmWave cable solution

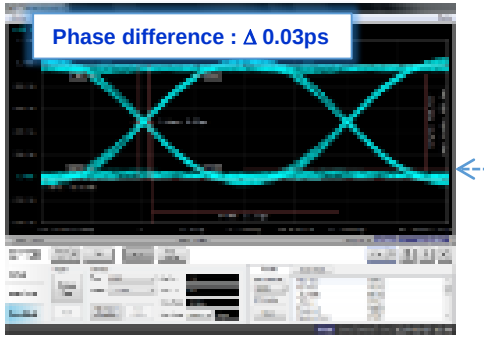
- mmWave(5G) cable Issue : Serious performance degradation of loss & phase characteristics
- Target : **Low loss, High Phase stability, Phase matching, Light weight**

Excellent phase matching technology





Cable 1 : SMA(m) – CSVA1 – SMA(m) 39.4 inch



Cable 2 : SMA(m) – CSVA1 – SMA(m) 39.4 inch

Big advantage for mmWave cable solution

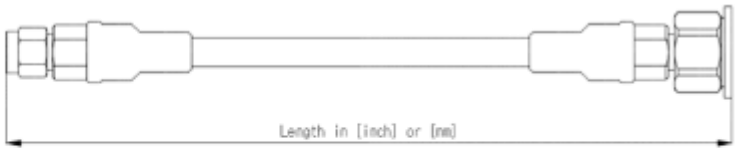
- mmWave(5G) cable Issue : Serious performance degradation of loss & phase characteristics
- Target : **Low loss, High Phase stability, Phase matching, Light weight**

Ultra low weight for aircraft market

Reduce total cable weight 30%↓

Aeroflon® series line up

• Part number for ordering



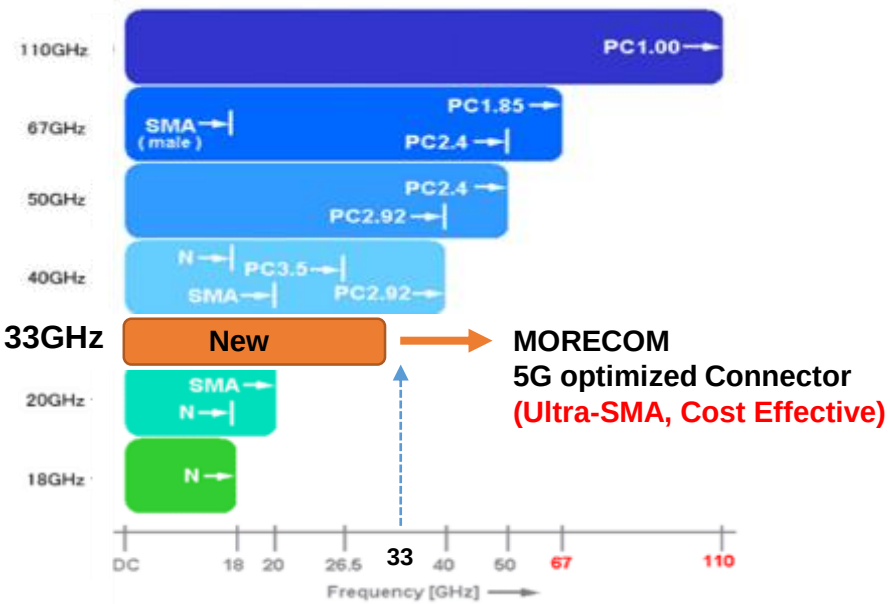
SMA(m)ST – CSVA1 – N(m)ST – 1000mm

1 2 3 4

Sequence	Designation
1	SMA male straight
2	CSVA1 Series Cable
3	Type N male straight
4	Assembly Length in [mm]

• Connector for assembly

• Operating frequency of connectors



Connector Insertion Loss & VSWR

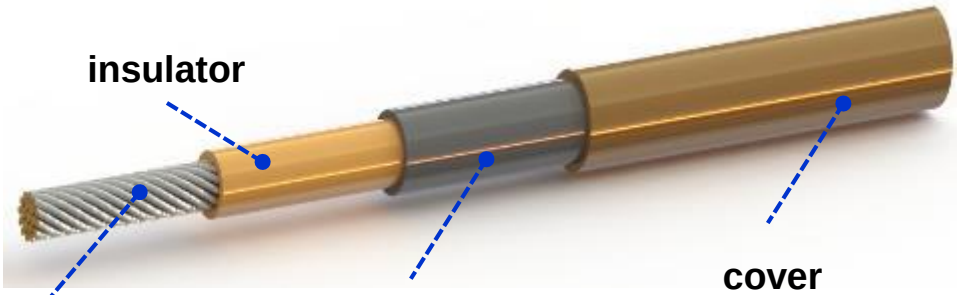
Frequency (Type)	Connector			ELECTRICAL PERFORMANCE	
	SMA	N	K(2.92)	IL dB/ft [dB/m]	VSWR
18 GHz(SMA/N), 26.5 GHz(SMA) 40 GHz(2.92mm)	✓	✓	✓	N : -0.05 dB@ 18GHz SMA : - 0.07 dB @18GHz K : - 0.12 dB @ 40GHz	1.22 : 1

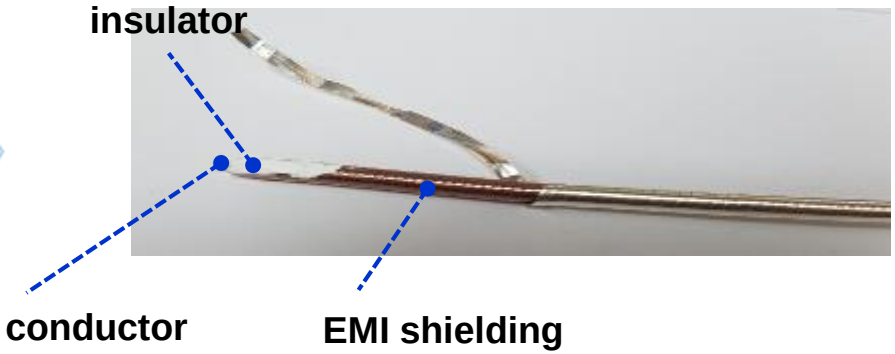
Full EMI shielding cable

Full EMI shielding cable

- Fully EMI shielded cable solution needed
- Proposed Conflon® technology can fully support EMI shielding performance

Military/airplane EMI shielding solution





Competitiveness

Incomparable competition solution.

