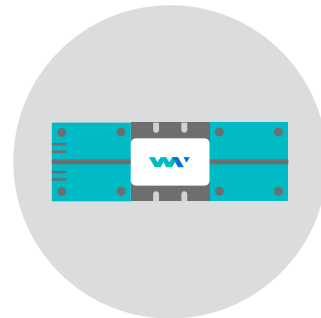
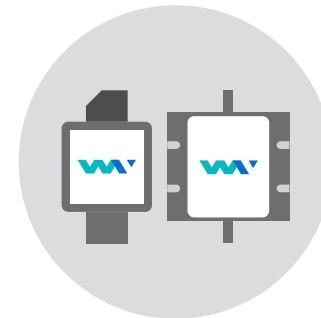
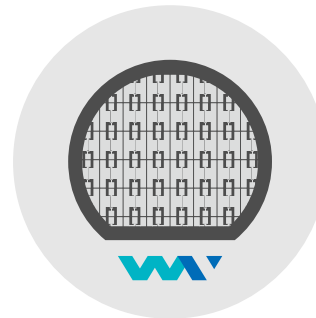




# Durable GaN **born to be strong**

Company Introduction  
April 2020



# Wavice has competitive edge for each sectors. Especially Wavice is only RF GaN manufacturer in South Korea.

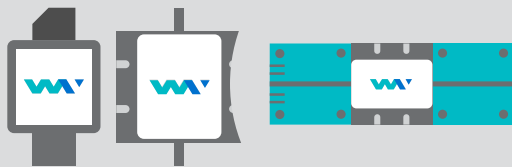
## Device & Foundry



- **The only RF GaN fab in Korea**
- Provides 0.4um gate process
  - Supports up to 6GHz & 28~50Volt
- **Provides 0.3um gate process**
  - **A unique process in the global market**
  - Supports up to 10GHz & 50Volt
- Durable GaN (Enhanced reliability)
- **0.4um Foundry service open**
- 0.3um Foundry service will be provided 2H of 2020

## Package

## Module



- **No. 1 GaN Module Provider to ROK Military**
  - Applied to various environments including aviation, ground, naval and missiles
- **Specialized for fully-matched Amps for defense application**

# Wavice(Wave + Device) provides vertically integrated GaN RF technology to fully address defense SR<sup>1</sup> system and commercial 5G system

## OVERVIEW

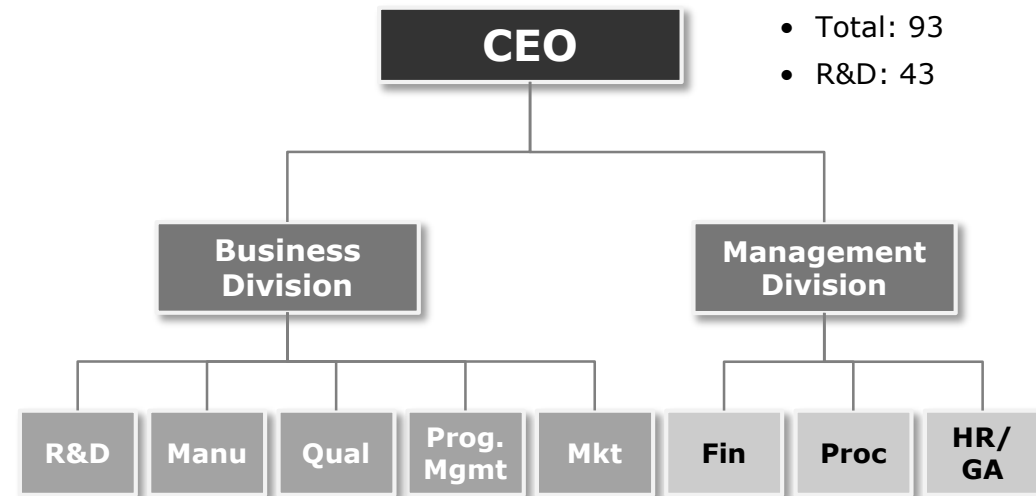
Summary	
<b>Wavice Inc.</b>	
CEO	Jung Gon Kim
Product	<b>RF GaN die · Packaged TR · RF Module</b>
HQ	Hwaseong-si, Korea (South)
Website	www.wavice.com

