

TDK products selection tool

- IoT



TDK Corporation
Electronic Components Sales & Marketing Group
ICT Group, Sales & Marketing Div.
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- IoT Block diagram example **page No.5**
- IoT Block diagram example - M2M Module **page No.6**
- TDK product introduction **page No.7~102**
- RF IC reference **page No.103~115**

How to use

You can jump to product pages by clicking products name on the block diagram.

Explanation for icon



: Go to IoT Block diagram example (page No.5)



: Go to Go to IoT Block diagram example – M2M Module (page No.6)

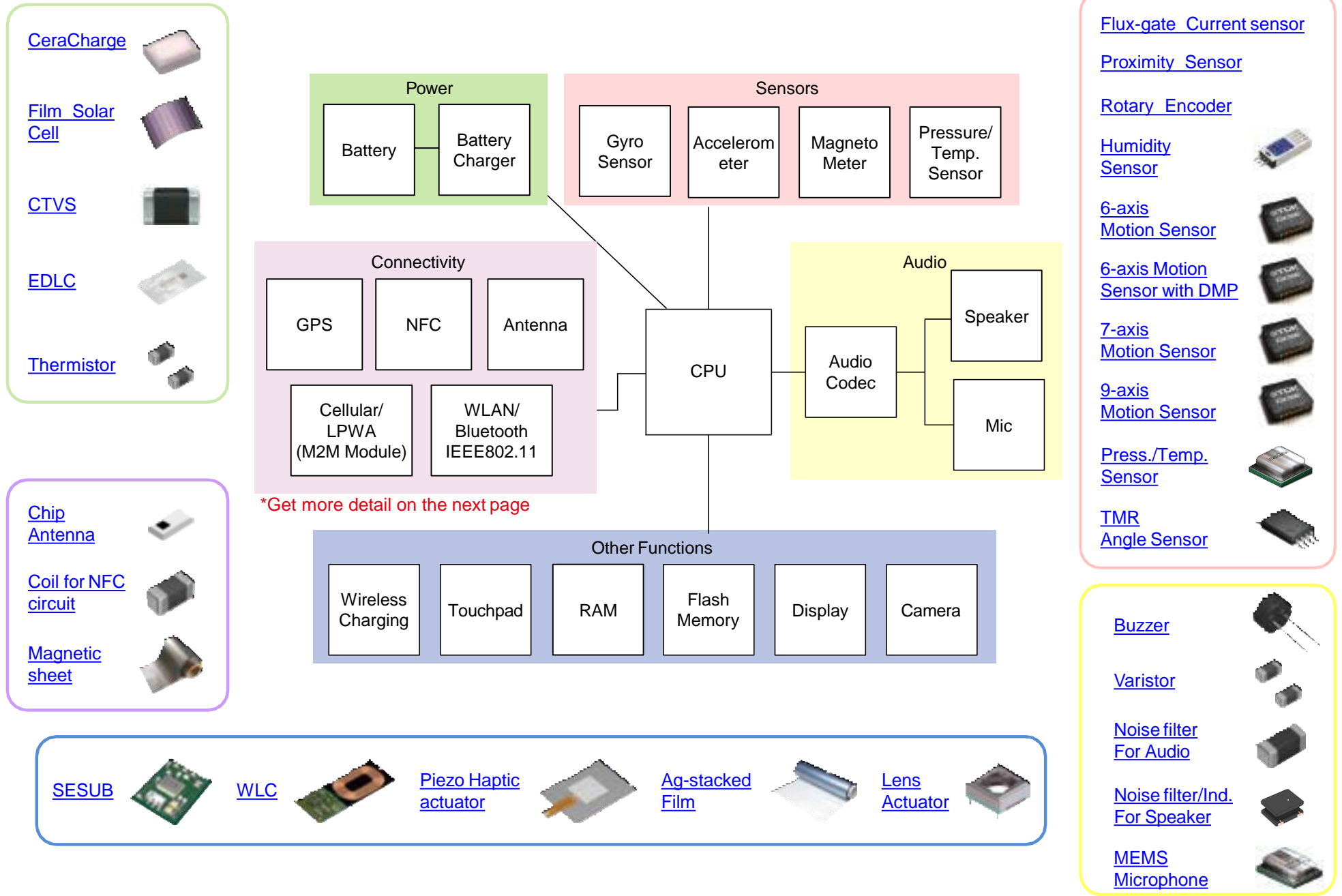
>> [Catalog](#) : Go to product web site (catalog)

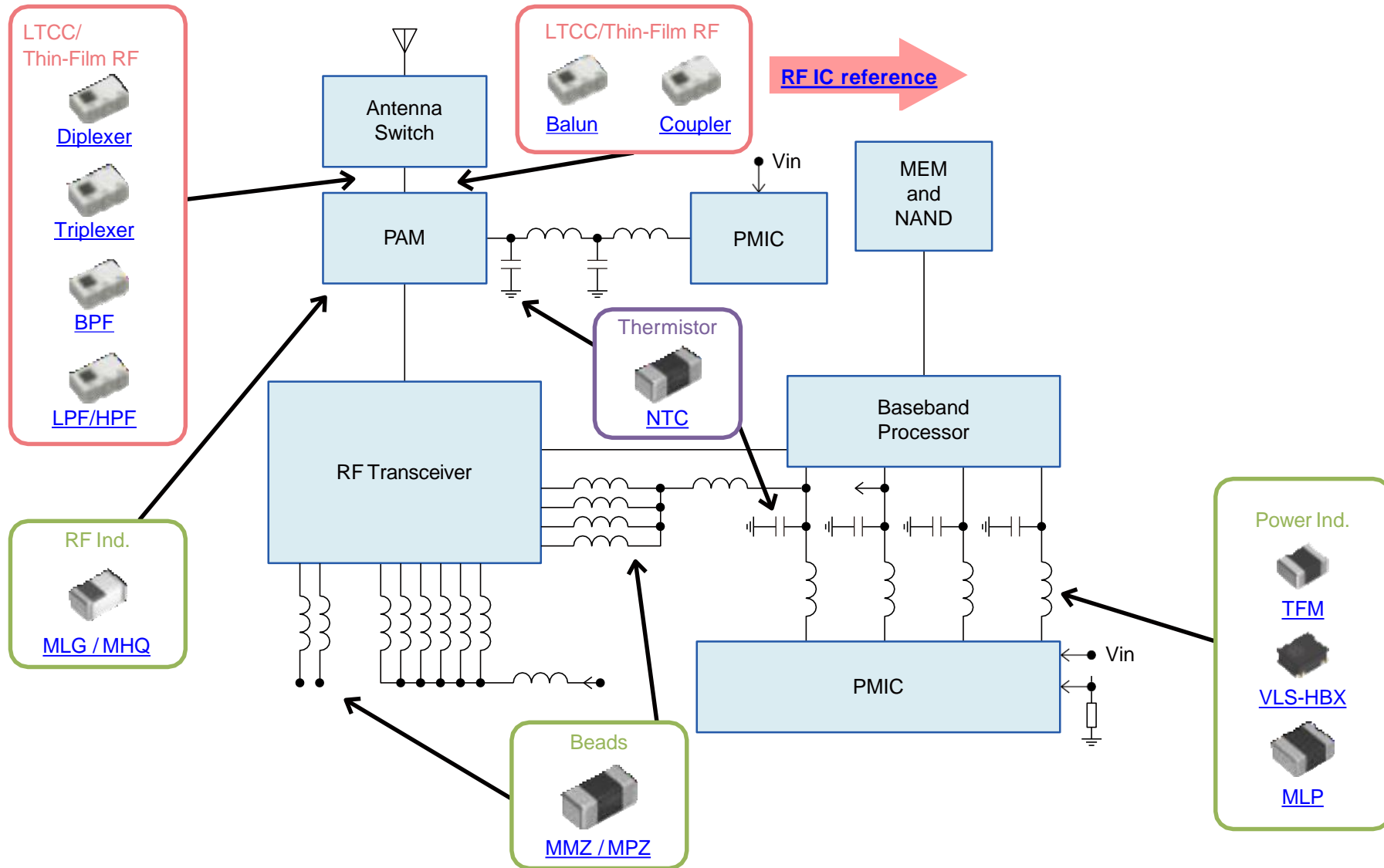
[RF IC ference](#) : Go to RF IC reference list (page No.103)



: Go back to RF IC reference list (page No.103)

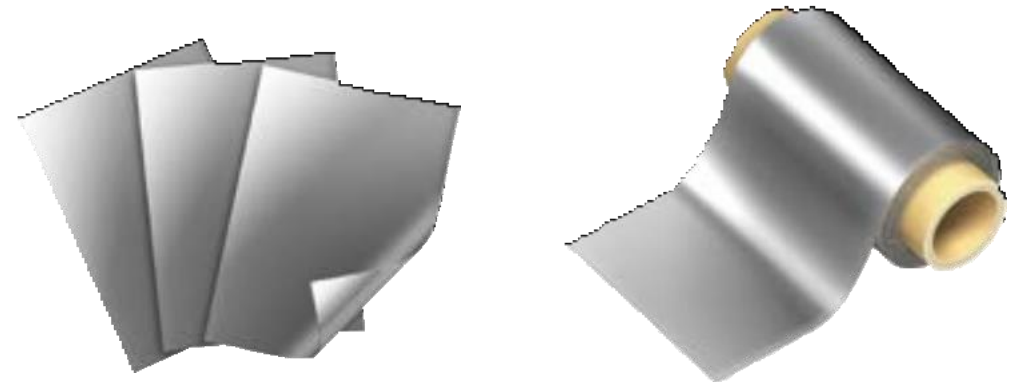
IoT Block diagram example — Connected device





FEATURES

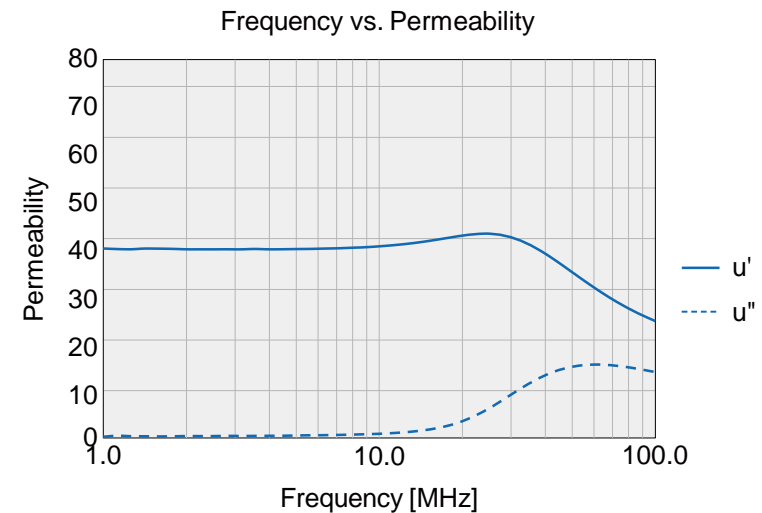
- High permeability, low magnetic loss (13.56MHz).
- It's also possible to load on a little gap because it's thin type.
- Has flexibility , it does not crack by impact or the like .
- Offer by a roll shape is possible.



APPLICATIONS

- For improving reception performance in RFID reader/writers.
- Integrate IC cards with metal.
- Integrate IC tags with metal.
- Improved antenna reception sensitivity.

		IFL04
Type		Polymer type
Operating temperature[°C]		-40 ~ +85
	μ' @ 13.56MHz	45
	μ'' @ 13.56MHz	1.3
Environmental		RoHS, Halogen free
Flame retardant property		N/A
Standard size [mm]		300X200
Standard roll size		Length x width : 100m x 300mm
Standard thickness [mm]		0.05, 0.10, 0.20
Product name of standard sample	t=0.05mm	IFL04-050NB300X200
	t=0.10mm	IFL04-100NB300X200
	t=0.20mm	IFL04-200ND300X200



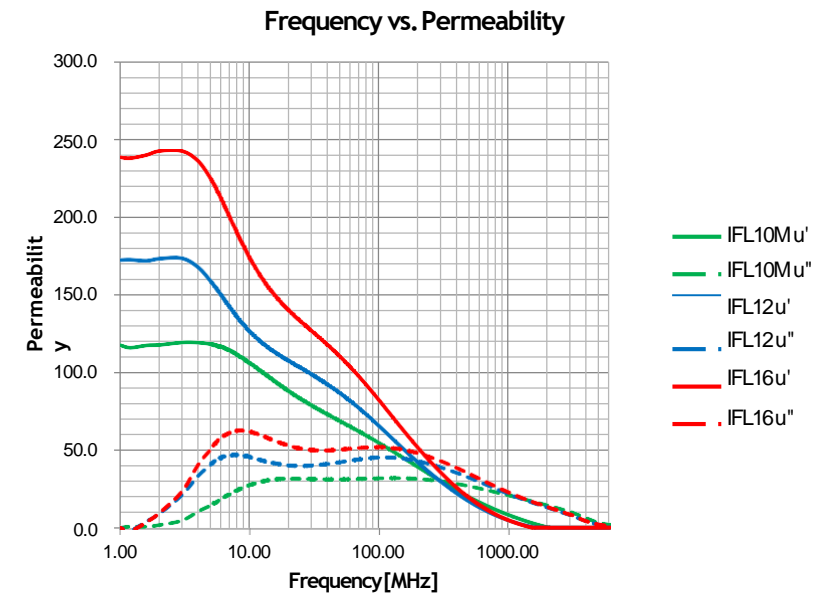
FEATURES

- It's also possible to load on a little gap because it's thin type
- Has flexibility, it does not crack by impact or the like
- It excels in shape processability and can respond to various dimensions and shapes
- Offer by a roll shape is possible

APPLICATIONS

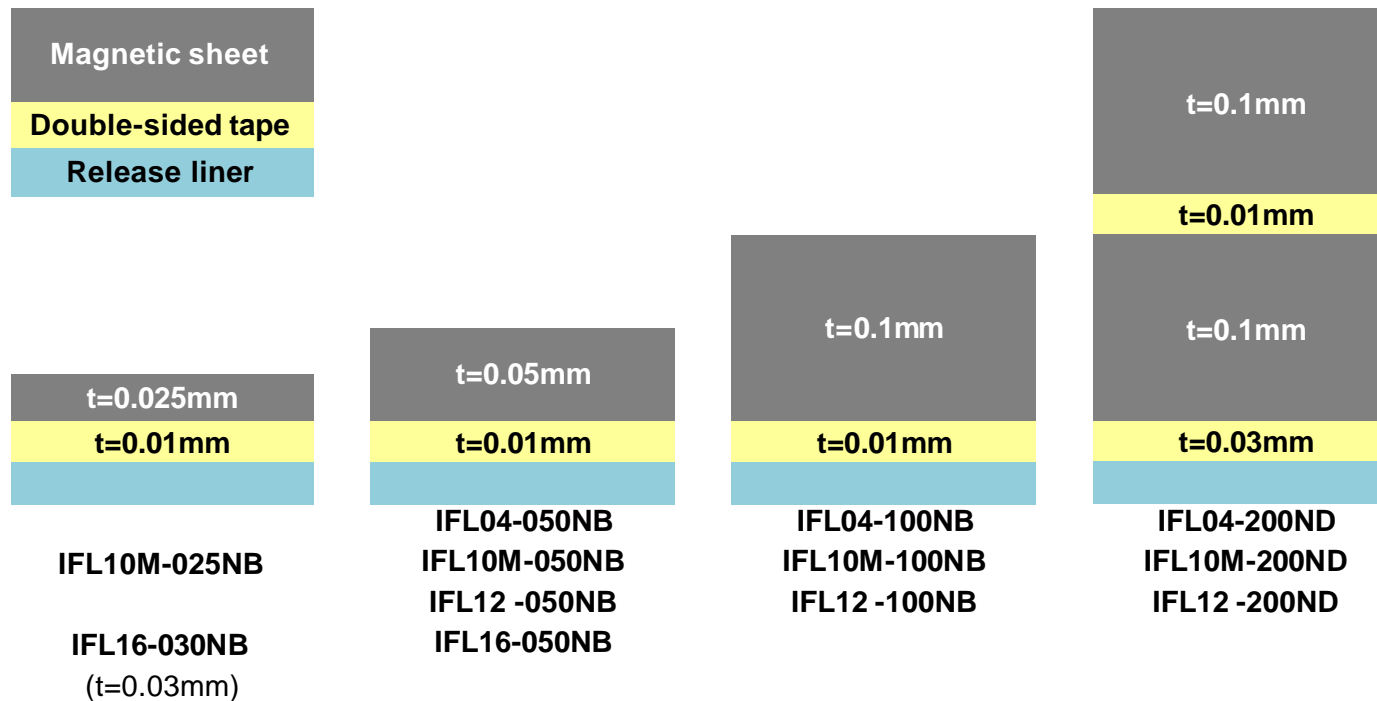
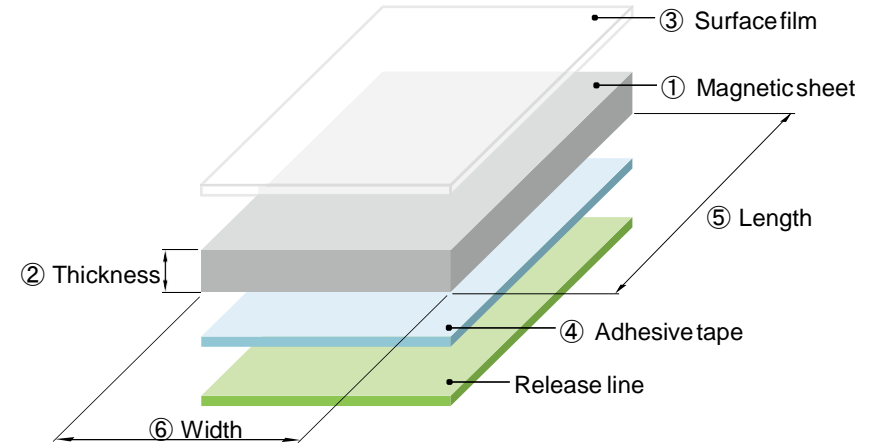
- Electromagnetic noise measures of various kinds of electronic equipment
- Receiver sensitivity improvement of PEN input (inductive coupling type)
- Performance improvement of RFID (on metal correspondence)