Performance

- Ultra Flexible
- Better Insertion Loss stability
- Better Phase stability
- Better Skew

Effectiveness

- Optimized/ customized 33GHz /28GHz low loss cable for 5G.
- Cost-efficient special SMA connectors

Price

- Incredible price due to 100% localization
- manufacturing coaxial cable & connectors in house (Korea)

Lead time

- Short Delivery 6 weeks

Electrical Data Comparison vs Global companies

"DC ~ 26.5GHz for 5G" Low Loss Phase Stable Test cable

DC ~ 26.5GHz						
		MORECOM COREA	Huber + Suhner	Gore	Junkosha	Radiall
Part No.		CSVA1	SUCOFLEX 104D	0TD01D010360	MWX021	Test Pro5
Dielectric Type		Aeroflon®	LD PTFE	e PTFE	LD PTFE	e PTFE
Velocity of Propagation		77%	77%	85%	79%	84%
Out Diameter [mm]		6.7	6.1	8	8.5	5.2 (no armor)
Typical MBR [mm]		25	20	25.4	30	25
Temperature Range		-50 ~ 135℃	-55 ~ 125℃	-55 ~ 125℃	-30 ~ 85℃	-55 ~ 125℃
Phase Stability vs bend		<4°(Typ.) < 6°(Max)	< 45°	< 6.56°	< 5.7°	< 4.3° @18GHz
Jacket Material		Aramid Jacket	Aramid Jacket	PTFE Braided	Polyester fiber	FEP
Connector Type		HFSMA	3.5mm	3.5mm	3.5mm	SMA
Attenuation [dB / 0.91 m] [dB / 36 in]	3 GHz	0.22	0.37	0.45	0.53	0.38
	6 GHz	0.57	0.55	0.70	0.75	0.52
	12 GHz	0.85	0.82	1.05	1.12	0.75
	18 GHz	1.07	1.00	1.40	1.44	0.92
	26.5 GHz	1.35	1.27	1.70	1.84	1.15

Electrical Data Comparison

"DC ~ 30GHz for 5G" Low Loss Phase Stable Test cable

DC ~ 30GHz for 5G						
		MORECOM COREA	Huber + Suhner	Gore	Junkosha	Radiall
Part No.		CSVA2	SUCOFLEX 102D	0D0CQ0CQ0360	MWX051	Test Pro3
Dielectric Type		Aeroflon®	LD PTFE	e PTFE	LD PTFE	LD PTFE
Velocity of Propagation		77%	77%	85%	79%	76%
Out Diameter [mm]		5.8	4.6	6.1	6.6	7.04
Typical MBR [mm]		25	15	25.4	30	25
Temperature Range		-55 ~ 135℃	-55 ~ 125℃	-55 ~ 75℃	-30 ~ 85℃	-55 ~ 125℃
Phase Stability vs bend		<5°(Typ.) < 10°(Max)	< 36°	< 9.58°	< 9°	< 7° @40GHz
Jacket Material		Aramid Jacket	Aramid Jacket	PTFE Braided	Polyester fiber	PTFE Braided
Connector Type		HFSMA	2.92mm (K)	2.92mm (K)	2.92mm (K)	2.92mm (K)
Attenuation [dB / 0.91 m] [dB / 36 in]	6 GHz	0.68	0.82	1.25	1.38	1.60
	12 GHz	1.00	1.22	1.75	1.97	1.90
	18 GHz	1.26	1.55	2.25	2.44	2.10
	28 GHz	1.63	1.95	2.75	3.08	2.30
	30 GHz	1.70	2.05	2.85	3.20	2.35

Electrical Data Comparison

"DC ~ 40GHz for 5G" Low Loss Phase Stable Test cable

DC ~ 40GHz for 5G						
		MORECOM COREA RF MORECOM COREA	Huber + Suhner HUBER+SUHNER	Gore GORE	Junkosha Junkosha	Radiall Radiall
Part No.		CSVA4	SUCOFLEX 102D	0D0CQ0CQ0360	MWX051	Test Pro3
Dielectric Type		Aeroflon®	LD PTFE	e PTFE	LD PTFE	LD PTFE
Velocity of Propagation		77%	77%	85%	79%	76%
Out Diameter [mm]		5.4	4.6	6.1	6.6	7
Typical MBR [mm]		25	15	25.4	30	25
Temperature Range		-55 ~ 135℃	-55 ~ 125℃	-55 ~ 75℃	-30 ~ 85℃	-55 ~ 125℃
Phase Stability vs bend		<6°(Typ.) < 10°(Max)	< 36°	< 9.58°	< 9°	< 7° @40GHz
Jacket Material		Aramid Jacket	Aramid Jacket	PTFE Braided	Polyester fiber	PTFE Braided
Connector Type		2.92mm (K)	2.92mm (K)	2.92mm (K)	2.92mm (K)	2.92mm (K)
Attenuation [dB / 0.91 m] [dB / 36 in]	6 GHz	0.80	0.82	1.25	1.38	1.60
	12 GHz	1.17	1.22	1.75	1.97	1.90
	18 GHz	1.46	1.55	2.25	2.44	2.10
	26.5 GHz	1.85	1.90	2.70	3.00	2.24
	28 GHz	1.90	1.95	2.75	3.08	2.30
	40 GHz	2.35	2.40	3.30	3.74	2.70