Summary of B/S	
Item	Value (MUSD)
<b>Asset</b>	<b>29.2</b>
<b>Liability</b>	<b>26.2</b>
Equity	3
L+E	29.2

1. SR: Surveillance and Reconnaissance

2019.12.31

## ORGANIZATION



## CERTIFICATION



# Wavice have been building up its technology across all GaN RF domain by conducting major defense projects in Korea since 2011

## 2020

- **0.3um GaN HEMT process is in progress (targeting technology qualification in 4Q)**
- Certified with ISO14001

## 2019

- **Opened 0.4um GaN foundry service (discrete transistor only)**
- **Completed technology qualification of 0.4um GaN process**
- Certified as one of the 100 Material/Components hidden champion by Korea Gov
- Completed GaN RF Fab expansion

## 2018

- Completed technology development of 0.4um GaN HEMT and Demonstrated 180W IMFET at Korea Military Exhibition
- Completed Ku-Band/W-Band SSPA development
- Certified with AS9100D

## 2017

- **Established Wavice Inc (Spinoff from GigaLane Co., LTD, a KOSDAQ listed company)**
- Completed S-Band Tx Pallet development
- Certified with Inno-Biz company by SMBA

## 2016

- Completed C-Band 4KW SSPA development

## 2015

- **Completed GaN RF Fab** installation
- Completed L-Band TRM development

## 2014

- Completed S-Band TRM development

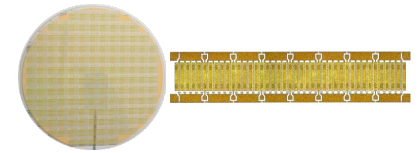
## 2013

- Completed Ku-Band SSPA development

## 2012

- Completed X/K-Band GaN amplifier development

Device & Foundry



IMFET for military radar



S-Band 100W

S-Band 200W

X-Band 75W

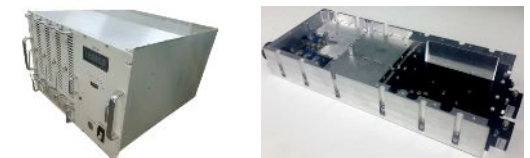
Tx Pallet for military radar



S-Band 100W

S-Band 200W

SSPA














C-Band 4kW

Ku-Band 40W

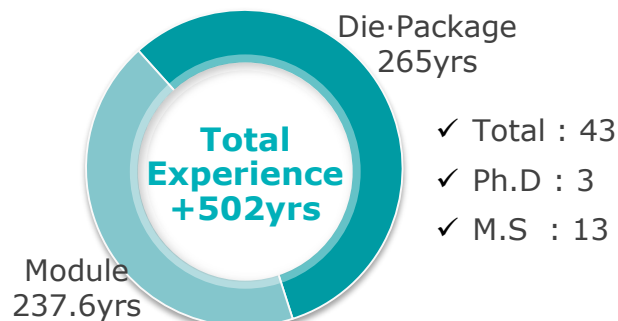
# Wavice is the only Korean company equipped with die-package-module value chain and has the greatest technology competitiveness in GaN in Korea

#1 domestic  
R&D  
And  
production  
facilities

DIE	PACKAGE	MODULE	RELIABILITY
			
The only RF GaN Fab in ROK	Auto Package Line	Module Integration Line	Reliability Test Line
 	 		 