		IFL10M	IFL12	IFL16
Feature		Thin	High permeability	Super High permeability
Application	Noise suppression	○	○	○
Operating temperature [°C]		-40 ~ +85		
Permeability (Typical)	μ' @ 1MHz	120	180	220
	μ' @ 13.56MHz	100	120	140
	μ'' @ 13.56MHz	30	50	60
Surface Resistivity [Ω / □]		$\geq 1M$	$\geq 10k$	$\geq 10k$
Heat Conductivity [W/m·k]		1.5	1.5	1.5
Environmental		RoHS, Halogen free		
Flame retardant property		N/A		
Standard size[mm]		300x200		
Standard roll size		Length x Width : 100m x 300mm		
Standard thickness: t [mm]		0.025, 0.05, 0.1, 0.2	0.05, 0.1, 0.2	0.03, 0.05
Product name of standard sample	t=0.025	IFL10M-025NB300X200	-	IFL16-030NB300X200
	t=0.05	IFL10M-050NB300X200	IFL12-050NB300X200	IFL16-050NB300X200
	t=0.1	IFL10M-100NB300X200	IFL12-100NB300X200	-
	t=0.2	IFL10M-200NB300X200	IFL12-200NB300X200	-



IFL04 - 050 N B 300 X 200
 (1) (2) (3) (4) (5) (6)

- (1) Material name
- (2) Magnetic sheet thickness (050 : 50um)
- (3) Surface film thickness symbol (N : Non surface film, R : Release film)
- (4) Double-sided tape thickness symbol (B : 10um, N : Non double-sided tape)
- (5) Length (300 : 300mm, 1HR : 100m)
- (6) Width (200 : 200mm)



FEATURES

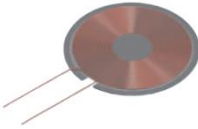
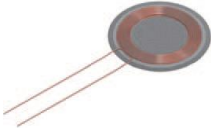
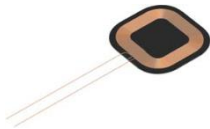



- TDK will provide best material from our various type of magnetic materials with high efficiency and thin thickness by speedy support.
- Possible to support different type of coils such as wound type, FPC and PCB type of coils are available with best matching with our magnetic sheets. And we will do test and evaluation to meet your require specifications
- TDK will provide to meet customer requirement of small size and thickness for our Rx, Tx-coil based on our best experience with smartphone. products

APPLICATIONS

- Smartphone, Tablet PC, Notebook PC
- Wearable device, Head set, MP3 player










SMALL COIL UNIT STD LINE UP

	Rx Coil			Tx Coil		
Parts number	WR121210-27M8-ID	WR202010-18M8-ID	WR303050-12F5-ID	WT151512-22F2-ID	WT202012-15F2-ID	WT303012-12F2-ID
WLC Outer Size [mm]	Φ 12mm	Φ 20mm	30 × 29.6 mm	Φ 15.3mm	Φ 20.3mm	Φ 30mm
WLC Coil total Thickness [mm]	0.32 mm Typ	0.84 mm Typ	0.86 mm Typ	2.20 mm Typ	2.65 mm Typ	1.99 mm Typ
	0.34mm Max	0.88 mm Max	0.94 mm Max	2.42mm Max	2.84 mm Max	2.15 mm Max
Inductance (100kHz, 1Vrms) [uH]	8.32 uH	11.00 uH	8.23 uH	6.80 uH	6.20 uH	6.30 uH
Resistance (100kHz, 1Vrms) [Ω]	0.98 Ω	0.40 Ω	0.28 Ω	0.18 Ω	0.095 Ω	0.115 Ω
Picture						

◇ COMBINATION TABLE

	1W	2W	3W	IC
Rx	WR121210-27M8-ID	WR202010-18M8-ID	WR303050-12F5-ID	P9027LP-R (IDT)
Tx	WT151512-22F2-ID	WT202012-15F2-ID	WT303012-12F2-ID	P9235A-R (IDT)



	ICS-40618 (InvenSense)	ICS-40720 (InvenSense)	INMP621 (InvenSense)	ICS-43434 (InvenSense)	ICS-52000 (InvenSense)	T4064 (TDK)	T4081 (TDK)
Size	3.5 x 2.65 x 0.98mm	4.0 x 3.0 x 1.2mm	4.0 x 3.0 x 1.0mm	3.5 x 2.65 x 0.98mm	4.0 x 3.0 x 1.0mm	2.7 x 1.6 x 0.89mm	3.35 x 2.5 x 0.98mm
SNR	67 dB	70 dB	65 dB	65 dB	65 dB	61 dB	66 dB
AOP (Acoustic Overload Point)	132 dB (THD 10%)	124 dB (THD 10%)	133 dB (THD 10%)	120 dB (THD 10%)	117 dB (THD 10%)	115 dB (THD 5%)	135 dB (THD 10%)
Other function	Low-Power Mode	-	-	Low-Power Mode	-	-	-
Out-put	Analog	Analog	PDM	I ² S	TDM	Analog	Analog
							

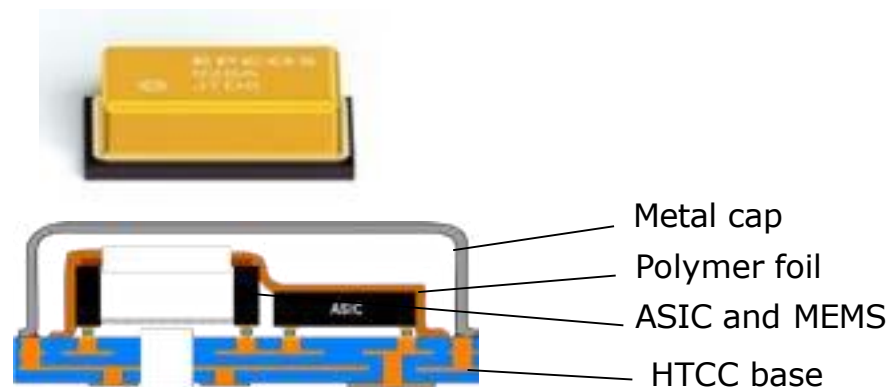


FEATURES

- Achieved smaller and thinner package based of SAW filter package technology
- High S/N ratio
- Analog Output, Bottom port
- High dynamic range, better THD (Total Harmonic Distortion)
- Digital Output in development

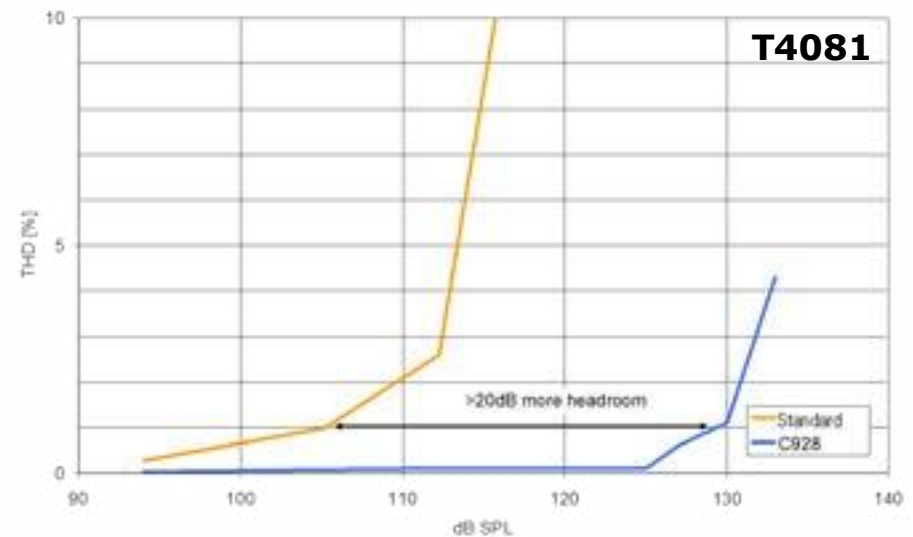
Smallest size T4060

- Size: 2.7 x 1.6 x 0.89 mm³
- 20 Hz-20 kHz flat freq. response
- Very low current consumption 90 μ A
- THD: 5 % typ. @ 115 dB
- S/N ratio: 61.5 dB(A) typ.



Highest Performance T4081

- Size: 3.35 x 2.5 x 0.98 mm³
- High RF performance
- Low current consumption 135 μ A
- THD: 10 % typ. @ 135 dB
- S/N ratio: 66 dB(A) typ.
- Balance output



ICS-40618: Low-Power Mode Analog-Out Mic

FEATURES

- Listening Mode consumes 55 μ A with 67 dB SNR
- High SNR of 67 dB / 27 dB SPL EIN
- Acoustic Overload Point (AOP) of 132 dB SPL
- Sensitivity of -38 dBV (+/-1dB tolerance)
- Package size 3.5mm x 2.65mm x 0.98mm

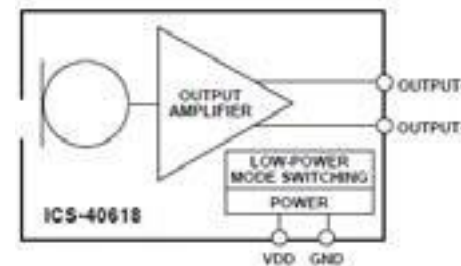
BENEFITS

- Low power state continues to acquire audio data
- Supports far-field (conference phones, video conf.)
- Enables clear audio capture in loud conditions: wind, rock concerts, close range speaking, etc.
- Analog, differential output supports entire range
- Industry standard size

APPLICATIONS

- Mobile devices
- Voice control arrays
- Remote Controls

SPEC	HIGH PERFORMANCE MODE	LOW-POWER MODE
SNR	67 dBA	67 dBA
Current	165 μ A	55 μ A
AOP	132 dB SPL	128 dB SPL



Samples: Now
Production: Now



ICS-40720: High SNR MEMS Mic

FEATURES

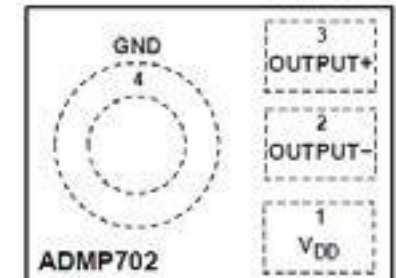
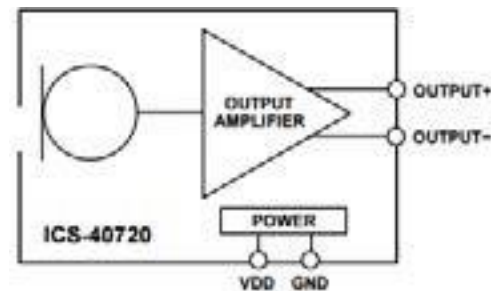
- Ultra High SNR of 70 dB / 24 dB SPL EIN
- Sensitivity of -32 dBV (± 2 dB tolerance)
- Bandwidth of 75Hz to 20kHz
- 124 dB Acoustic Overload Point
- Package size 4 x 3 x 1.2 mm

BENEFITS

- World's Highest SNR MEMS Mic
- Strong output optimized for discrete signal chain
- Full HD Bandwidth
- 100 dB Dynamic Range
- Incredibly small size for very low noise floor

APPLICATIONS

- Video Conferencing
- Pro-audio microphones
- Voice controlled appliances
- STB/Smart TVs
- Remote Controls
- Noise Cancellation



Surface Mount Package
4x3x1.2mm

Samples: Now
Production: Now



INMP621 : Wide Dynamic Range PDM-output Mic

FEATURES

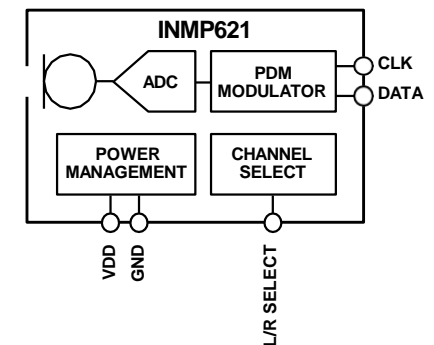
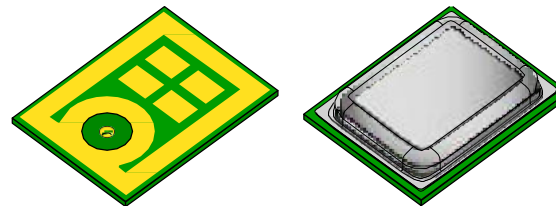
- Acoustic Overload Point (AOP) of 133 dB SPL
- -46 dB FS sensitivity tolerance of ± 2 dB
- High SNR of 65 dB / 29 dB SPL EIN
- PDM output with low power
- Package Size: 4.0 x 3.0 x 1.0 mm

BENEFITS

- Enables clear audio capture in loud conditions
- Strong response, consistent across all units
- Supports far-field, voice controlled applications
- Sleep Mode for Extended Battery Life: 5.5 μ A
- MEMS microphone, an impedance converter amplifier followed by a fourth-order Σ - \otimes modulator

APPLICATIONS

- Voice Control Arrays
- Teleconferencing Systems
- Remote Microphones
- Gaming Consoles
- Mobile Devices
- Tablet PCs



Samples: Now
Production: Now



ICS-43434 : Low Power I²S-output Mic

FEATURES

- I2S output with low power
- -26 dB FS sensitivity tolerance of +/-1dB
- Integrates full signal chain – preamp and ADC
- I2S output with high precision 24-bit data
- Tiny 3.5 x 2.65 x 0.98 mm package

BENEFITS

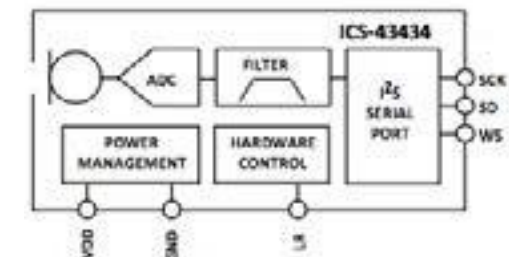
- 490 μ A standard mode / 230 μ A low power mode
- Mic response is consistent across all units
- Saves cost, space and design complexity
- Supports direct interface with microcontroller or DSP
- Full signal chain in small package

APPLICATIONS

- Security Systems
- Teleconferencing Systems
- Remote Microphones
- Gaming Consoles
- Mobile Devices
- Tablet PCs



SPEC	HIGH PERFORMANCE MODE	LOW-POWER MODE
Sensitivity	-26 dB FS \pm 1 dB	-26 dB FS \pm 1 dB
SNR	65 dBA	64 dBA
Current	490 μ A	230 μ A
AOP	120 dB SPL	120 dB SPL
Sample Rate	23 - 51.6 kHz	6.25 - 18.75 kHz



Samples: Now
Production: Now



ICS-52000 : Low Noise, TDM Digital Output Mic

FEATURES

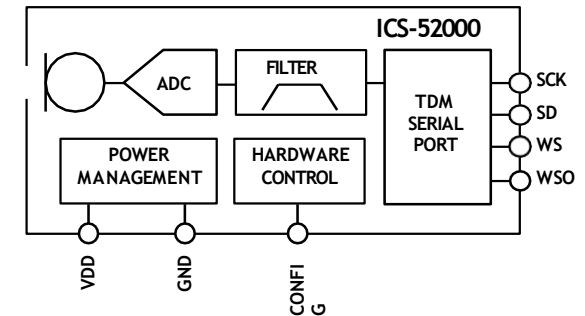
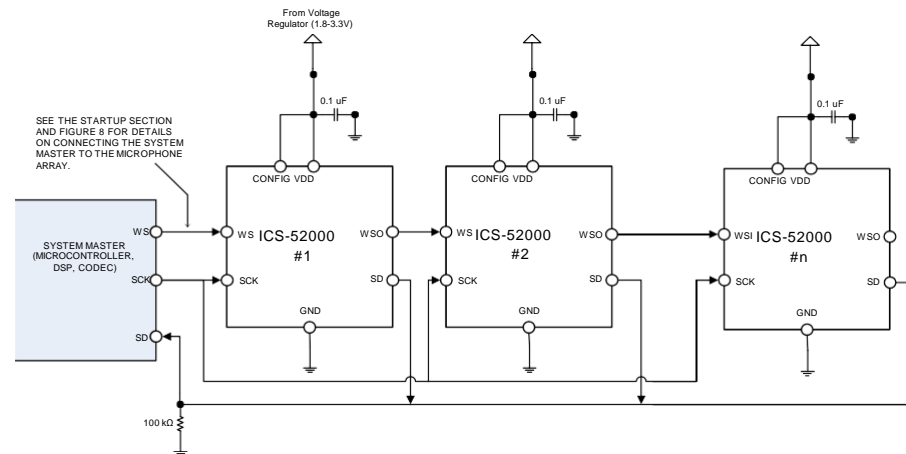
- High SNR of 65 dB / 29 dB SPL EIN
- 24-bit time-division multiplex (TDM) Digital Output
- -26 dB FS sensitivity tolerance of +/-1dB
- Up to 16 synchronized mics on one data line
- 4.0 x 3.0 x 1.0 mm package

BENEFITS

- Supports far-field, voice controlled applications
- Supports direct interface with microcontroller or DSP
- Mic response is consistent across all units
- Enables precise array processing
- Full signal chain in small package

APPLICATIONS

- Speech Recognition Arrays
- Smart Televisions
- Teleconferencing Systems
- Gaming Consoles
- Security Systems
- Microphone Arrays



Samples: Now
Production: Now



ICM-20602

World's Best 6-axis Solution

FEATURES

- High Performance Gyro
 - Gyro Sensitivity Error: $\pm 1\%$
 - Gyroscope Noise: $\pm 4 \text{mdps}/\sqrt{\text{Hz}}$
- High Performance Accel
 - Accel Noise: $\pm 100 \mu\text{g}/\sqrt{\text{Hz}}$
 - Accel Sensitivity: $\pm 1\%$
- Low Power Solution
 - Full Power: 2.79mA
 - LP Gyro/Accel Mode: 1.33mA
- Gyroscope Full-Scale Range: $\pm 250/500/1000/2000 \text{ deg/sec}$
- Accelerometer Full-Scale Range: $\pm 2/4/8/16\text{g}$
- Package Size: 3x3x0.75mm 16-Pin LGA
- Software Available: Yes

APPLICATIONS

- IoT
- Drone
- Augmented Reality
- Virtual Reality

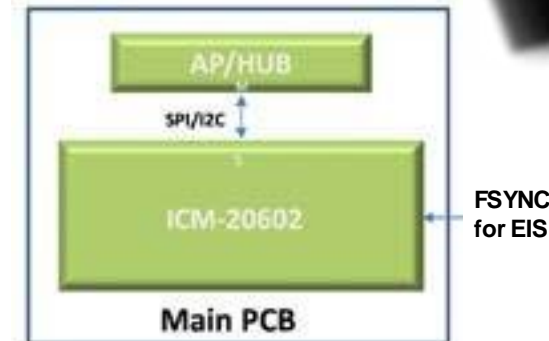
Samples: Now
Production: Now

>> [SmartMotion Platform :
Development Kit / Software](#)



BENEFITS

- Device includes 1K-byte FIFO to reduce traffic on serial bus interface
- Reduce power consumption by allowing the system processor to burst read sensor data and then go to LP mode
- Includes on chip, 16-bit ADC's, programmable digital filters, an embedded temp sensor, and programmable interrupts.