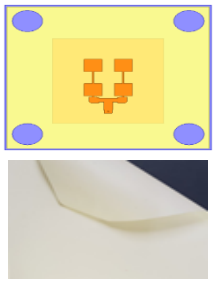
mmWave/5G Antenna

RF MORECOM
COREA

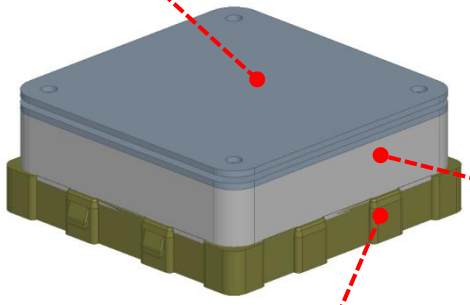
High-end mmWave/5G antenna technology – Element Tech. & Performance

SLLFM®

Low Loss (dielectric loss) Antenna



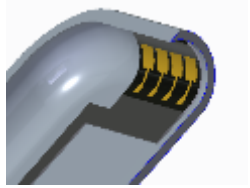
- Low Loss mmWave Antenna Technology
- Minimized dielectric loss solution @mmWave



TLIA®

Transmission Line Integrated Antenna for 5G/60GHz

- 2.5D flexible Low Loss mobile antenna
- Low loss transmission line Integrated MIMO antenna
- Beam-forming support



Cable integrated 5G antenna for smart phone

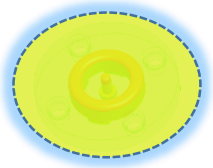
Cable integrated 60GHz antenna for smart TV

JPlug®

Just plug-in-connection minimized board-to-board connector for 5G antenna

- Low loss solution
- Minimized horizontal-to-vertical transition solution
- Low cost solution

Existing connector (3 parts)



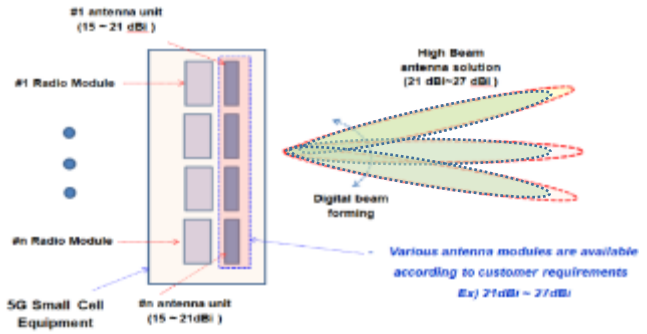
Proposed new connector (1~2 parts)

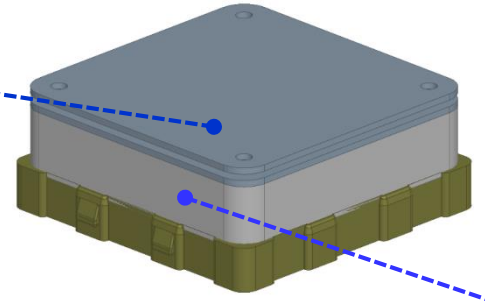
High performance mmWave/5G antenna technology – Prototype & Performance

Gain+®

Low loss planar lens for additional higher gain

- Low loss dielectric lens solution
- Additional antenna gain available for 5G small-cell cell planning
- High performance design @ small size

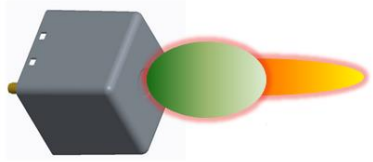




MFocus®

Antenna beam/gain variable solution w/o phase shifter for in-building solution

- Variable Beam & Gain Without phase shifter
- Available for tunable gain/ beam tilt of 5G antenna



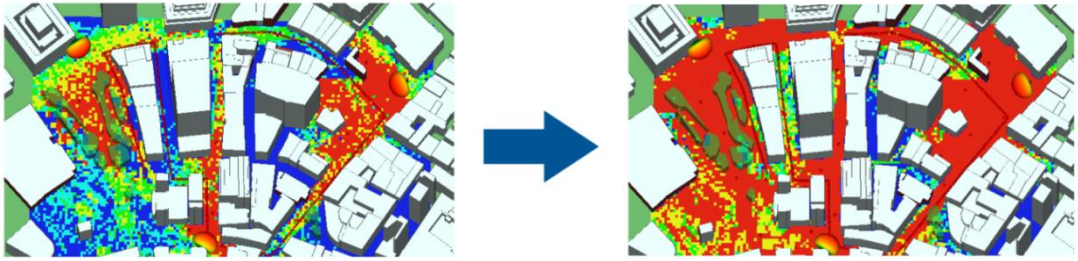
Expected 5G antenna system

Gain+® (Antenna technologies for wider beam scanning + Higher gain)

Support for various service by using massive MIMO beam forming
High gain, compact size, and wide beam steering by using antenna technologies with super focusing array

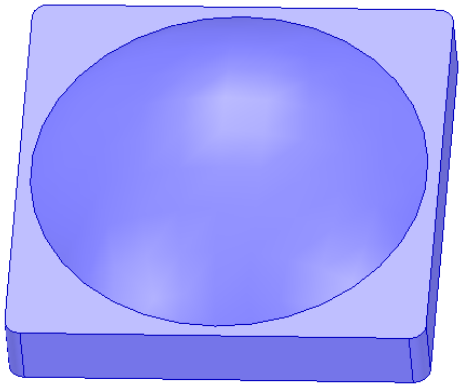
Strength

Massive MIMO antenna for wide range steering
→ Better than 8% (±65°)
→ Extended coverage (minimized blind)
→ Antenna technologies for super focusing array