Technical  
Competitiveness

R&D Snapshot	Intellectual Property	R&D History
<ul style="list-style-type: none"> <li>CTO with more than 15yrs of development, processing, mass production, reliability experience in 3 major GaN global companies leading technology               <ul style="list-style-type: none"> <li>The only one w/relevant experience in Korea</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>21 key patents &amp; PCT registered               <ul style="list-style-type: none"> <li>High-electron-mobility transistor and manufacturing method therefor</li> <li>High-electron-mobility transistor and method for fabricating same</li> <li>High-frequency power amplifier</li> <li>GaN-based high electron mobility transistor device and method of manufacturing the same</li> <li>Nitride-based electronic device and manufacturing method thereof</li> <li>High-frequency power transistor package and manufacturing method thereof</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Has domestic #1 S to Ka-band Defense/Commercial GaN RF PA &amp; Module track records               <ul style="list-style-type: none"> <li>S-Band 30W/150W GaN TR</li> <li>Ground MFR 200W IMFET/Module</li> <li>X-Band 20W H-MMIC development</li> <li>Ship MFR S-Band 100W IMFET</li> <li>3.1W/5W/10W 2stage Doherty PA</li> <li>Helicopter RWR RF synthesizer and RF distributor development in progress (2017)</li> <li>Ku-Band 20W, 40W SSPA</li> <li>Surveillance flight L to Ka-band wide band RF synthesizer and PLO/BIT mass production (2014)</li> <li>Flight Radar power distribution board development (2017)</li> </ul> </li> </ul>



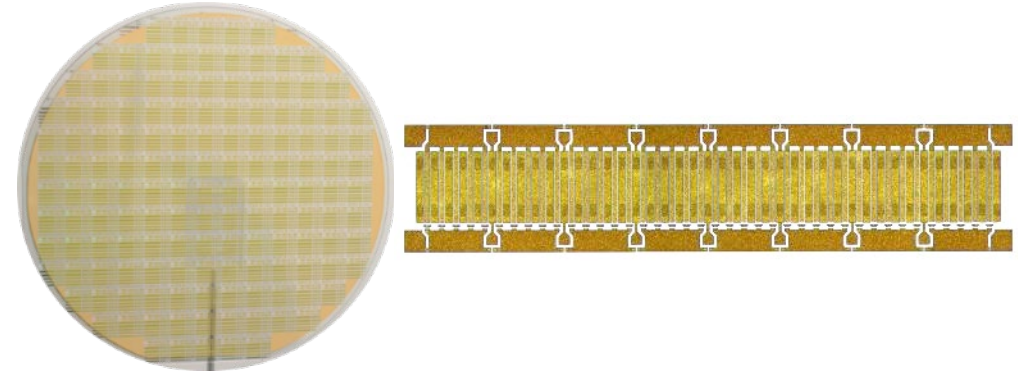


Wavice is **the only company** who has internalized RF GaN Fab in Korea.

## GaN FAB




## GaN HEMT TR



- **The only 4" GaN-on-SiC Fab in ROK**
- **85um final thickness**
- **0.4um** Gate process
  - Optical photonics
  - Supports **Up to 6GHz** frequency
  - Supports 28~50Volt
- **0.3um** Gate process
  - **A unique process that no other foundries provide**
  - Optical photonics
  - Supports **Up to 10GHz** frequency
  - Supports 28~50Volt

# A unique process(0.3um) that no other foundries provide

Tech Node (um)	P/N	F <sub>Min</sub> (GHz)	F <sub>Max</sub> (GHz)	V <sub>DS</sub> (V)	P <sub>OUT</sub> (Watt)	
					28Volt	50Volt
0.4	WG40004B	DC	6	28~50	2	4
	WG40007B	DC	6	28~50	4	6
	WG40008B	DC	6	28~50	5	7
	WG40020B	DC	6	28~50	10	18
	WG40035B	DC	6	28~50	15	30
	WG40070B	DC	6	28~50	35	64
	WG40105B	DC	6	28~50	55	85
	WG40175B	DC	6	28~50	95	140
	WG40280B	DC	4	28~50	150	215
	WG40350B	DC	4	28~50	190	350
 0.3	WG30007A	DC	10	28~50	4	6
	WG30021A	DC	10	28~50	10	18
	WG30035A	DC	10	28~50	15	30
	WG30070A	DC	8	28~50	35	64
	WG30105A	DC	8	28~50	55	85
	WG30350B	DC	6	28~50	190	350

※ The above plans may change without notice according to the development circumstances.