ICM-20648

6-Axis DMP Enabled Solution

>> [SmartMotion Platform :
Development Kit / Software](#)



FEATURES

- Digital Motion Processor (DMP) for autonomous operation
- Programmable interrupts, filters, and 4k-byte FIFO
- Gyroscope Full-Scale Range: $\pm 250/500/1000/2000$ deg/sec
- Accelerometer Full-Scale Range: $\pm 2/4/8/16g$
- Runtime Calibration
- Dedicated Wearable Software Stack
- Operating Temperature Range: -40°C to 85°C
- Operating Voltage Range:
 - VDD1: 1.71V – 3.6V
 - VDDIO: 1.71V – 3.6V
- Host Interface: SPI 7MHz, I2C up to 400kHz
- Package Size: 3x3x0.9mm 24-Pin QFN
- Software Available: Yes

Datasheet: [ICM-20648 DataSheet](#)

APPLICATIONS

- IoT
- Wearables
- EIS

Samples: Now
Production: Now

BENEFITS

- Provides Step Count, Activity Classifier, and B2S (Bring-to-See) Gestures tuned for wrist worn wearable applications.
- DMP offloads computation of motion processing algorithms from the host processor, improving system power performance
- Enhanced FSYNC functionality to improve timing for applications like EIS



ICM-20789

6-Axis Motion Sensor and Barometric Pressure Sensor

>> [SmartMotion Platform : Development Kit / Software](#)



FEATURES

- Digital Motion Processor (DMP) for autonomous operation
- Programmable interrupts, filters, and 4k-byte FIFO
- Gyroscope Full-Scale Range: $\pm 250/500/1000/2000$ deg/sec
- Accelerometer Full-Scale Range: $\pm 2/4/8/16$ g
- Pressure Operating Range: 00hPa – 1100hPa
- Relative Pressure Accuracy: ± 1 hPa 10hPa change, 700-1000hPa
- Absolute Pressure Accuracy: ± 1 hPa (300hPa-1100hPa, 0°C-65°C)
- Temperature Sensor Accuracy: ± 0.4 °C
- Operating Temperature Range: -40°C-85°C
- Operating Voltage Range:
 - VDD: 1.7V – 3.45V
 - VDDIO: 1.8V $\pm 5\%$
- Host Interface: SPI 8MHz, I2C up to 400kHz
- Packages: 4 x 4 x 1.365mm 24-pin LGA

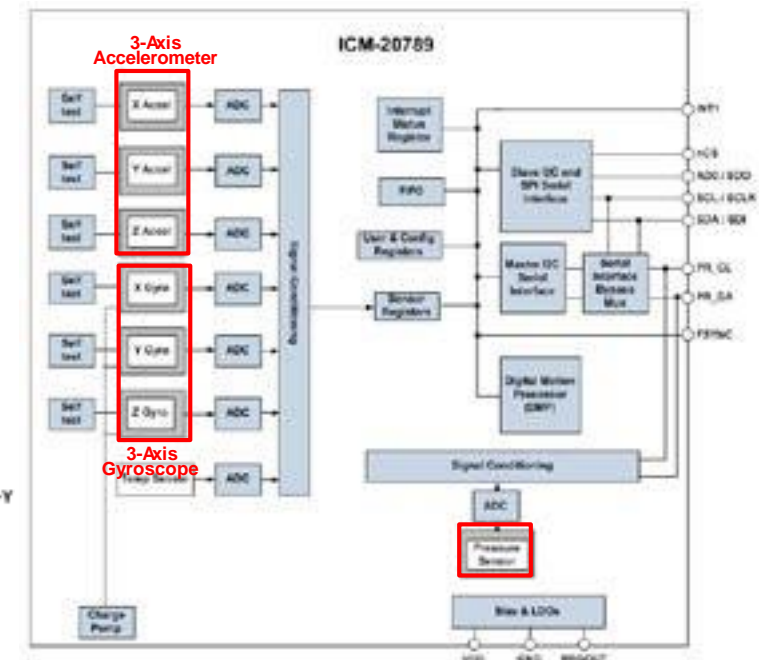
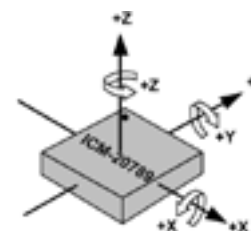
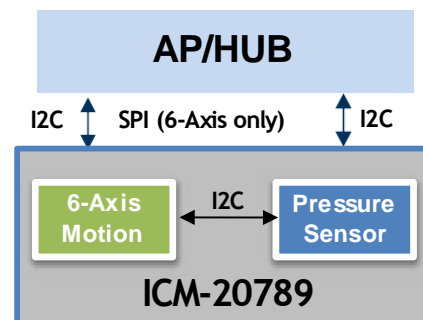
BENEFITS

- Integrated & calibrated Accel+Gyro+Pressure+Temp sensor provides quick time-to-market in small footprint
- Allow host to sleep/save power while monitoring motion
- Detect Z-height of 8cm for accurate motion measurements: navigation, dead-reckoning, floor detection, fitness recognition
- Lower power consumption extends battery life
- Easy migration from 6-Axis motion sensor to 6-Axis+Pressure

APPLICATIONS

- Drones
- Virtual Reality Headsets/Controllers
- Motion-based controllers
- Toys
- Mobile Phones

Samples: Now
Production: Now



ICM-20948

World's Best 9-axis Integrated Solution



>> [SmartMotion Platform :
Development Kit / Software](#)

FEATURES

- Digital Motion Processor (DMP) for autonomous operation
- Gyroscope Full-Scale Range: $\pm 250/500/1000/2000$ deg/sec
- Accelerometer Full-Scale Range: $\pm 2/4/8/16g$
- Operating Voltage Range:
 - VDD: 1.71V – 3.6V
 - VDDIO: 1.71V – 1.95V
- Host Interface: SPI 7MHz, I2C up to 400kHz
- Software Available: Yes
- Low Power Mode: 2.5mW
- Compass FSR: $\pm 4900\mu T$
- Package Size: 3x3x1mm 24-Pin QFN
- Software Available: Yes

Datasheet: [ICM-20948 DataSheet](#)

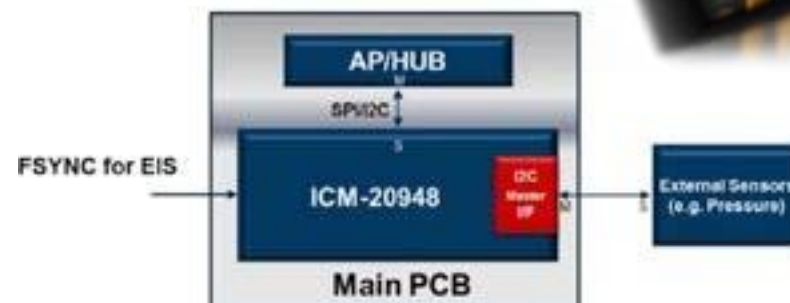
APPLICATIONS

- IoT
- Drone
- Wearables

Samples: Now
Production: Now

BENEFITS

- Lowest power 9-axis solution in the world
- P2P compatible with the MPU-9250
- 1/3 less power than previous solution
- Supports FSYNC for EIS



ICP-101xx

>> [SmartMotion Platform : Development Kit / Software](#)

Barometric Pressure Sensor and Temperature Sensor

FEATURES

- Pressure Operating Range: 300hPa – 1100hPa
- Relative Pressure Accuracy: $\pm 1\text{Pa}$ (10hPa change, 700-1000hPa)
- Pressure Noise RMS and Current Consumption:
 - Low-Power Mode: 3.2Pa at 1.3 μA
 - Low-Noise Mode: 0.8Pa at 5.2 μA
 - Ultra Low-Noise Mode: 0.4Pa at 10.4 μA
- Absolute Pressure Accuracy: $\pm 1\text{hPa}$ (300hPa-1100hPa, 0 $^{\circ}\text{C}$ -65 $^{\circ}\text{C}$)
- Pressure Sensor Tempco: $\pm 0.5\text{Pa}/^{\circ}\text{C}$ (25 $^{\circ}\text{C}$ -45 $^{\circ}\text{C}$, 100kPa)
- Temperature Sensor Accuracy: $\pm 0.4^{\circ}\text{C}$
- Operating Temp & Voltage: -40 $^{\circ}\text{C}$ -85 $^{\circ}\text{C}$, 1.8V $\pm 5\%$
- Host Interface: I2C up to 400kHz

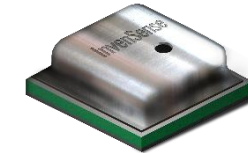
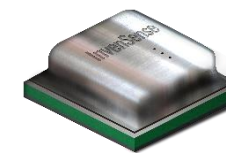
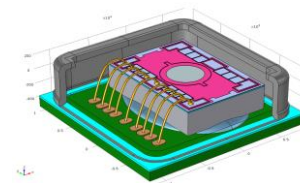
PACKAGE	3-HOLE IPX8: 1.5m WATERPROOF	1-HOLE
2x2x0.72mm 10L LGA	ICP-10100	ICP-10101
2x2.5x0.92mm 8L LGA	ICP-10110	ICP-10111

APPLICATIONS

- Drones
- Mobile Phones
- Fitness Bands/Trackers
- Virtual Reality Headsets/Controllers
- Elderly Fall Detection
- Security Systems
- Hard Drives & Servers

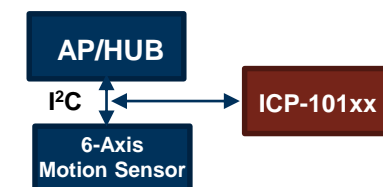
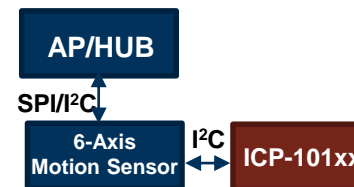
BENEFITS

- Completely integrated & calibrated pressure and temp sensor IC provides quick time-to-market
- Detect Z-height of 8cm for accurate motion measurements: navigation, dead-reckoning, floor detection, fitness recognition
- Lower power consumption extends battery life or improved accuracy at same power consumption
- Three-0.025mm holes reduce liquid intrusion



3-Hole: IPx8 Compliant Waterproof to 1.5m Depth

Single Hole Package



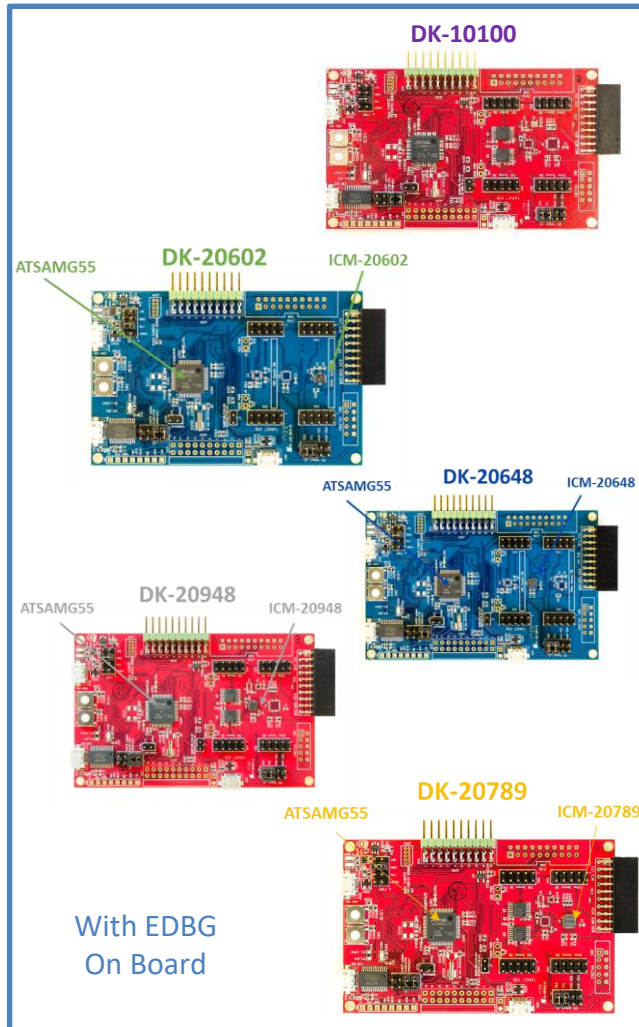


User Friendly Development Platform for TDK-InvenSense 1-Axis, 6-Axis, 7Axis and 9-Axis Sensors

- ✓ Single Board “Out of the Box” experience
 - Microchip G55 MCU + TDK-InvenSense Motion Sensor
- ✓ On-board embedded debugger
 - Saves \$100-\$150 for external debugger
 - Simpler set up/no cables for debugger
 - Program and debug the MCU
 - Debugging features to assist in code development
- ✓ Affordable - \$99 ASP
 - Better than other Sensor Development Kits
 - Buy several platforms for parallel development
 - System prototyping and demonstration vehicle
- ✓ Scalable design
 - Supports legacy and future motion sensors
 - WiFi/BLE support with external modules from Microchip
- ✓ Less than 15 minutes to set-up



SmartMotion Platforms



Motion Sensors

Development Platform for Motion Sensors

DK-10100 – for ICP-10100: 1-axis pressure sensor

DK-20602 – for ICM-20602: 6-axis motion sensor that combines a 3-axis gyroscope and 3-axis accelerometer

DK-20648 – for ICM-20648: 6-axis motion sensor that combines a 3-axis gyroscope, 3-axis accelerometer, and Digital Motion Processor™ (DMPTM)

DK-20789 –for ICM-20789: 7-axis motion sensor combining a 3-axis gyroscope, 3-axis accelerometer, and a high accuracy pressure sensor

DK-20948 – for ICM-20948: 9-axis motion sensor that combines a 3-axis gyroscope, 3-axis accelerometer, 3-axis compass, and a Digital Motion Processor™ (DMPTM).

Applications

DK-10100

- Drones
- Security systems
- Wearables
- Servers Air Flow Control
- E-cigarettes

DK-20602

- IoT
- Smartphones, Tablets, Smart Watches, Wearables, Activity monitors
- Cleaner Robots
- Sports Equipment
- Drones, Toys

DK-20648

- IoT
- Smart Watches
- Robots
- Wearables, Health Monitoring band

DK-20789

- IoT
- Drones
- Flying Toys
- Wearables, Activity Monitors

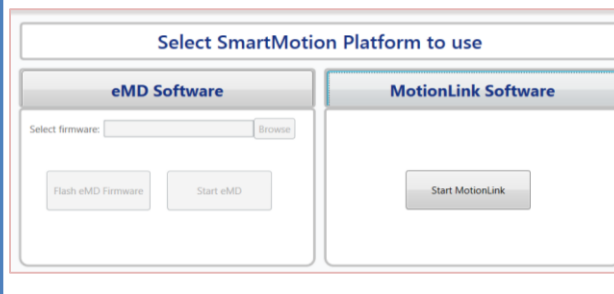
DK-20948

- IoT
- Navigation
- Industrial application
- Wearables, Smartphones, Activity Monitors, Smart Watches
- Drones, Toys and Sports Applications



Software Tools

- SmartMotion Installer with MotionLink
- Embedded Motion Drivers (eMDs)
- Both tools available for free download at the TDK-InvenSense Developer's Corner (requires registration)

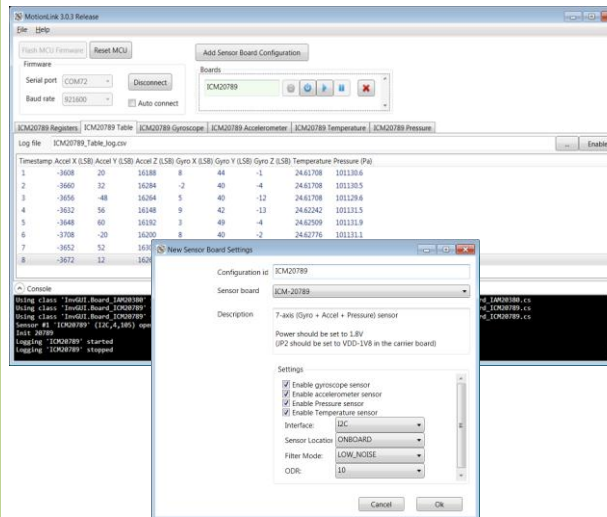


MotionLink

Hardware Evaluation Tool - Evaluate and log raw gyro, accel, and other sensor data

PC Based Software with following features:

- Read Register Map Values
- Simple I2C read and writes
- Display raw sensor data up to 1Khz sample rate
- Log Data to text file
- Display graphical sensor data



Embedded Motion Driver (eMD)

Fully Featured Motion Software with Atmel Studio

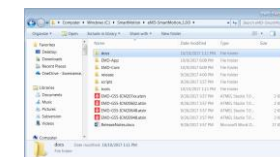
- Sensor Fusion
- Gesture Tracking
- DMP Image (if applicable)
- Factory Test and Calibration
- In-Use Calibration

Currently supported SmartMotion eMDs

- ICM20602
- ICM20648
- ICM20948
- ICM20789

eMD - Atmel Studio Project

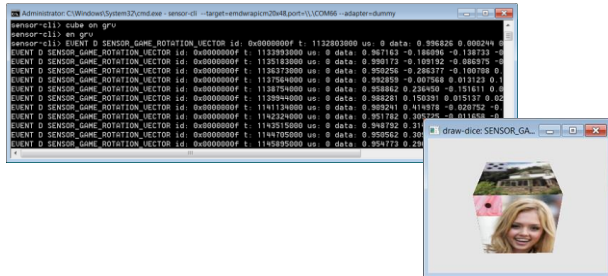
EMD-App and EMD-Core : contains main driver code. 'App' has the main.c as well as board specific files. 'Core' has the libraries as well as the sensor driver files.