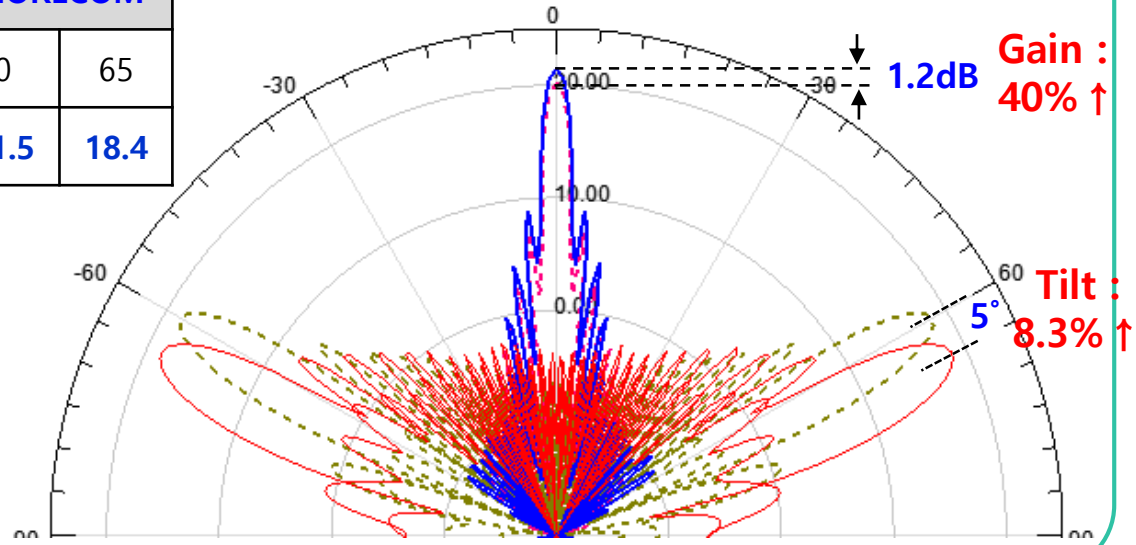
[Improvement of cell coverage by applying SMFinder-BSA]

Antenna structure



Size: 20x20cm²

Parameter	Typical		MORECOM	
Beam tilt [˚]	0	60	0	65
Gain [dBi]	20.3	18.3	**21.5**	**18.4**



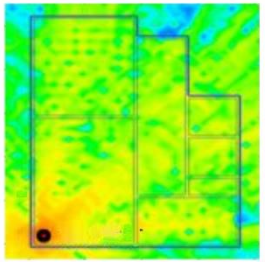
Ultra-Band Radiator (Antenna technologies for Ultra Wideband and Higher Gain)

Ultra wideband antenna for in-building solution
Antenna technologies for high gain

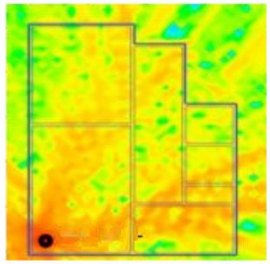
Strength

Ultra wide band antenna with higher gain
→ Ultra wide band antenna (6GHz bandwidth)
→ Ecosystem available with high gain & compact size
→ Higher service quality via lower maintain cost

[General service]

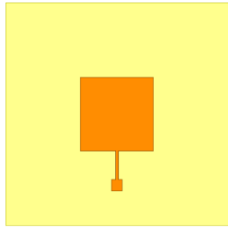


[Advanced service]

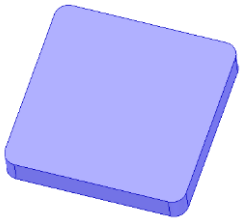


Higher service quality

Antenna structure



Typical

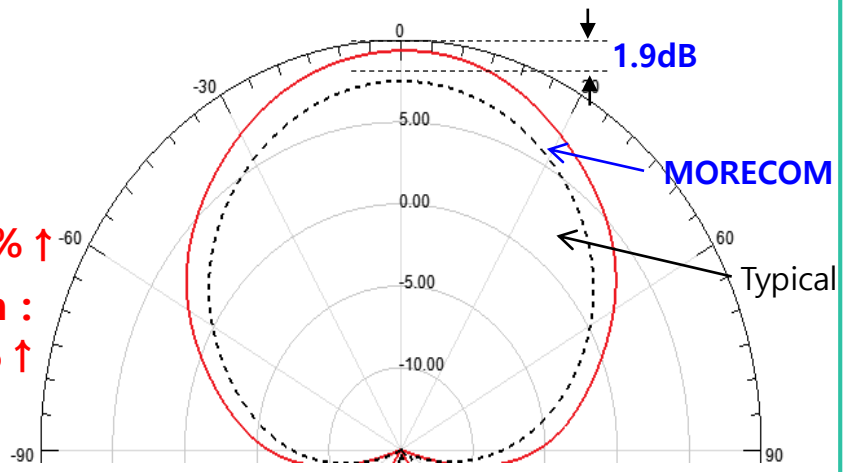


MORECOM

Parameter	Typical	Sensorview
Freq. [GHz]	27.5 ~ 28.5	24 ~ 30
BW[GHz]	1.0 (3.6%)	6.0 (22.2%)
Gain [dBi] @ 28GHz	7.5	9.4
HPBW [˚] @ 28GHz	74	73

BW: 600% ↑

Gain : 63% ↑



@ 28 GHz

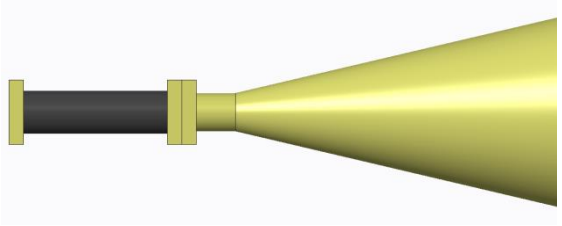
Low cost SET UP Solution for 5G CP Antenna & Cable

Low cost and compact size for 5G CP Antenna & Cable at OTA Chamber, and this solution is very useful for smart phone factory line and 5G module and products production line.