# Wavice specializes IMFET\* products which can save foot prints

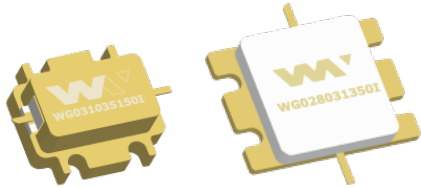
- **Performance** proven in various Korea's military projects
  - Ground reliability test passed
- **Customized packaged TR** available
  - Average development time : 4 months
    - 1<sup>st</sup> simulation data : within 3 weeks
    - ES1 test data : within 3 months
- **It only takes 2 weeks for Gov's export license to be issued**
  - Expedites development time
  - E/L requirement on specific products will be confirmed upon inquiry

\* IMFET : Internally Matched Field Effect Transistor



# Guarantees fast response within **4 months** when requested to develop Matched TR samples

## Matched Products



Application	Part Number	$F_{Min}$ (MHz)	$F_{Max}$ (MHz)	$P_{Sat}$ (W)	$V_{DS}$ (V)	$E_{ff}$ (%)	$G_P$ (dB)
L Radar	WG012014500P	1200	1400	500	50	60	14
L Radar	WG012014140P	1200	1400	140	TBD	TBD	TBD
L Radar	WG012014250P	1200	1400	250	TBD	TBD	TBD
S Radar	WG027031220I	2700	3100	220	36	52	9.5
S Radar	WG027029300I	2700	2900	300	50	65	13
S Radar	WG030034150I	3000	3400	150	50	58	10
S Radar	WG030034280I	3000	3400	280	42	55	10.5
S Radar	WG031035150I	3100	3500	150	50	53	10.5

※ P : Pre-matched, I : Fully Matched

※ High performance C-Band products will be released by the end of 2019

# Guarantees fast response within **3 months** when requested to develop Unmatched TR samples

## Unmatched Products



	Application	Part Number	F <sub>Min</sub> (MHz)	F <sub>Max</sub> (MHz)	P <sub>Sat</sub> (W)	V <sub>DS</sub> (V)	E <sub>ff</sub> (%)	G <sub>P</sub> (dB)
<b>NEW</b>	L Radar	WG012014030S	1200	1400	30	50	65	20
	L Radar	WG011012150S	1100	1200	150	42	68	14
	General Purpose	WG60002S	DC	6000	2	28	70	17
	General Purpose	WG60005S	DC	6000	5	50	70	17
	General Purpose	WG60014S	DC	6000	14	28	65	18.5
<b>NEW</b>	General Purpose	WG60014S	DC	6000	14	50	65	18.5
	General Purpose	WG60028S	DC	6000	28	50	65	18.5
<b>NEW</b>	General Purpose	WG60056S	DC	6000	56	50	65	18
<b>NEW</b>	General Purpose	WG60075S	DC	6000	75	50	65	18
	General Purpose	WG40120S	DC	4000	120	28	68	18.5
	General Purpose	WG40180S	DC	4000	180	50	70	18.5
<b>NEW</b>	General Purpose	WG01004050S <b>CW</b>	1000	4000	50	50	40	7
	General Purpose	WG005025100S	500	2500	100	TBD	TBD	TBD