Additional Features

Command Line tool – “Sensor-cli”

- Interfaces with the eMD and the SmartMotion board



Scalable design

- Supports legacy and future motion sensors

Accelerate Product Deployment

- SmartMotion provides everything to evaluate and develop applications with TDK-InvenSense motion sensors
 - Simple to set up, easy to use
 - Software toolchains are free
 - **MCHP EDBG Chip integrated - No external debugger required – saves \$\$\$**
- MotionLink enables easy evaluation of the sensor hardware
- **eMD, an Atmel Studio Project, includes sensor fusion and motion algorithms**
- Affordable : \$99 ASP

TDK InvenSense SmartMotion Support

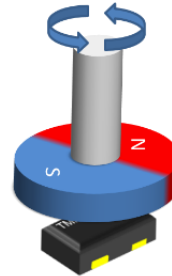
- TDK-InvenSense SmartMotion Website - <https://www.invensense.com/smartmotion-platform/>
- General Tech Support - techsupport_NorthAmerica@invensense.com
- General Sales Support – sales.us@invensense.com
- TDK InvenSense Distributors
- <https://www.invensense.com/distributors/>



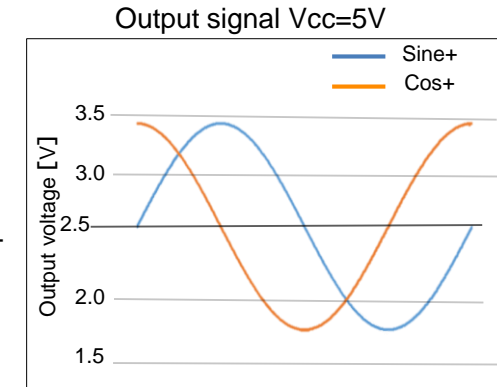
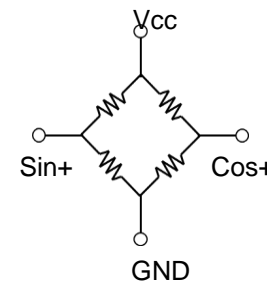
FEATURES

Angle Type

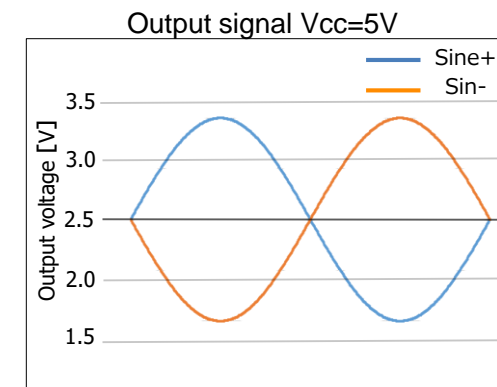
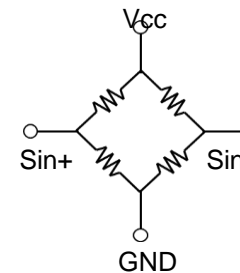
- High sensitivity: 0.3Vp-p@Vcc=1V (Analog output)
 - Size : D0.8 x W0.5 x H0.25(max)mm
- <Operating Conditions>
- Temperature: -40degC~85degC
 - Detection range: 360deg(TMS1142), +/-30deg(TMS1143)



[TMS1142]



[TMS1143]



<Comparison TMR vs Hall>

	Unit	TMR	Hall (HG0714)
Resistance	kohm	1	0.6
Sensitivity	mV/deg/V	4.7	n/a
Sensitivity Temp Co.	%/degC	-0.09	-0.06
Sensitivity Temp Co. of magnet		less affect	affect
Offset Temp Co.	uV/degC	+/-80	+/-180

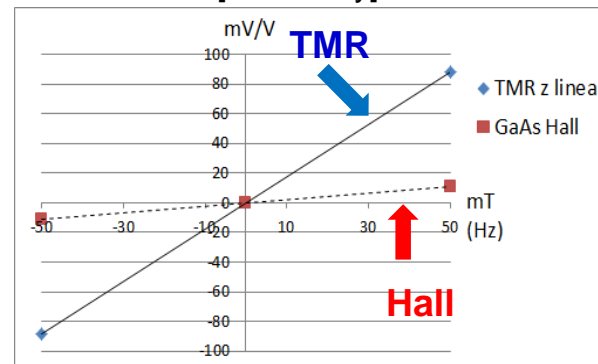
Linear Type

- High sensitivity: 1.8V/mT@Vcc=1V (Analog output)
 - Size : D0.8 x W0.5 x H0.25(max)mm
- <Operating Conditions>
- Temperature: -40degC~85degC
 - Detection range: +/-60mT (TLS1131)

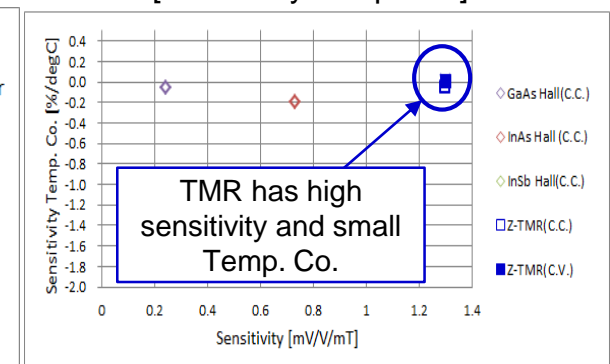
<Comparison TMR vs Hall>

- ✓ Output: more than **8 times higher** than GaAs Hall
- ✓ Resolution: more than **1bit better** than GaAs Hall
- ✓ Excellent temperature coefficient and high sensitivity at the same time.

[Sensitivity]

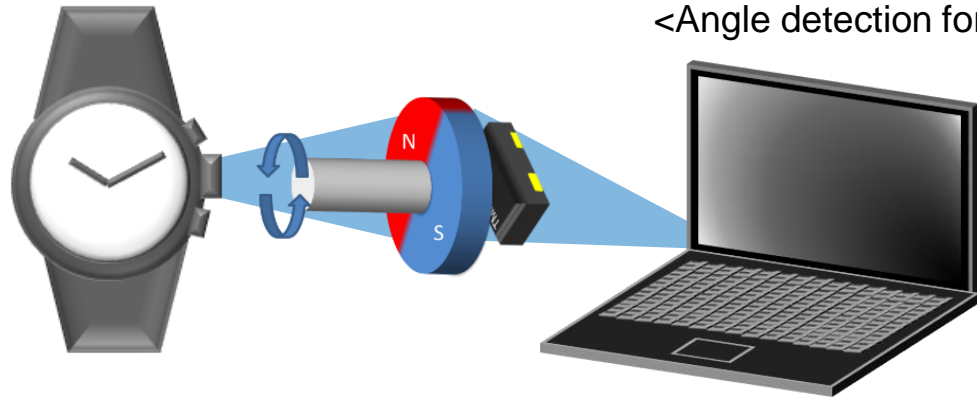


[Sensitivity Temp. Co.]



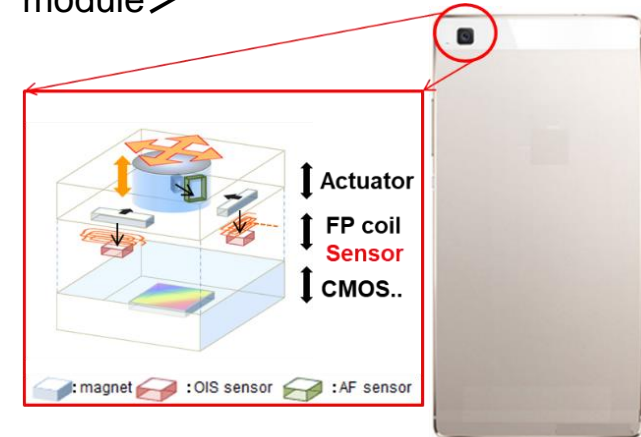
APPLICATIONS

<Angle detection for crown of smart watch>



<Angle detection for hinge>

<VCA(AF/OIS) for smartphone camera module>



LINEUP

	TMS1142 (angle type)	TMS1143 (angle type)	TLS1131 (z-linear)	TLS1112 (x-linear)
Max input voltage[V]	5	5	5	5
Operating tem.[degC]	-40~+85	-40~+85	-40~+85	-40~+85
Sensing range	360deg	+/-30deg	+/-60mT(z-axis)	+/-20mT(x-axis)
Resistance[kohm]	1.0	1.0	5.5	7.8
Sensitivity@VDD=1V	0.3[Vp-p]	0.3[Vp-p]	1.8 [mV/mT]	2.8 [mV/mT]
Temperature Co.[ppm/deg]	Typ: -1350	Typ: -1350	Typ: 0	Typ: 600(est.)



FEATURES

Analog Sensor

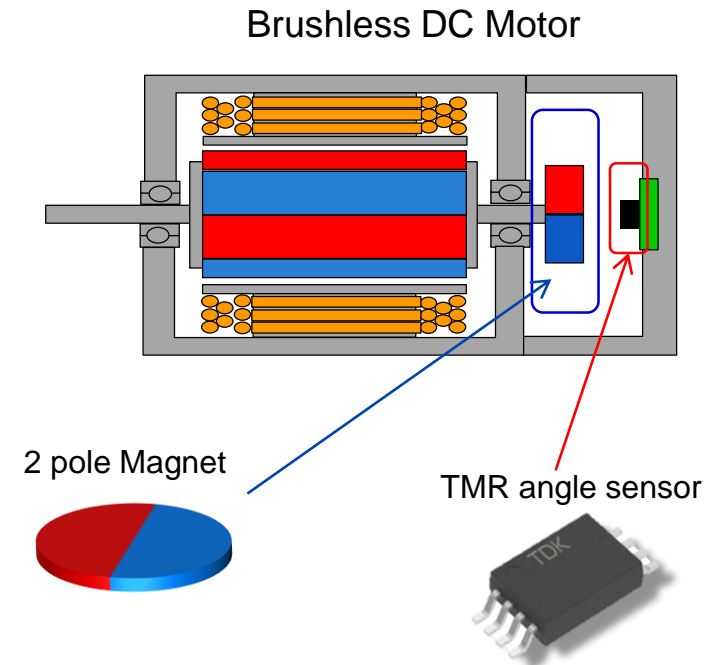
- 360deg angle detection
- High output: 1.5Vp-p / 3.0Vp-p @VDD5V (Analog sensor)
- Angle accuracy: +/- 0.6deg or less

Digital Sensor





- 360deg angle detection
- Angle accuracy: +/- 0.2deg or less
- Interface: SPI / PWM / HSM / ENC
- Self-diagnosis function for functional safety
- Powerful prediction function minimize angle delay

<Operating Conditions>

- Temperature: -40degC ~ 150degC
- Magnetic field: 20mT~80mT



LINEUP

Sensor type	Part No.	Size(mm)	PKG type	Angle error
Analog	TAS2141	6.4*3.0*1.0	TSSOP-8 	+/- 0.6 deg or less
Analog (Dual)	TAS4140	6.4*5.0*1.0	TSSOP-16 	+/- 0.6 deg or less
Digital	TAD2141	6.4*5.0*1.0	TSSOP-16 	+/- 0.2 deg or less
Digital (Dual)	TAD4140	6.4*5.0*1.0	TSSOP-16 	+/- 0.2 deg or less



APPLICATIONS

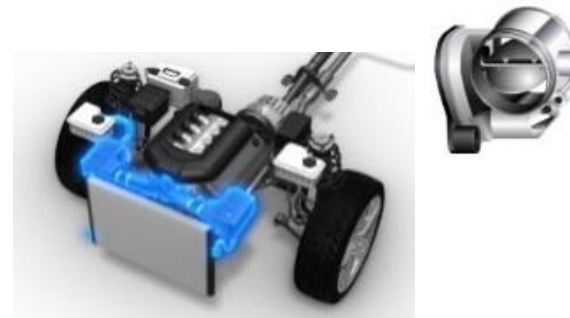
Automotive



<Wiper(Direct Control)>



<EPS motor>

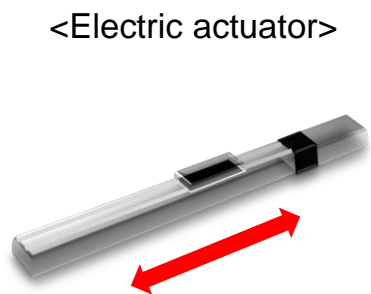


<Electric Throttle Valve>

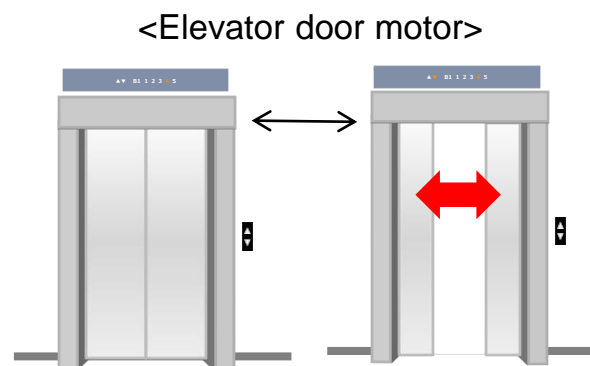


<Steering Angle>

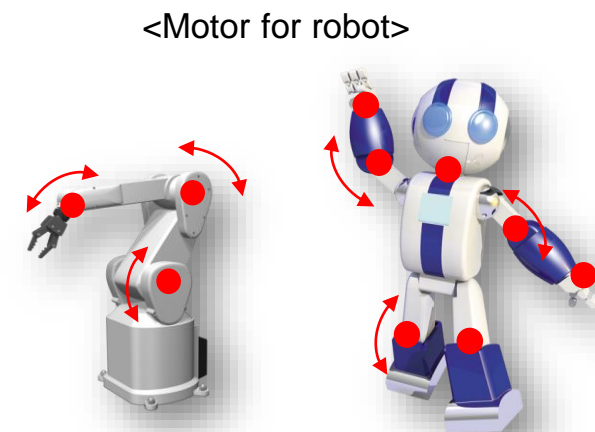
Industrial



<Electric actuator>

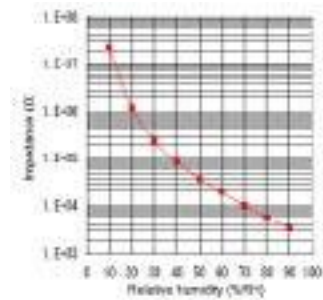


<Elevator door motor>



<Motor for robot>

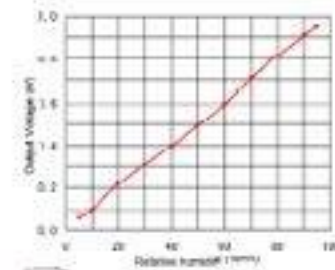




CHS-ESS-CA5

SENSING
ELEMENT

AC OPERATED



CHS-U Type

TEMPERATURE
COMPENSATION



CHS-CGC5-28

TI THERMISTOR
CHIP

LINEARIZATION / DC OPERATED

Item	Accuracy range	Nominal accuracy	Operation voltage	Output voltage	Shapes	Dimension [mm]
CHS-UPS	5 to 95 %RH	±3%RH	5VDC	0 to 1.0V	square	27*11.5*6.5
CHS-UPR					round	φ20*9
CHS-UGS		±5%RH			square	27*11.5*6.5
CHS-UGR					round	φ20*9
CHS-MSS	20 to 85 %RH	square			20*10*5	
CHS-CGC5-28	50 %RH	±7%RH		0 to 2.0V	PCB ASSY	19*21*12.6
CHS-ESS-CA5	50 %RH	±5%RH	AC1V	Impedance: 40k omega (25°C/50%RH)	square	9.0*6.5*3.7



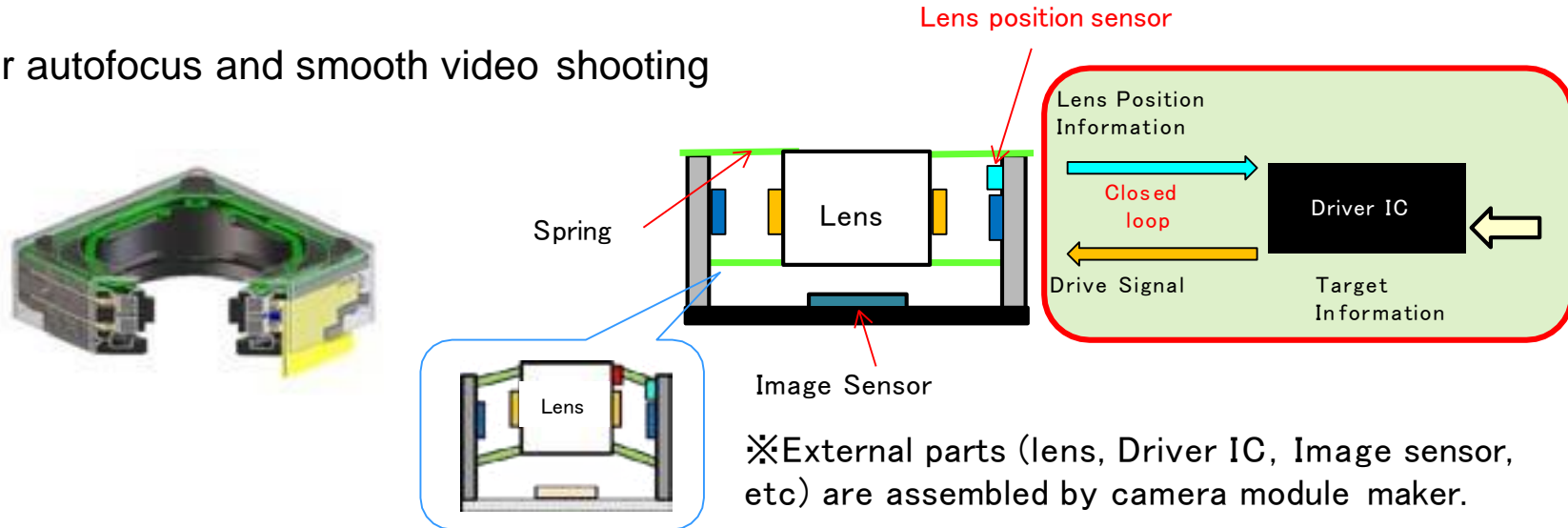
Buzzer is inexpensive compared to speakers.
It can be used for confirmation sound in IOT products.