Current test set up

Horn type Antenna

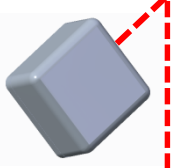
- **SIZE : 177.8 * Φ63.7mm**
- **Volume : 179,307㎣**



New concept

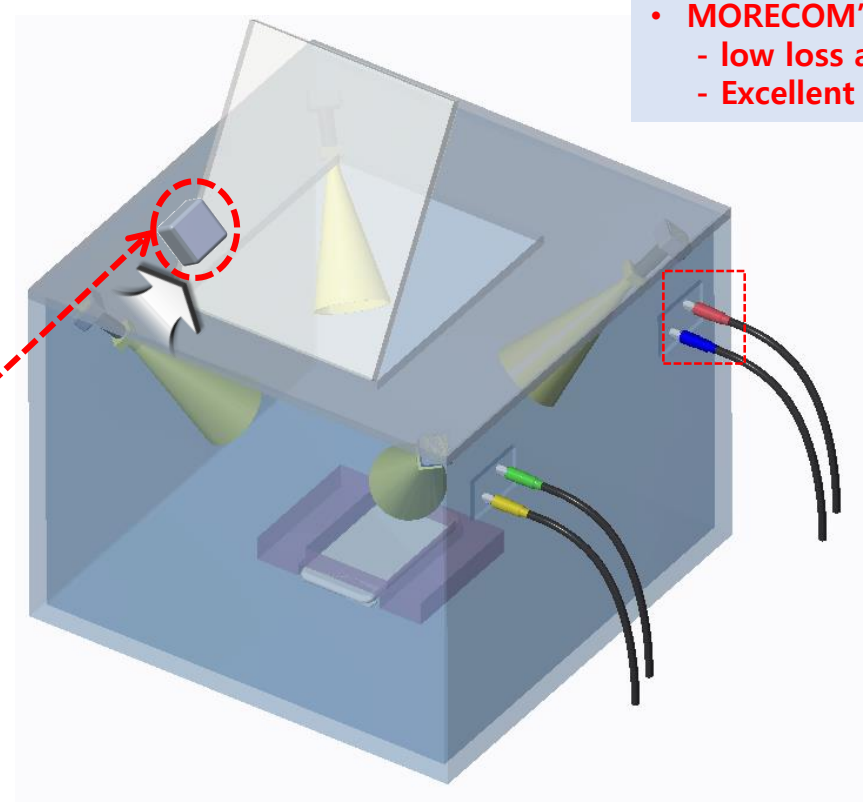
Cube type Antenna

- **SIZE : 26 * 26 * 15mm**
- **Volume : 10,140㎣**

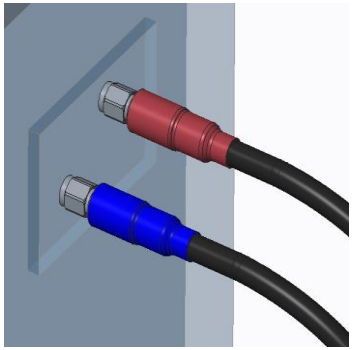


Antenna has 70~90% downsized

Compact multi-function miniature 5G antenna (26GHz/28GHz/39GHz)



- **MORECOM's mmWave cable**
  - **low loss and very flexible**
  - **Excellent Phase & loss stability**

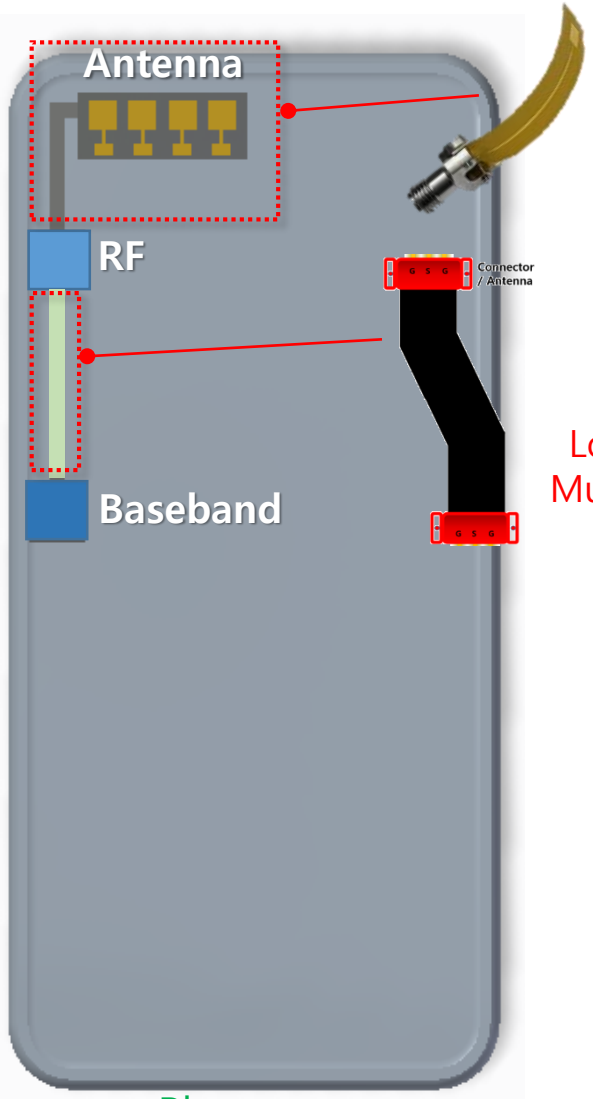


mmWave/5G Antenna Line Solution for CPE

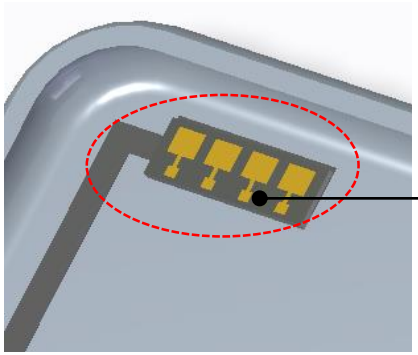
RF MORECOM
COREA

5G ALD(Antenna Line Product) for Smart Phone [Multi-line Cable+Antenna]