※ High performance C-Band products will be released by the end of 2019

# Small size(7x6.5mm<sup>2</sup>) dual output products available

## Low Cost Products



Single output  
<3x3 DFN>



Single output  
Dual output  
<7x6.5 DFN>

Application	Part Number	F <sub>Min</sub> (MHz)	F <sub>Max</sub> (MHz)	P <sub>Sat</sub> (W)	V <sub>DS</sub> (V)	E <sub>ff</sub> (%)	G <sub>P</sub> (dB)
General Purpose	WG60002S-DFN	DC	6000	2	28	70	17
General Purpose	WG60014S-DFN	DC	6000	14	28	65	17
General Purpose	WG60014D-DFN	DC	6000	14	28	65	17
General Purpose	WG60005S-DFN	DC	6000	5	50	70	17
General Purpose	WG60028S-DFN	DC	6000	28	50	65	18.5
General Purpose	WG60028D-DFN	DC	6000	28	50	65	18.5
General Purpose	WG60028S-DFN	DC	6000	28	28	TBD	TBD
General Purpose	WG60056S-DFN	DC	6000	56	50	TBD	TBD

※ High performance C-Band products will be released by the end of 2019

# In addition, Wavice owns the core technology to design and manufacture RF Module

Wavice Development Experience								
L	S	C	X	Ku	K	Ka	V	W
1-2	2-4	4-8	8-12	12-18	18-26.5	26.5-40	40-75	75-100

- **No. 1 GaN Module Provider to ROK Military**
- Obtain 1GHz(L-Band)~90GHz(W-Band) development experience
- High Power RF combining technology & analysis technology
  - C-Band 4KWatt / Ku-Band 〇KWatt / W-Band 〇Watt
- Optimized RF GaN Large Signal Modeling technology
  - Core technology required to predict and verify output power and efficiency to make effective production
- Equipped with RF design analysis test know-hows
  - Designed by EM and Circuit Simulation - Minimizing trial and error

# Wavice has extensive experience in partnering with defense contractors for large-scale projects

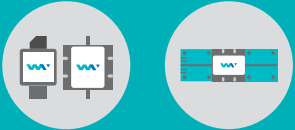
Application	Program	Product
Aviation	<ul style="list-style-type: none"> <li>• RF16(Done)</li> <li>• Light Armed Helicopter Radar Warning Receiver(Running)</li> <li>• Flight radar(Running)</li> </ul>	<ul style="list-style-type: none"> <li>• RF synthesizer</li> <li>• RF signal distributor/ RF synthesizer</li> <li>• RF power divider</li> </ul>
Ground	<ul style="list-style-type: none"> <li>• Ground Multi Function Radar(Running)</li> <li>• SR<sup>1)</sup> Radar PIP<sup>2)</sup> (Running)</li> </ul>	<ul style="list-style-type: none"> <li>• GaN Tx module / IMFET</li> <li>• RF synthesizer</li> </ul>
Naval	<ul style="list-style-type: none"> <li>• Battle Ship Multi Function Radar(Running)</li> </ul>	<ul style="list-style-type: none"> <li>• GaN Tx module / IMFET</li> </ul>
Missile	<ul style="list-style-type: none"> <li>• W-Band Seeker(Done)</li> <li>• Ku-Band Seeker(Done)</li> </ul>	<ul style="list-style-type: none"> <li>• SSPA</li> </ul>

1) SR : Surveillance & Reconnaissance

2) PIP : Product Improvement Program

# Wavice's Product & Service offerings

## Build-to-print



Offset

- **Wavice can be trustworthy OEM partner**
  - Wavice's manufacturing, quality control, SCM capabilities i.e) RF Module Assembly & Testing

## Build-to-spec



Offset

- **Wavice can be incomparable ODM partner**
  - Wavice's design, engineering, manufacturing, SCM, QA and system integration capabilities
  - Wavice already is a No.1 tier ODM in the fields of military radar and e-Warfare system for Korean defense companies

## GaN Foundry Service



- **Durable 0.4/0.3um GaN process**
  - **TR only foundry service open now!**
  - **0.3um will be provided mid of 2020**
  - Customized GaN Transistor
  - Exclusive GaN Transistor

## Off the shelf



- **High quality catalogue products**
  - GaN Transistor Die
  - Fully matched amps
  - RF Module for Jamming systems such as HPA





## **End of document**

Contact information:

Todd Jongwoo Kim([belllab@wavice.com](mailto:belllab@wavice.com))