Line-Up	Driving source	Example of driving circuit	Typical features
Piezoelectric Buzzer	Applying voltage to the Piezoelectric Materials		Low power consumption, slim & light, Low cost
Electromagnetic Buzzer	Flowing current to the Electromagnet		Low frequency operations, High sound pressure, Low impedance

Auto focus (AF)

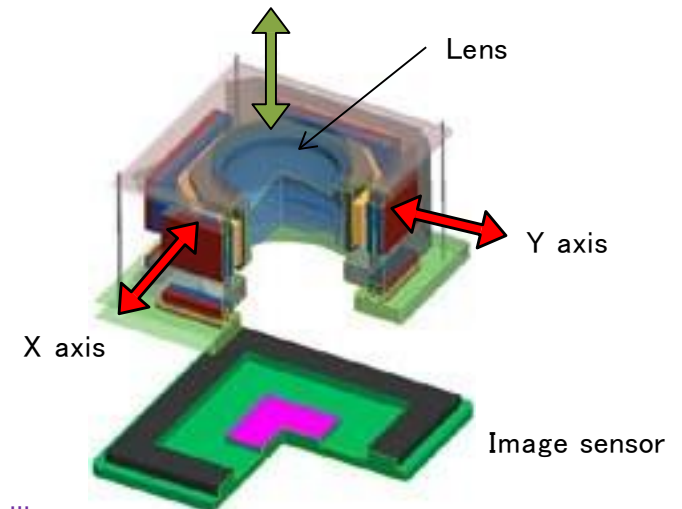
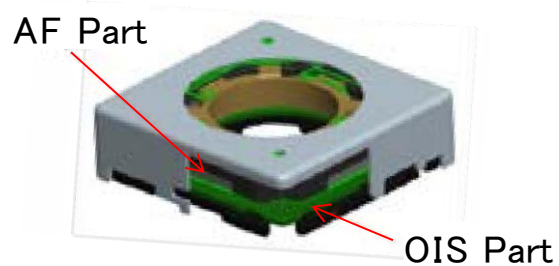
- Faster autofocus and smooth video shooting



Auto focus (AF) + Image stabilizer (OIS)

OIS

- High quality video and photo shooting



X, Y axis :Image Stabilizer
Z axis :Autofocus



VARIETY OF TDK LENS ACTUATOR

	Voice Coil Actuator (VCA)	Bi-directional VCA (BD-VCA)	Closed loop VCA (CL-VCA)	Optical Image Stabilizer (OIS)
Full view				
Function	Autofocus(AF)	Autofocus(AF), low electric consumption	High speed AF, low electric consumption	Autofocus(AF) and optical image stabilization(OIS)
Moving direction of lens(position control)	1 axis (+Z direction) for AF Open loop control	1 axis(+Z & -Z direction) for AF, Open loop control	1 axis(+Z & -Z direction) for AF, Closed loop control	3 axis (+Z direction for AF, $\pm X$ & $\pm Y$ direction for OIS)
Position sensor(Hall element)	no	no	1 pc for AF(Z direction)	2 pcs for OIS (X & Y direction each)
Contact terminal	Lead terminal	Lead terminal	FPC is needed for In-/Out- put of hall sensor.	FPC is needed for In-/Out- put of hall sensor.
Autofocus method	Contrast AF	Contrast AF	Contrast AF Phase contrast AF	Contrast AF



FEATURES

- ① Power generation efficiency under indoor light is good
 - * Material of amorphous silicon suits for indoor light
(2 ~ 5times output power : vs crystal Si under indoor light.)
- ② Thin , Light , Flexible
[Ex] Product size 50×15mm
⇒ Weight 0.1g / Thickness 0.2mm (max)
- ③ High flexibility for custom design (Variety shapes and voltages)
 - * Realize many shapes for customer's products
 - * Selectable output voltage for rechargeable
- ④ devices 20 years experience in watch market



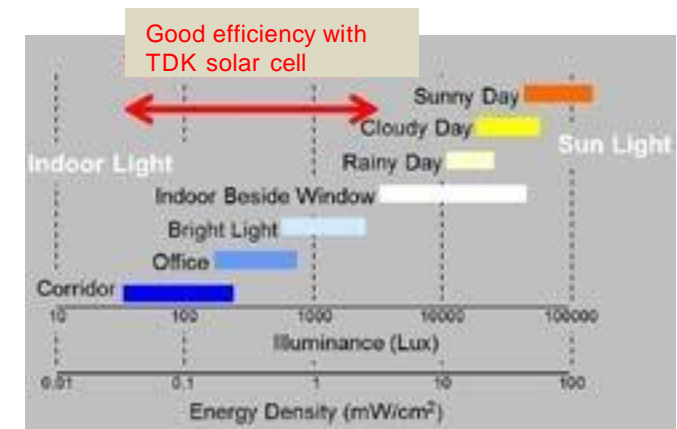
Example of shape

OUT-PUT POWER

Solar cell output power depends on size and illuminance

[Ex] Output power from 50X15mm solar cell

Type of product	Standard efficiency	10% higher efficiency	20% higher efficiency
Indoor (500Lx)	Abs. 125μW	Abs. 138μW	Abs. 150μW
Outdoor (50000Lx)	Abs. 15mW	Abs. 16.5mW	Abs. 18mW

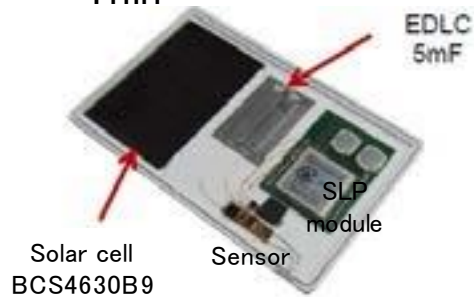


APPLICATIONS

DEMOS with solar cell

Wireless sensor network

Thin



46X30mm solar cell with EDLC, Temp/Humid sensor, Specified low-power module

Small



17X14mm solar cell with BTLE, Temp/Humid sensor on EDLC

Flexible



50X15mm solar cell with EDLC, BTLE, Temp/Humid sensor

No need for
Battery replacement
Electric wiring

Beacon



Smart card

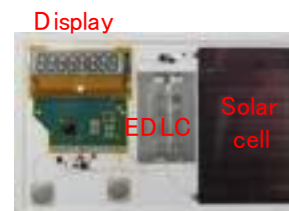
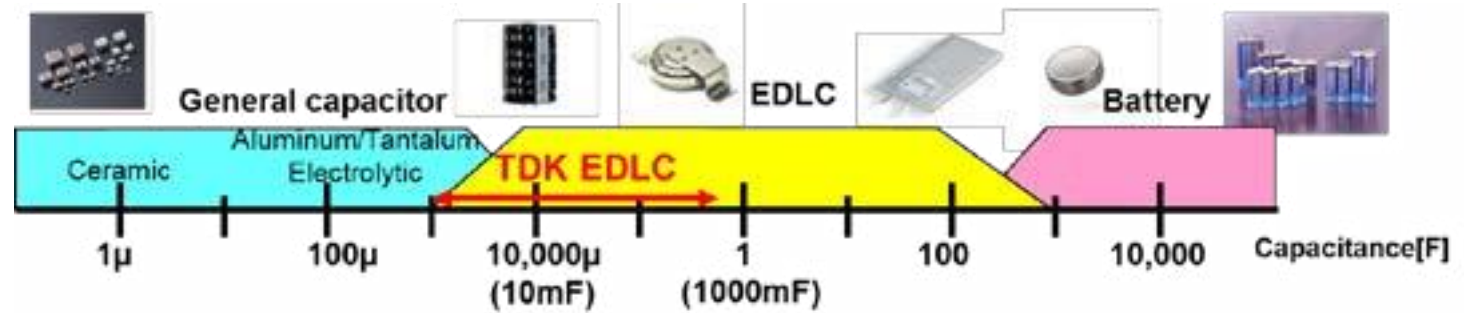


Image of wearable device with solar cell





FEATURES

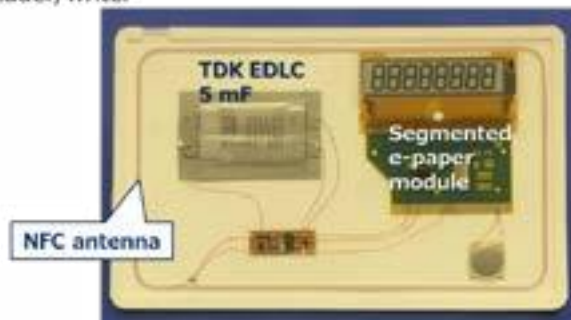
- To fit in small space: low profile (0.4mm~), small footprint
- To support various power demand, weak~instantaneous: wide capacitance range (5-500mF), low impedance
- Superior cyclic life: remaining 80+% of initial cap. after 10mil.-discharge at 7A-5msec (i.e. LED flash type)

OUT-PUT POWER

- Energy harvesting, RF- and sensor-driving power on healthcare/wearable devices
- Current assistances on high-power LED flashes, SSD back-up, audio amplifier boosting
- Power supplying for NFC-CPUs, secure-ICs, e-paper displays

Battery-less e-paper display card

- To refresh the card's e-paper display by the power stored onto TDK's thin-type-EDLC
- EDLC to be charged in less than one second by a typical NFC reader/writer



Battery-less Beacon

- To transmit a unique ID-code every 0.5 second, using Bluetooth Low Energy (BLE)
- Powered by TDK's film-solar-cell and thin-type-EDLC



GENERAL FEATURES

- High capacitance and low impedance.
- Thin small size.
- Long-life.
- Clean materials.
- Safety.

ADDITIONAL "THIN TYPE" FEATURES

- Very thin small size.
- High bending strength.
- Compliant with ISO standards (dimensions, bending, torsion tests)

Quick charge-discharge

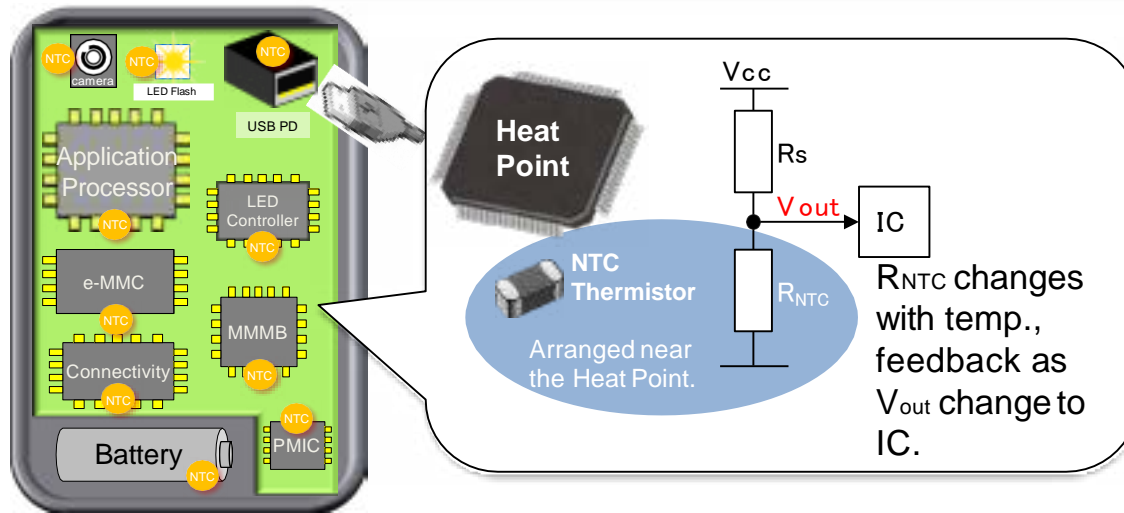
PRODUCT LINE UP

Product Image	Features	Height	L×W size	Capacitance	Rated Voltage	Impedance	Series, Types
	Thin Type	0.4mm	27 x 17mm	5 to 15mF	3.2V(Continuous) 5.0V(Peak)	7 \wedge (1kHz)	EDLC041720
	Low Profile Type	2.1mm	20 x 25mm (Without Lead)	350mF	4.2V(Continuous) 5.5V(Peak)	55m \wedge (1kHz)	EDLC212520
		2.6mm		500mF		35m \wedge (1kHz)	EDLC262520
	Small Footprint Type	3.3mm	20 x 14mm (Without Lead)	500mF	4.2V(Continuous) 5.5V(Peak)	40m \wedge (1kHz)	EDLC351420

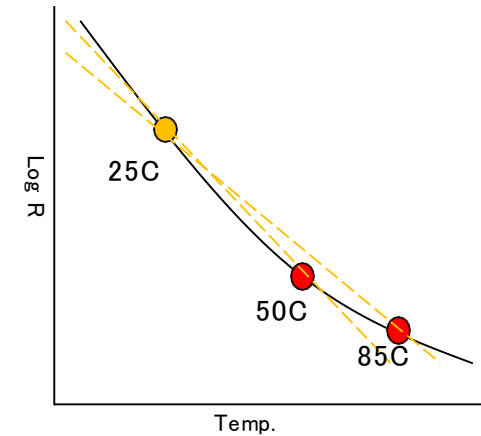


PURPOSE

NTC Thermistor is Temperature detection & compensation device



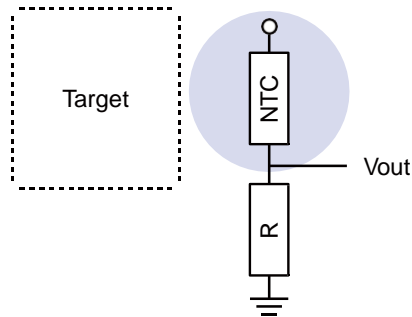
Basic Characteristics



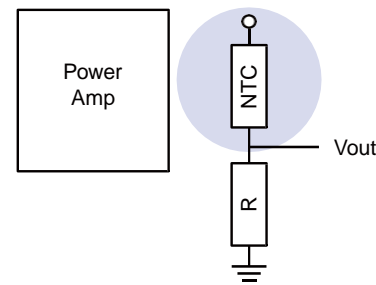
APPLICATIONS

TDK Web=> <https://product.tdk.com/info/en/products/protection/temperature/chip-ntc-thermistor/technote/chip-ntc-selection-guide.html>

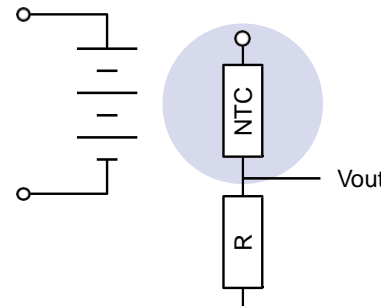
Various circuit



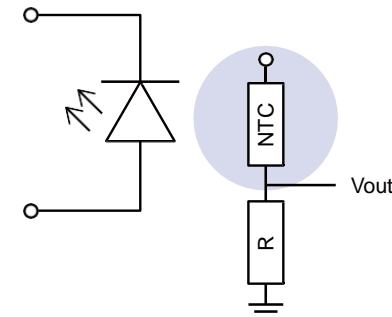
PA, PMIC



BMS



LED

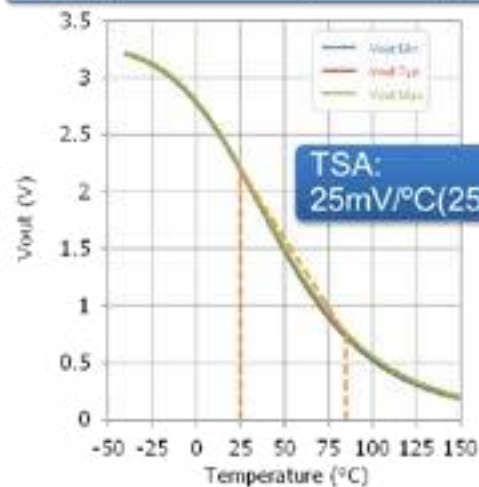


FEATURES

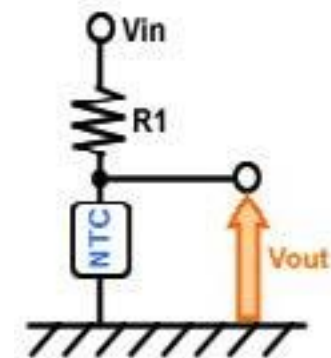
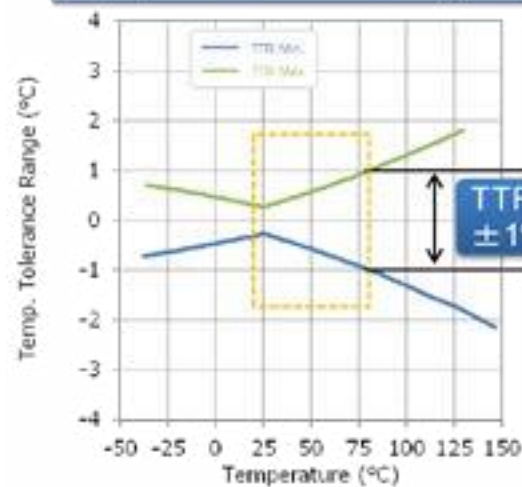
- TDK has wide case size line up EIA0805, 0603, 0402, 0201. (EIA01005:Under development)
- Same electrical characteristics in different case size
- Excellent Vout Temperature performance(TSA:Temp. Sensing Accuracy, TTR:Temp. ToleranceRange)

Product Image	Series, Types	LxW size	Height	Nominal Resistance [@25°C]	B value [25/50°C]	B value [25/85°C]
	NTCG06	0.6x0.3mm [EIA 0201]	0.3mm	30 Ω ~ 100k Ω	(3244 ~ 4485K)	3250 ~ 4550K
	NTCG10	1.0x0.5mm [EIA 0402]	0.5mm	22 Ω ~ 470k Ω	(3244 ~ 4662K)	3250 ~ 4750K
	NTCG16	1.6x0.8mm [EIA 0603]	0.8mm	30 Ω ~ 1M Ω	(3244 ~ 4662K)	3250 ~ 4750K
	NTCG20	2.0x1.2mm [EIA 0805]	1.0mm	470 Ω ~ 150k Ω	(3057 ~ 4085K)	3150 ~ 4150K