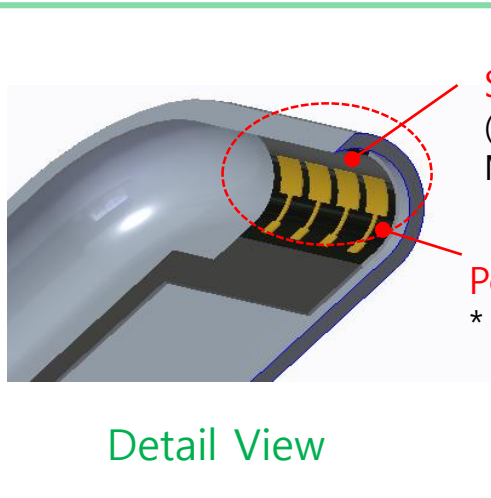
*** Expected 5G Smart Phone & MORECOM's Proposal**



[Typical hard PCB Antenna: Q-company solution]



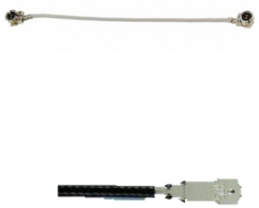
[Proposed Antenna] : expected better performance. than Q-comp.



Low Loss Flexible Cable comparison for 5G Antenna Line

1G/2G/3G

RF Coax Cable



4G/4.5G

muRata

Multiline Cable (Murata)

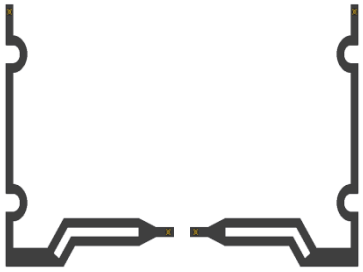
SV typical lead times will be approx. 6 weeks (Oversea)