Temperature Sensing Accuracy(TSA)

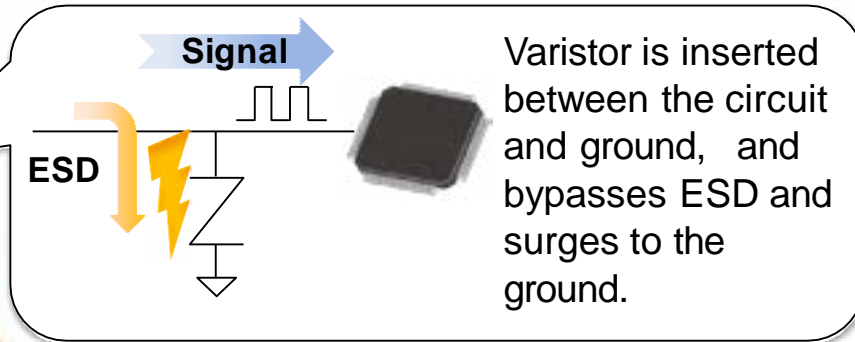


Temperature Tolerance Range(TTR)

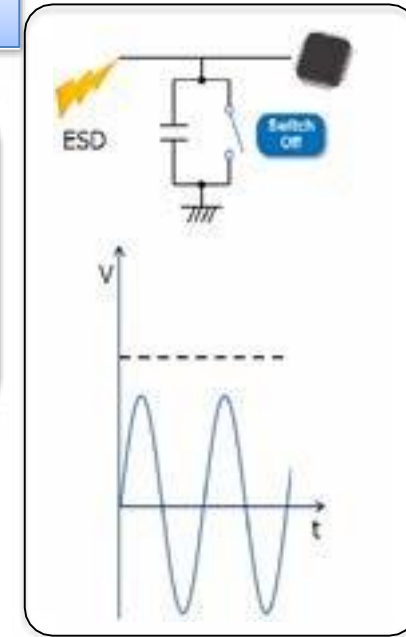


PURPOSE

Varistor is an ESD/surge protection device



Varistor has functions initially with high resistance, but once it exceeds a specified voltage (varistor voltage), the resistance value drops suddenly and allows current to flow

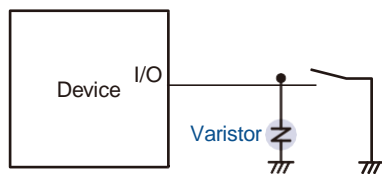


APPLICATIONS

TDK Web=> <https://product.tdk.com/info/en/products/protection/temperature/chip-ntc-thermistor/technote/chip-ntc-selection-guide.html>

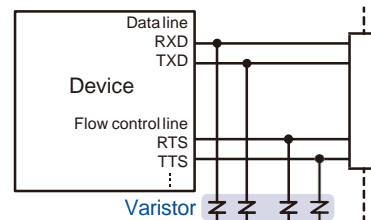
Switch/Button

Switch



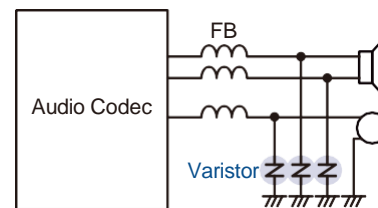
Serial Interface

RS-232C/RS-423/RS-422 /RS-485



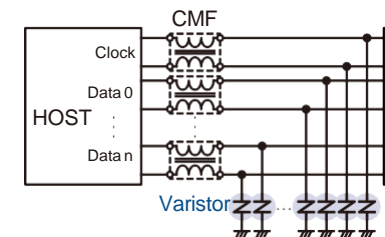
Audio

Speaker, Mic, Headphone

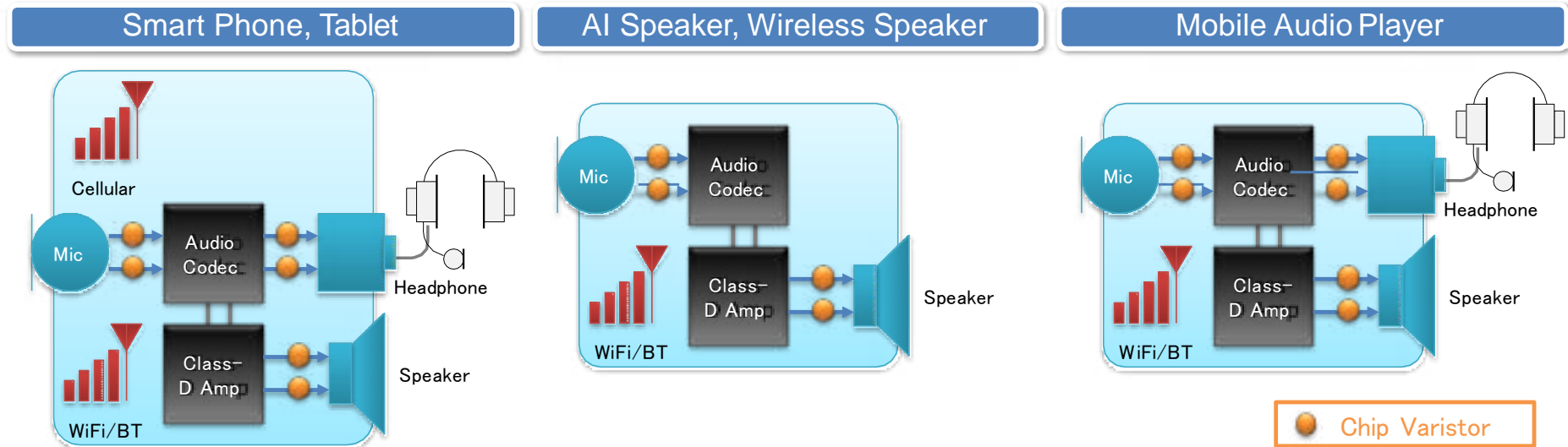


High Speed I/F

USB2.0/LVDS/HDMI /USB-SS



BLOCK CHART FOR AUDIO DEVICE



FEATURES : GOOD PERFORMANCE IN AUDIO CIRCUIT

Products	Case Size [mm]	Qty & Space	ESD Clamp [V]	Cost *	THD+N	Desense
TVS Diode + MLCC 	TVS diode 0603~1005 MLCC 0402~	Poor 2pcs/100%	Average Vpeak 44, Vave 15	Poor 100%	Poor	Poor
Chip Varistor 	0402~	Excellent 1pc/40%	Average Vpeak 45, Vave 14	Excellent 50%	Excellent	Excellent



Excellent ESD and surge protection for PoE devices

- Ethernet is a widely used standard for high-speed communication. The addition of Power over Ethernet (PoE) provides many advantages in the field of application. Since the same cable used for communication is also used to power the device, it eliminates the need to provide an AC power source for devices such as Internet Protocol (IP) phones, IP cameras and wireless access points.
- Many applications are located in hostile environments and require protection against damage that can be caused by power surges, indirect lightning strikes and other transient events.
- Ceramic transient voltage suppressors (CTVS) of the high surge series enables an efficient protection against severe transient overvoltage and high surge currents, such as 8/20 μ s pulses with peak currents up to 5 kA and 10/700 μ s pulses up to 150 A.

ADVANTAGES OF CTVS®:

- Fulfil all common PoE pulse requirements for indoor and outdoor applications
- Affordable price and high miniaturization potential due to high energy capability in a compact package
- No temperature derating up to +85 °C
- UL approval according to UL 1449 standard

➔ **Perfect choice to protect indoor and outdoor PoE systems!**

		Indoor Basic	Indoor Enhance	Outdoor
Product range	Application	VoIP Phones Wireless Access Point Networked Audio	Door Access Systems Video Phones, IP cameras, Point-of-Sale Systems	Base station
	Pulse requirement	500A (10 x 8/20 μ s) 100A (10 x 10/700 μ s)	1000A (10 x 8/20 μ s) 150A (10 x 10/700 μ s)	3000A...5000A (10 x 8/20 μ s)
	Recommended type	CT1210K25E2G CT1210K45E2G CT1210K50E2G	CT1210K45E2G CT1210K50E2G CT1210K60E2G	CT2220K30E2G CT2220S50E3G



FEATURES

- 2 Lineup of Transparent Conductive Material (ITO & Ag)
- High Transmittance & Low Haze by ITO Film
- Low Resistance & High Heat Shielding by Ag-Stacked Film



STRUCTURE

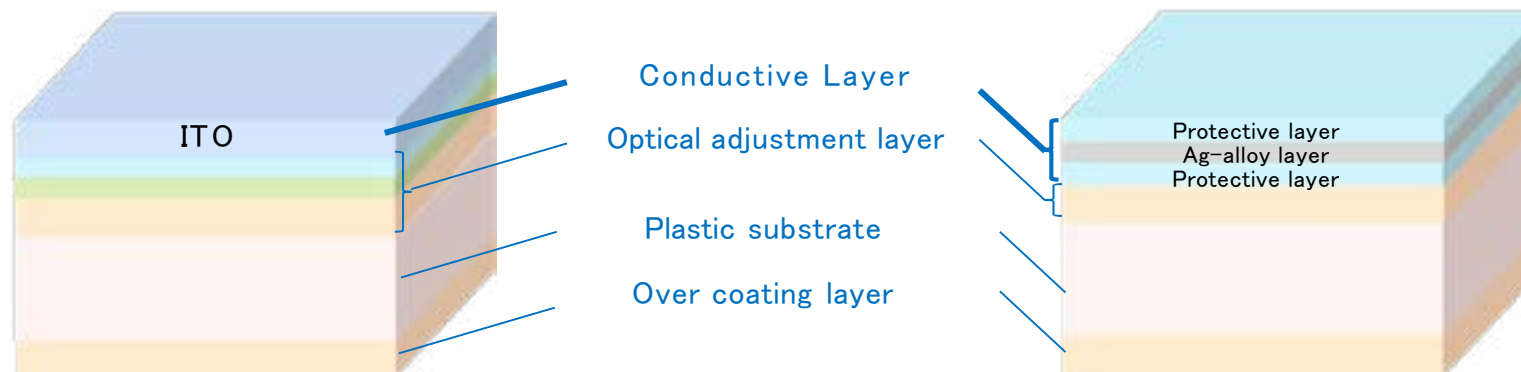
○ITO Film

We have formed ultra thin anti-reflection layer by wet coating technology.

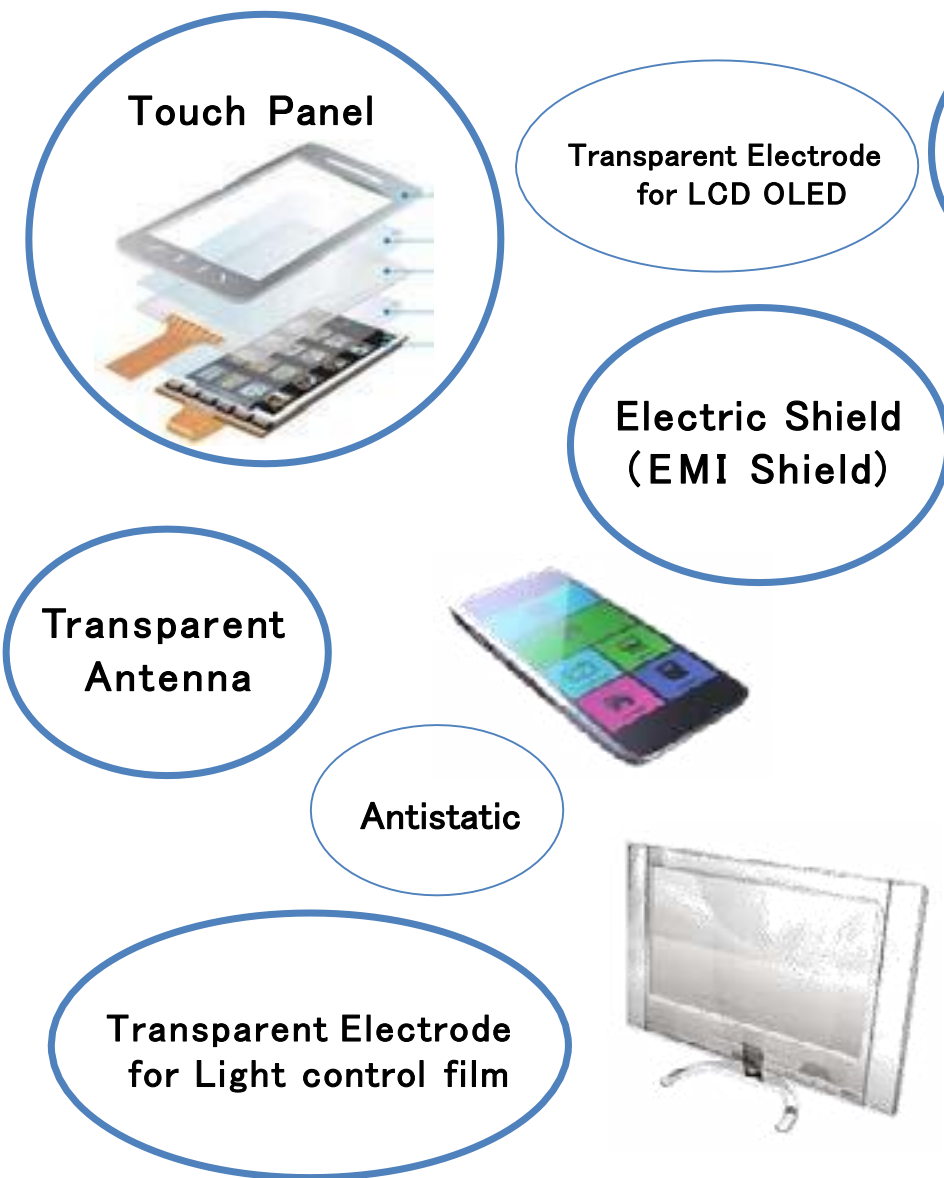
So this product has good transparency and productivity.

○Ag-Stacked Film

We have adopted an Ag-alloy and its original protective material. So this product has low resistance , high heat shielding and durability.



APPLICATIONS FOR CONSUMER ELECTRONICS



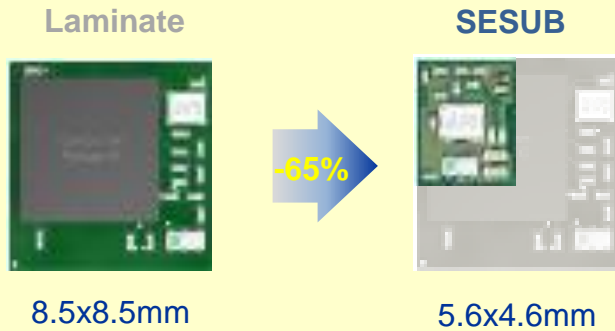
SPECIFICATION

Specification	ITO Film	Ag-stacked Film
Thickness of PET Film [μm]	Available 125 or 50 μm upon request	
Total Light Transmittance [%]	90	88
Haze[%]	1.0	0.5
b*Value(color)	0.5	1.0
Surface Resistance [Ω/sq]	120	10
Shielding Coefficient	0.9	0.7



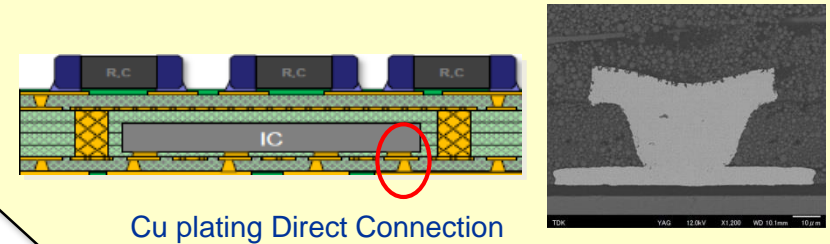
TECHNOLOGY HIGHLIGHT

PCB Miniaturization

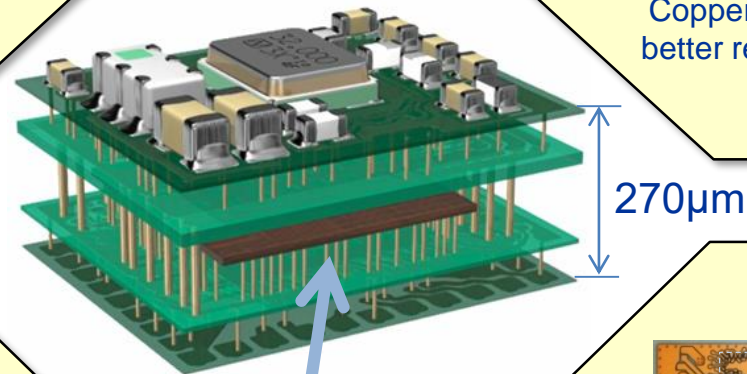


※Example of Miniaturization

Improve Thermal Performance

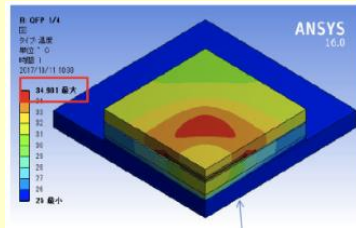


Copper direct connection technology shows better reliable connection than Wire bonding and/or Solder joints

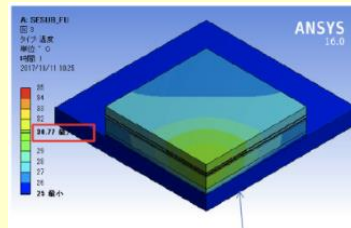


Embedded Bare IC

Package	QFP-176Pin	SESUB-188Pin
Pkg Size [mm]	20x20	20x20
Die Temp Source: 5W	34.9 °C	30.8 °C

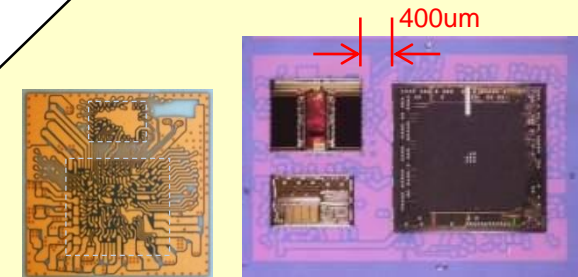


QFP-176Pin



SESUB Package

Improve Thermal Performance



Coreless Structure enable to multi-dies integration

- Die to Die gap : 400µm
- Die to Edge : 250µm


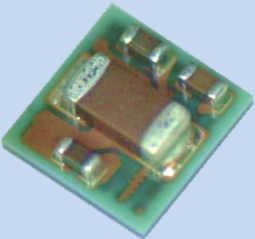
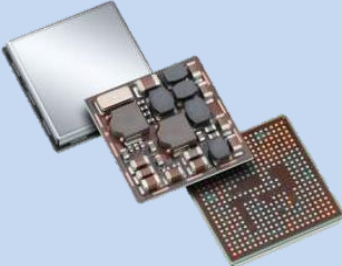
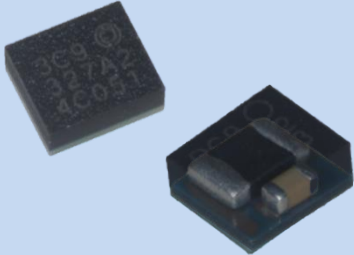
Many Experiences in volume production

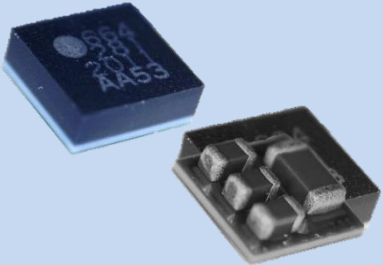
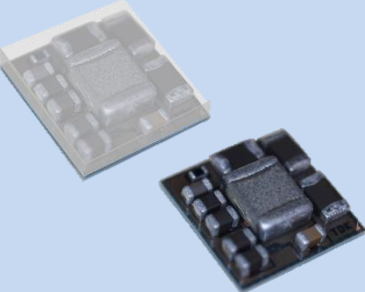
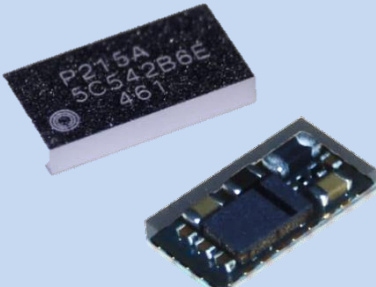
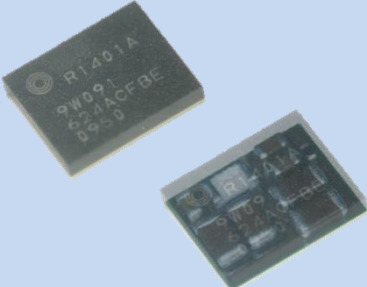
- Embedded Die Counts : LVM: 4, HVM: 3
- Maximum Die Size : 8.0x8.0mm

Efficient Multi Chip Embedding



APPLICATION (Customer Application Examples)

Application	μ DCDC Buck Converter	Boost Up Converter	Power Management Unit	μ DCDC Buck Converter
Power Supply				
Package Size	2.3x2.9mm (7.0mm ²)	2.3x2.4mm (121mm ²)	11.0x11.0mm (121mm ²)	2.5x2.0mm (7.3mm ²)

Application	Wearable Battery Charger	Quick Battery Charger	Envelope Tracker	Wireless Power Receiver
Advanced Function (Power)				
Package Size	2.8x2.6mm (7.3mm ²)	5.0x5.0mm (25mm ²)	5.8x3.0mm (17.7mm ²)	5.0x4.0mm (20mm ²)

Visit to TDK Web Site for more information about SESUB Technology and Products



PiezoHapt S

Key Infos

USP: „Cost effective solution!“

- Sample available for both types
- SOP : January 2018
- Automotive qualification to be acquired in December 2017

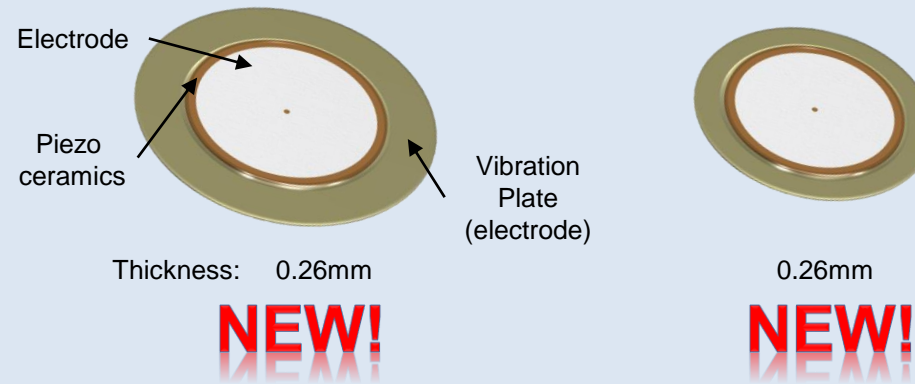
Target Applications (Examples):

- Automotive
 - Steering wheel switches
 - Overhead consoles' switches
 - Touchpads
- Industry
 - Switches
 - Touchpads
- Consumer
 - Home appliance switches
 - PC trackpads
 - Remote control buttons

Product range:

φ15mm type

φ12 mm type



Product Specification	Acceleration		Voltage	Capacitance	Max. Displacement	T _{op,max}
	20gr.	100gr.				
φ15mm type PHUA15-26A-10-000 (General use) PHUB15-26A-10-000 (Automotive)	4G	0.5G	400V*	7.0 nF	50μm	85° C
φ12mm type PHUA12-26A-9-000 (General use) PHUB12-26A-9-000 (Automotive)	2.4G	0.3G	400V*	5.5 nF	30μm	85° C

*400V with Aito system

Remark

These P/Ns are intended for the use with the AitoChip microcontroller. Pls. contact PM if this is not the case. Other P/Ns will be required.



PiezoHapt L

Key Infos

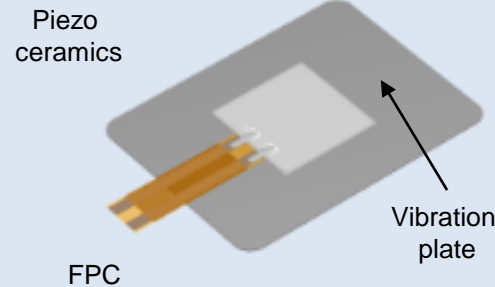
IUSP: „Ultra thin!“

- L8060 (General) & L3015 (General):
Samples available
- Automotive grade samples:
Jun 2018 (L8060)
Jun 2018 (L3015)
- SOP:
September 2017 (L8060/General)
Jun 2018 (L3015/General)

Product range:

L8060 type

L3015 type



80mm x 60mm
Thickness: 0.35mm



30mm x 15mm
0.30mm

Target Applications (Examples):

- Automotive
 - Steering wheel switches
 - Overhead consoles' switches
 - Touchpads
- Industry
 - Switches
 - Touchpads
- Consumer
 - Home appliance switches
 - PC trackpads
 - Remote control buttons

Product Specification	Acceleration		Voltage	Capacitance	Max. Displacement	T _{op,max}
	20gr.	100gr.				
L8060 (General use) PHUA8060-35A-33-000	1.5G	0.2G	24Vp-p max. (±12V)	0.6μF	65μm	60° C
L3015 (General use) PHUA3015-30A-21-000	1.6G	0.3G	12Vp-p max. (±6V)	1.5μF	40μm	60°C
L8060 (Automotive) PHUB8060-35A-33-000	1.5G	0.2G	24Vp-p max. (±12V)	0.6μF	65μm	105°C
L3015 (Automotive) PHUB3015-30A-21-000	1.6G	0.3G	12Vp-p max. (±6V)	1.5μF	40μm	105°C



PowerHap

Key Infos

USP: „Powerful but thin!“

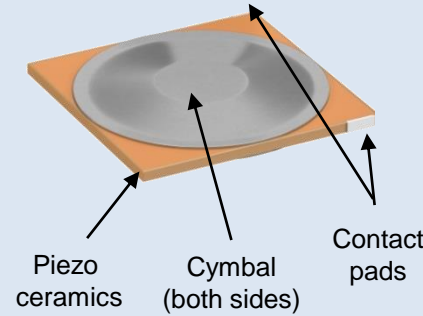
- Samples available
- Release and SOP
- 15G type : July 2018
- 7G / 2.5G type : October 2018
- Release based on AEC-Q200

Target Applications (Examples):

- **Automotive**
 - Displays
 - Steering wheel switches
 - Single buttons
- **Industry**
 - Human machine interface
 - Building automatisaton
 - Traction (e.g. control panel)
- **Consumer**
 - Mobile devices
 - Game controlers
 - High end kitchen equipment

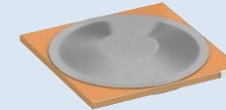
Product range:

15G type



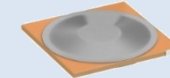
26mm x 26mm
Thickness : 2.4mm

7G type



12.7mm x 12.7mm
1.9mm

2.5G type






NEW!

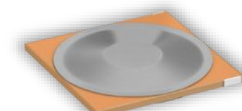
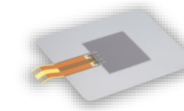
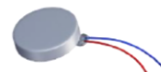
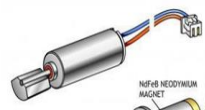
9mm x 9mm
1.2mm

Product Specification	Acceleration		Voltage	Capacitance	Max. Displacement	T _{op,max}
	20gr.	100gr.				
PowerHap 15G Z63000Z2910Z 1Z 4	65G	15G	120V	3.6μF	200μm	85°C
PowerHap 7G Z63000Z2910Z 1Z 5	30G	7G	120V	0.9 μF	65μm	85°C
PowerHap 2.5G Z63000Z2910Z 1Z 2	8G	2.5G	60V	0.8 μF	35μm	85°C



COMPARISON

	ERM Eccentric Rotating Mass	LRA Linear Resonant Actuator	Taptic Engine Linear Actuator @ Apple	PiezoHapt S Monolithic piezo disc on metal substrate 	PiezoHapt L TDK multilayer actuator on metal substrate 	PowerHap TDK multilayer actuator with mech. amplifiers 
Size x,y,z [mm]	8 x 3 x 3	Φ 10 x 3	34 x 10 x 3	Φ 15 x 0.26 / Φ 12 x 0.26	30 x 15 x 0.30 / 80 x 60 x 0.35	9 x 9 x 1.2 - 26 x 26 x 2.4
Acceleration [G] (20 g mass)	2	5	5	4 / 2.4	1.6 / 1.5	8 - 65
Acceleration [G] (100 g mass)	0.6	1.7	1.2	0.5 / 0.3	0.3 / 0.2	2.5 - 15
Rise Time [ms]	50	20	<2	< 1	< 1	< 1
Voltage [V]	3	3	10	200 - 400	12 / 24	60 - 120
Energy per click [mJ]	17	15	26	2	1 - 5	1 - 8
Custom Waveforms	no	no	yes	yes	yes	yes
Force Sensing	no	no	no	yes	yes	yes
Driver Design	easy	easy	easy	ASIC	ASIC	ASIC



Piezo based actuators show best haptic performance in the market.



NFC filter & matching circuit (Request characteristic)

L tolerance : J(+/-5%) tolerance. L value : 1005 size(75 to 560nH) / 1608 size(100 to 560nH) .

High performance new ferrite inductor.

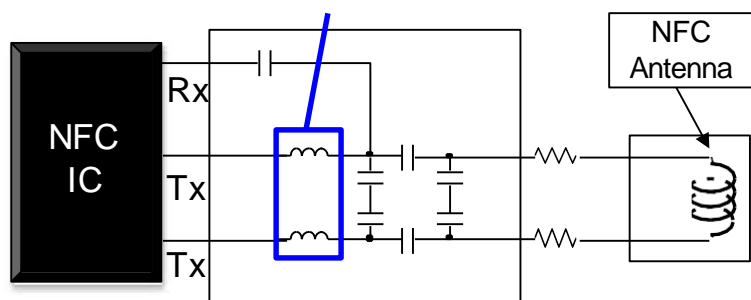
MLF Series has the approval of the NFC IC maker. However, a low loss coil is required of a trend.

As TDK succeed to develop the high performance new ferrite inductor "MLJ series" .

MLJ series big feature is High current capabilities that is same level with Wire wound inductor.

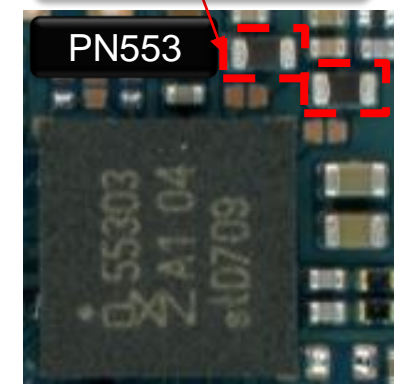
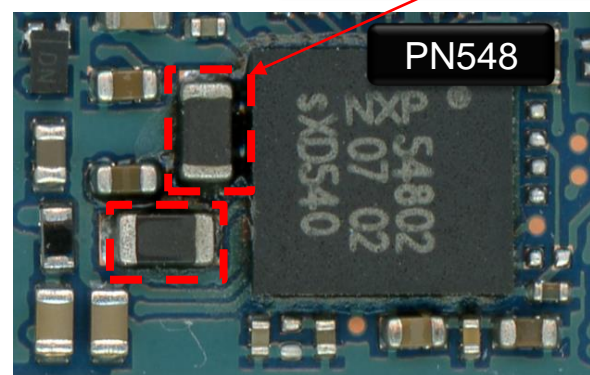
Also it has "Low AC loss" and "J(+/-5%) inductance tolerance supporting" as well.

IC	Reference Inductor
NXP	MLJ1608WR16J
MTK	MLJ1005WR56J
	MLJ1005W75NJ

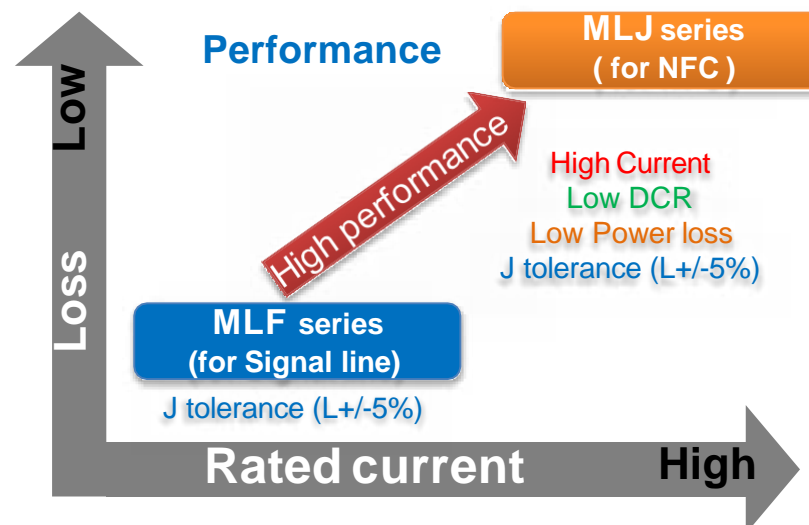
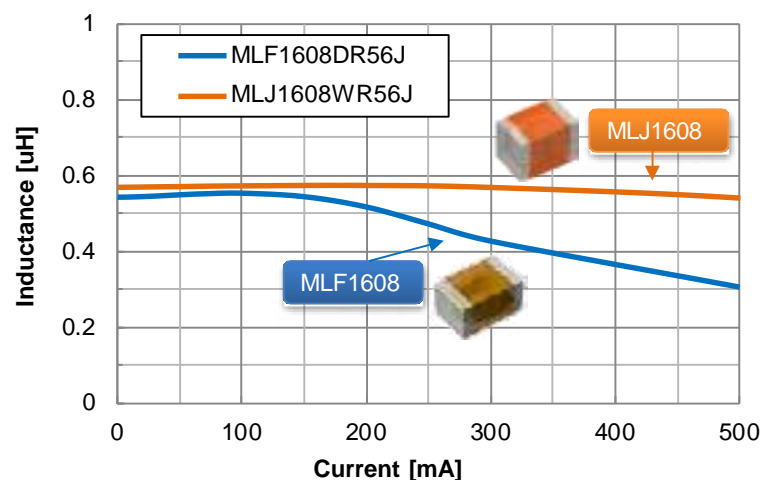


MLJ1608WR16J

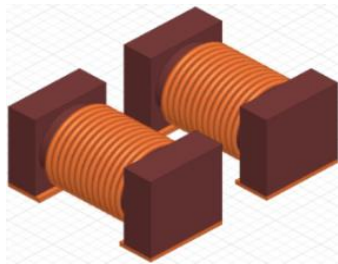
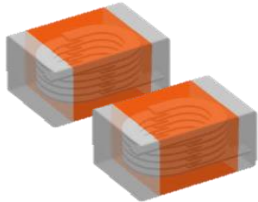
MLJ1005WR16J



Inductance vs DC Bias



KEY BENEFIT FOR NFC APPLICATION

	Wire wound inductors	Multilayer MLJ series
		 NEW
Better Q Factor	⊖	⊕
Magnetic Leakage flux	⊖ Open Magnetic field	⊕ Close Magnetic field
Cost	⊖	⊕