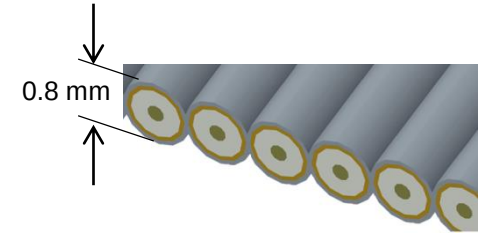
LCP

ε_r = 2.9~3.3

5G

RF MORECOM COREA





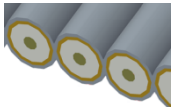
Multiline Cable

Nanoflon®

ε_r < 2

Flex-S®

ε_r ≈ 2.2



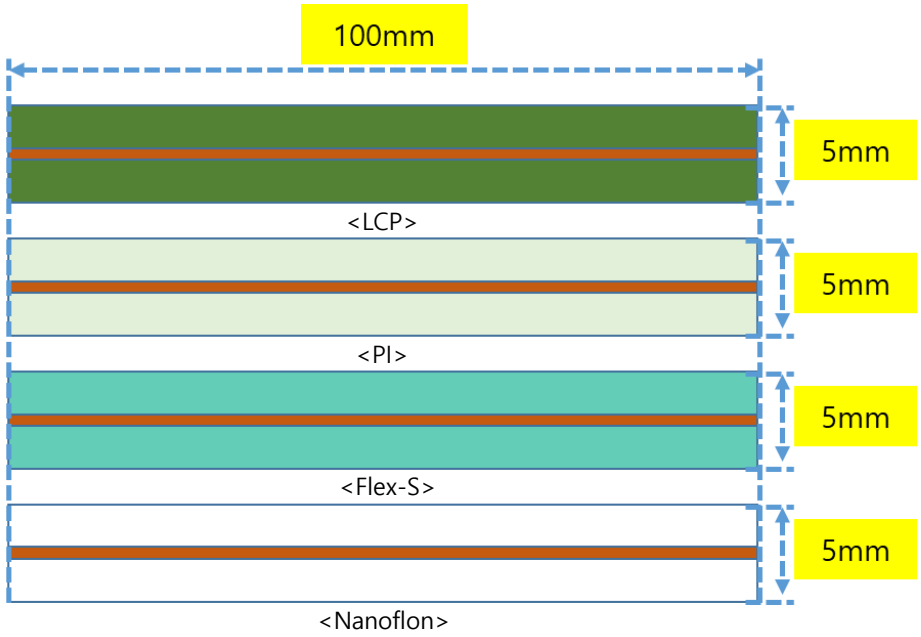
MConflon®

ε_r ≈ 2.2

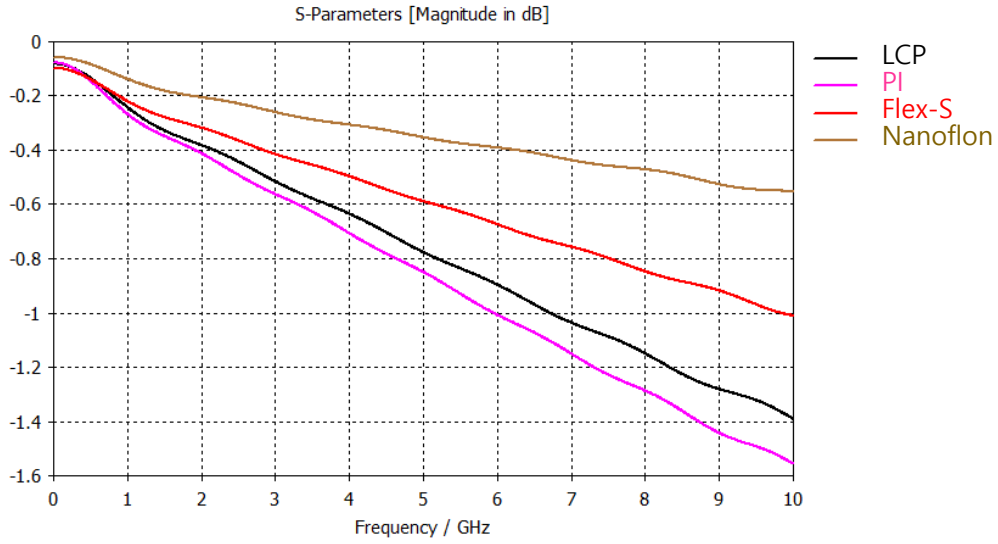
	Competitor(Murata)	MORECOM Solution		
Core Material	LCP	**Nanoflon®**	**Flex-S®**	**MConflon®**
Cost	Higher	*Lower*	*Lower*	*Lower*
Performance	Medium	*High*	*High*	*Very high*

Performance Comparison for 5G/mmWave Application

➢ Comparison of Transmission Line with different materials



Simulation Condition				
Parameter	LCP	PI	**Flex-S**	**N94K**
Frequency(GHz)	0.1 ~ 10			
Dielectric Constant	2.9	3.5	**2.1**	**1.56**
Dissipation Factor	0.001	0.0027	**0.0002**	**0.00008**
PCB size(W x L x H)	5 x 100 x 0.174 mm			

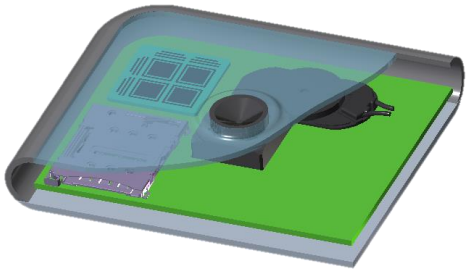


Simulation results							
Frequency (GHz)	Insertion Loss				Difference		
	LCP	PI	**Flex-S**	**N94K**	LCP	PI	Flex-S®
1	-0.24	-0.27	**-0.22**	**-0.14**	0.10	0.13	0.08
3.5	-0.58	-0.63	**-0.45**	**-0.29**	0.29	0.34	0.16
5	-0.78	-0.85	**-0.59**	**-0.36**	0.42	0.49	0.23
10	-1.39	-1.56	**-1.01**	**-0.56**	0.83	1.00	0.45

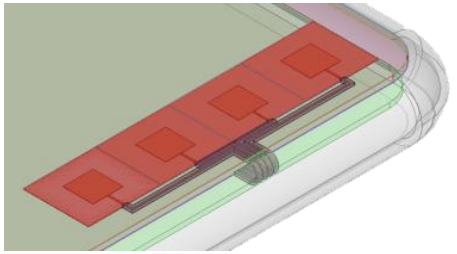
Typical Antenna VS TLIA® Comparison

Design

Typical Antenna



TLIA®

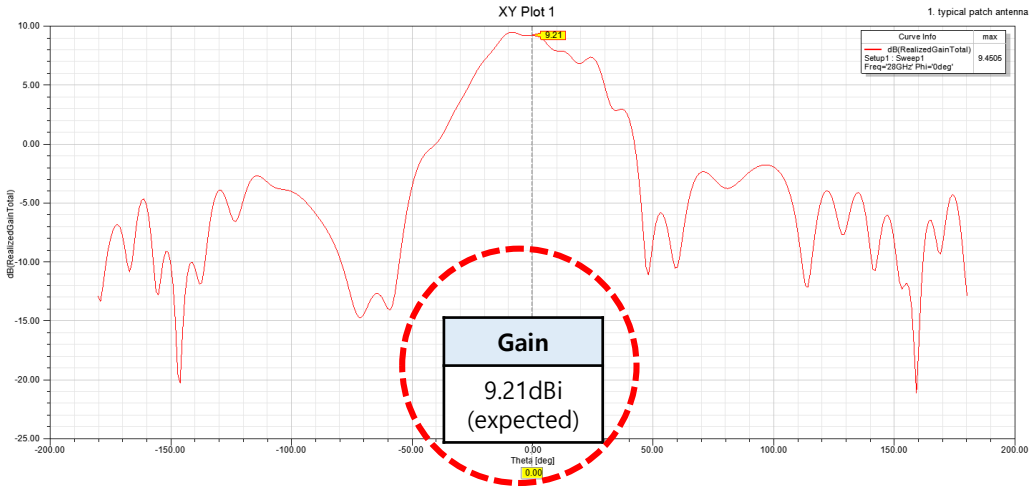


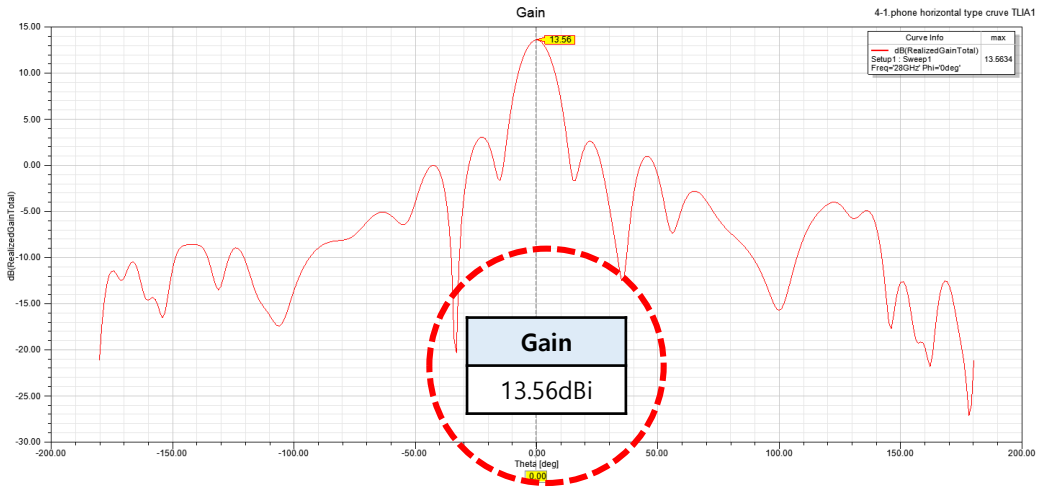
Pros & Cons

- ☺ No transmission signal loss due to direct contact between module and antenna
- ☹ Highly influenced by surrounding modules due to its fixed position
- ☹ Difficult to optimize the distance between the antenna & housing

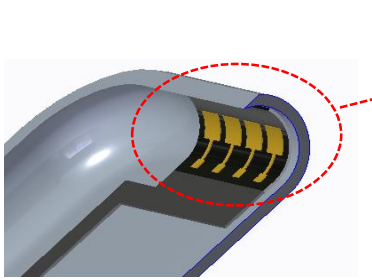
- ☺ Minimal influence by surrounding modules due to its flexibility
- ☺ Minimal loss by low loss, low dielectric material
- 😐 Small loss caused by flat cable

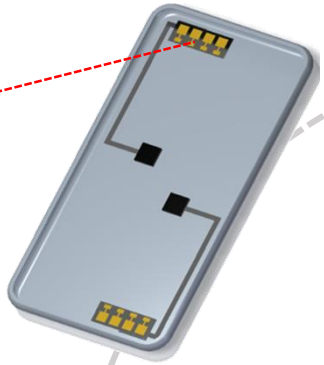
Performance





Market Potential & Application of TLIA



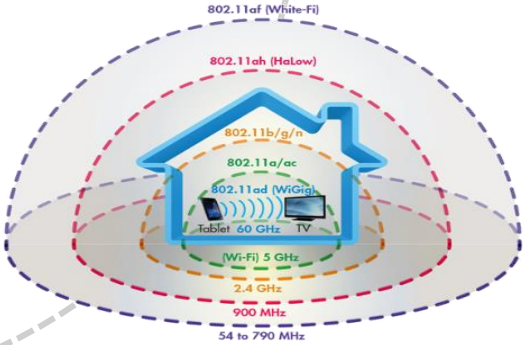


Smart Phone

Smart TV

TLIA®

Tablet PC



WiGig

TLIA® solution can be used in various IT application with huge market potential!

Advantage of MORECOM's solution

- **Various advanced technologies that can be used in many different industries**

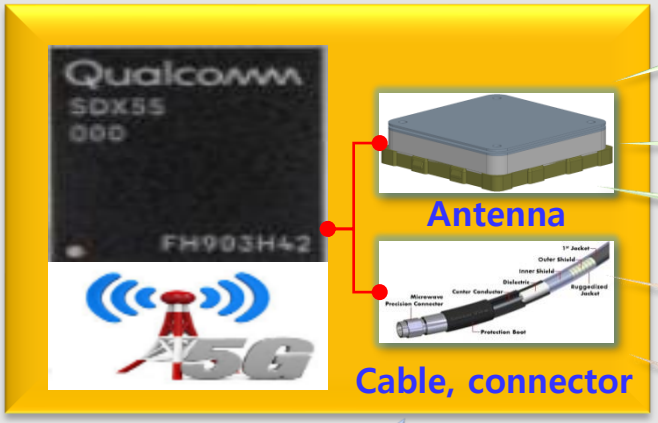
		Applicable product		Core technologies of MORECOM							Application
		Cable	Antenna	Lower dielectric constant **Aeroflon®**	Lower permittivity **Nanoflon®**	Lower conductor loss **Coolductor®**	Plating on PTEE **Conflon®**	Plating on fiber **Zenild®**	Precision assembly	Composite design	
1	**Low loss**	●	●	○	○	○	○		○		RF connectivity
2	**Low noise**	●					○	○			High sensitivity measurement
3	**Light weight**	●	◐	○	○		○	○			Aircraft, Automotive
4	**Low profile**	●		○	○	○	○			○	Mobile phone, AP
5	**Low cost**	●	●	○	○		○				Test & Measurement cable
6	**Flexibility**	●	●	○				○			Test cable & RRH
7	**High power**	●	●	○	○	○					High power component, TVAC
8	**EMI shielding**	●					○	○	○		Chamber, defense system
9	**Phase stable**	●	●	○	○						Phased array antenna, Radar
10	**Phase matching**	●		○			○		○		Phased array, High speed digital
11	**Composite**	●						○	○	○	5G infrastructure

Global monopoly technology introduced by MORECOM

Advantages of MORECOM's 5G Antenna/Cable Solution

Better 5G System Performance, Lower CAPEX/OPEX

Low loss materials & antenna design solution for mmWave/5G band



1. High Gain & Low Loss (conductor + dielectric) antenna
   +1.X~2.XdB gain
2. Low b'd-to-b'd connector loss antenna
   + 0.5 ~ 1.XdB gain
3. Low Loss Planar Lens/ Pattern Reshaping
   + 1~2 dB gain
4. Super Low Loss Cable
   1dB/m ↓ @GEN1, +2dB/m ↓ @GEN2
5. High Phase/Loss(Insertion) Stability, Perfect Phase Matching Cable
   3~4 times better
6. Ultra Low Weight Cable for Aircraft
   weight 30% ↓

max. +3dB (200% ↑) (material solution)

max. +2dB(60% ↑)/m (material solution)

Thank You

MORECOM COREA

kate@rfmkorea.com