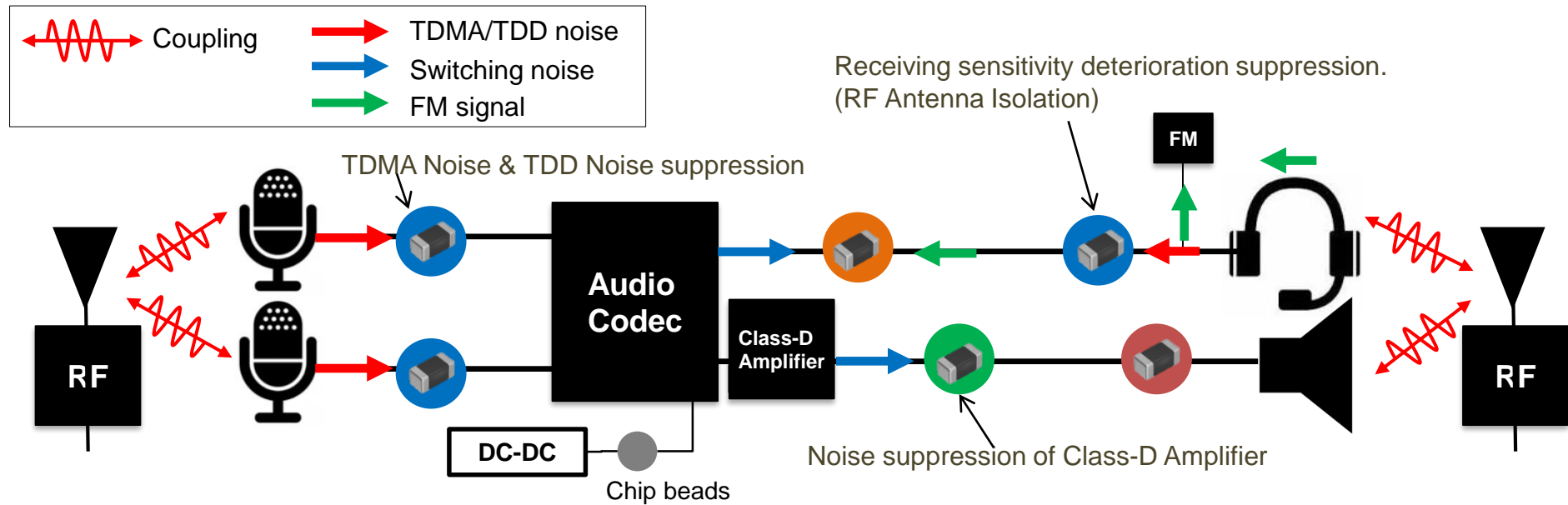
⊕ advantages

⊖ disadvantages

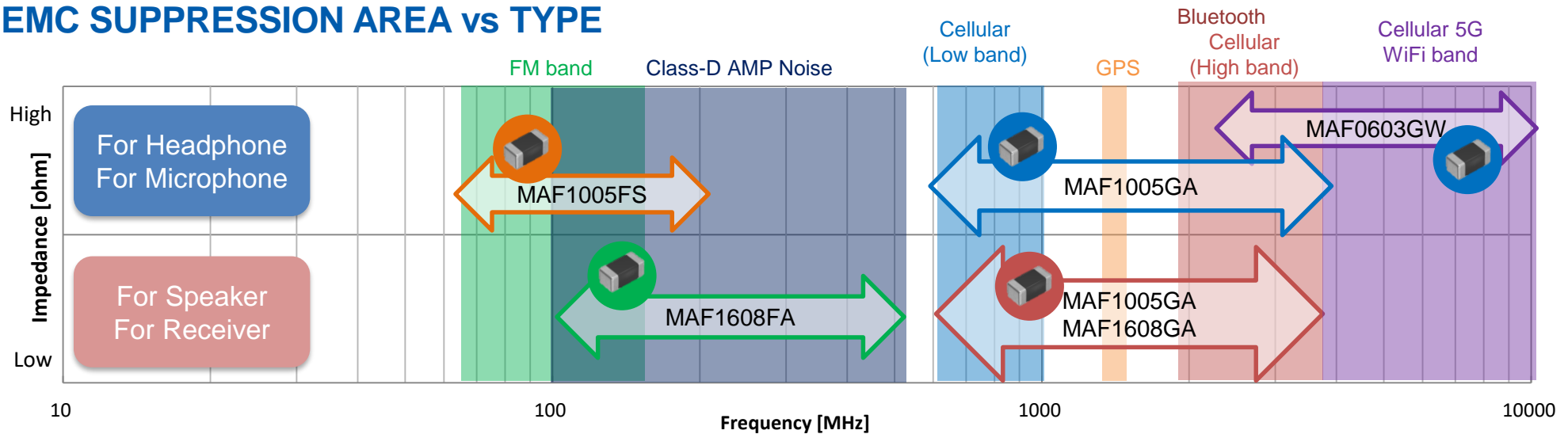
↓
Contribute for better Q and better leakage flux



AUDIO CIRCUIT AND NOISE IMAGE



EMC SUPPRESSION AREA vs TYPE

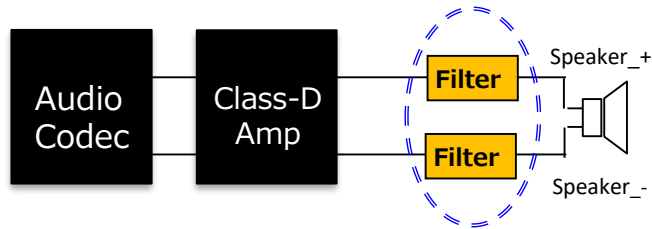


EMC Suppression Freq.	66MHz-108MHz 100MHz-400MHz	0.6GHz-2.7GHz	1.5GHz-10GHz
Headphone / Microphone	<p>MAF1005FS type</p>	<p>MAF1005GA type</p>	<p>MAF0603GW type</p>
Speaker / Receiver / Headphone GND		<p>MAF1005GA type</p>	
	<p>MAF1608FA type</p>	<p>MAF1608GA type</p>	

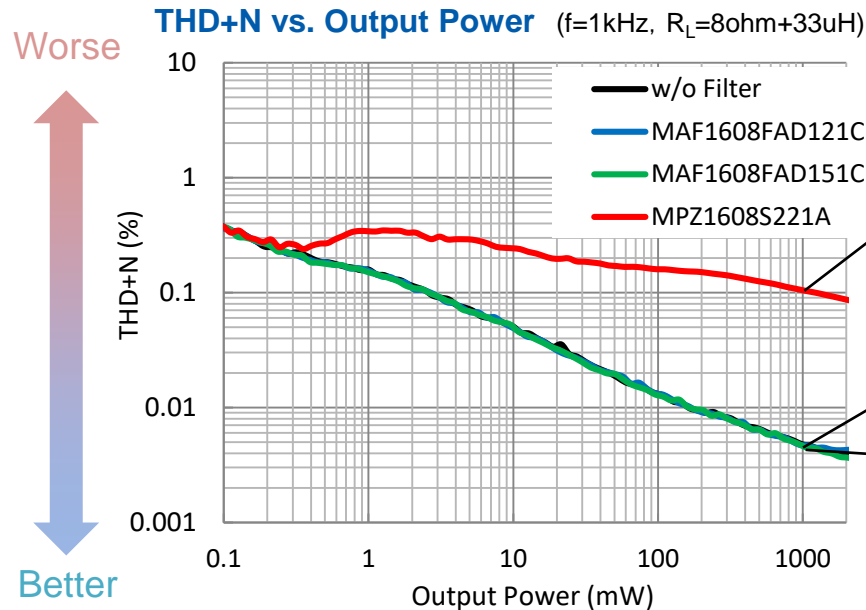


SUPPORTS HI-FI AUDIO

MAF1608 series

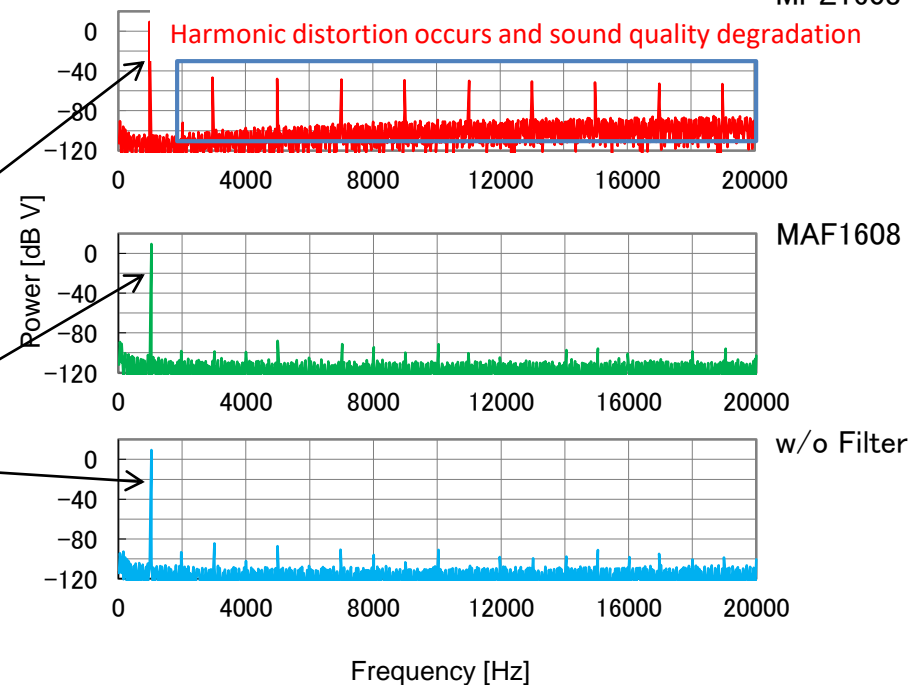


In general, chip beads are used for EMI countermeasures of class D amplifiers. However, with chip beads, the sound quality is reduced by distortion. Since the MAF series does not affect the sound quality, sounds with more realistic feeling are reproduced from the speaker.



FFT Spectrum Analysis

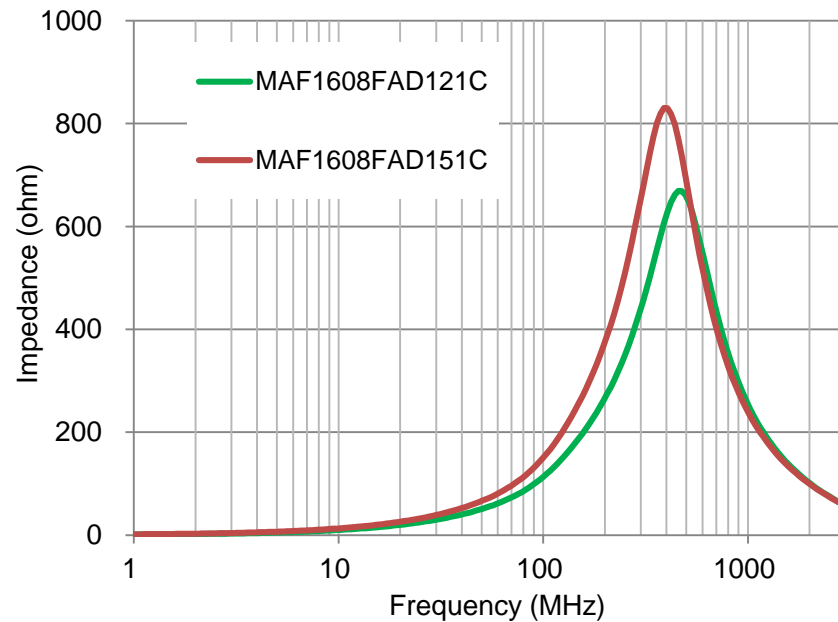
f=1kHz, $P_o=1\text{W}$



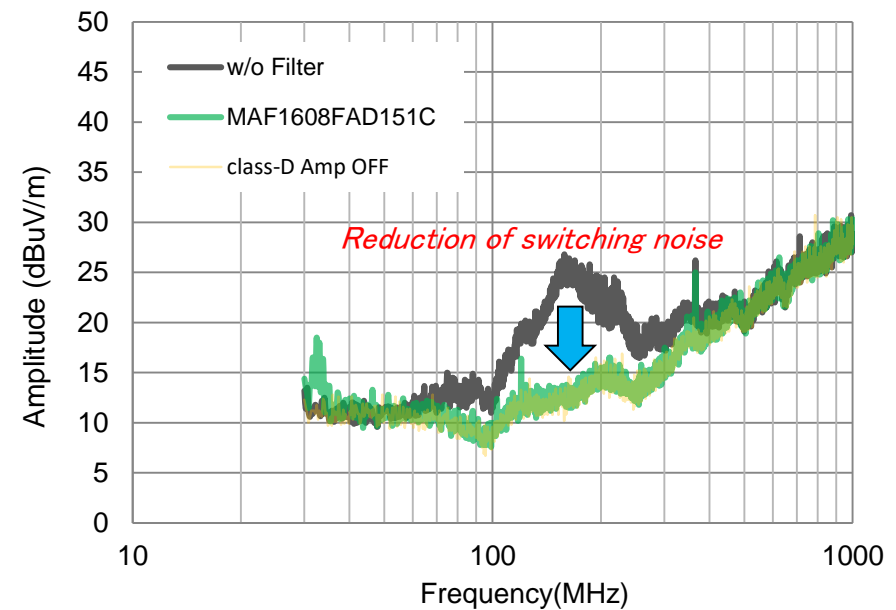
MAF1608FA SERIESE CHARACTERISTICS

ITEM	Impedance [ohm] @100MHz Typ.	DC Resistance [ohm]		Rated Current [A] Max.	
		Typ.	Max.		
MAF1608FAD121C	120	0.085	0.105	1.35	
MAF1608FAD151C	150	0.100	0.130	1.10	

Impedance vs. Frequency

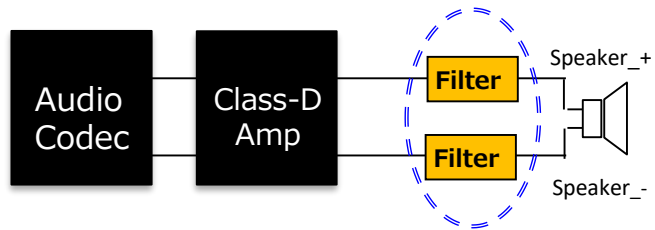


class-D Amp Radiated emission

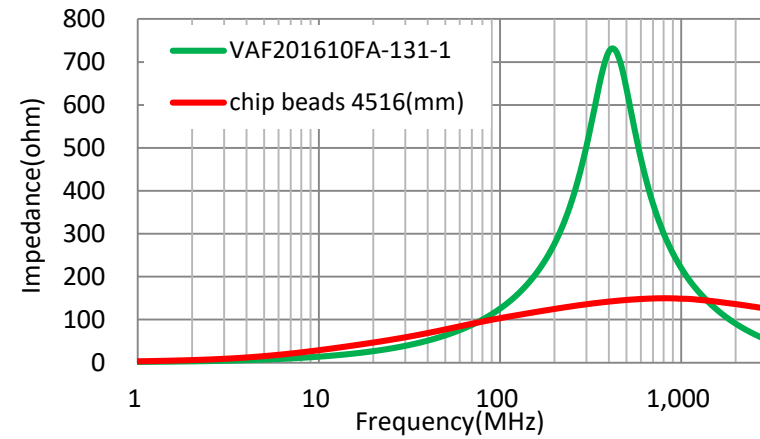


SUPPORTS HI-FI AUDIO

VAF201610FA series



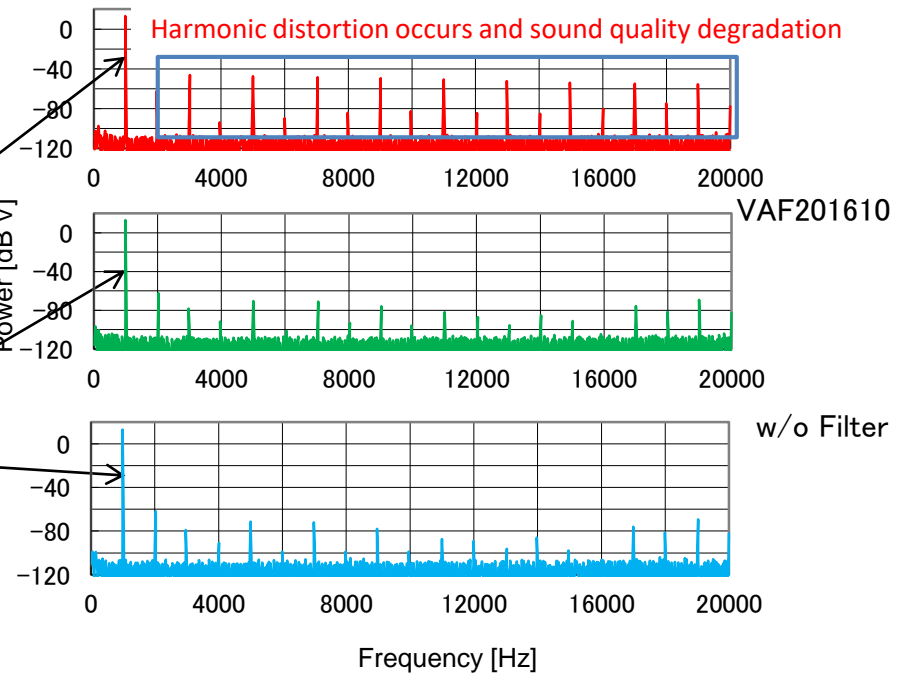
Impedance vs. Frequency



FFT Spectrum Analysis

f=1kHz, P_o=10W

Chip beads

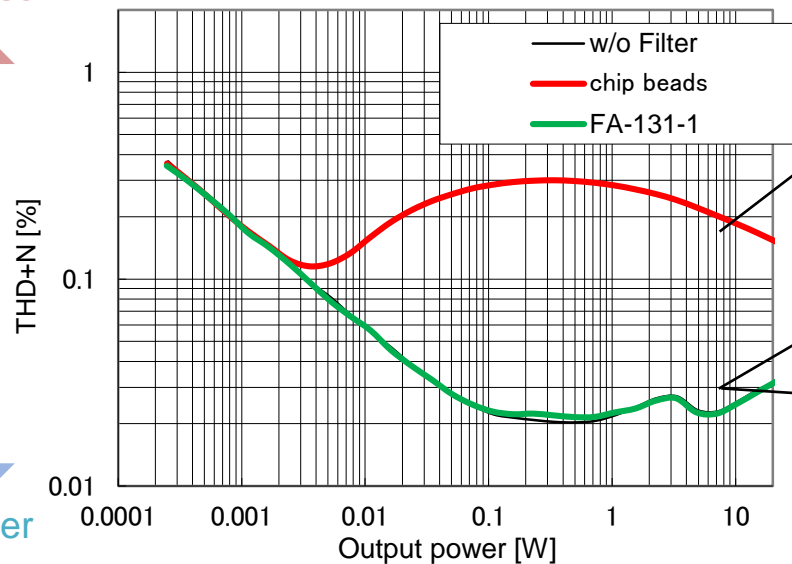


THD+N vs. Output Power (f=1kHz, R_L=4ohm)

Worse



Better

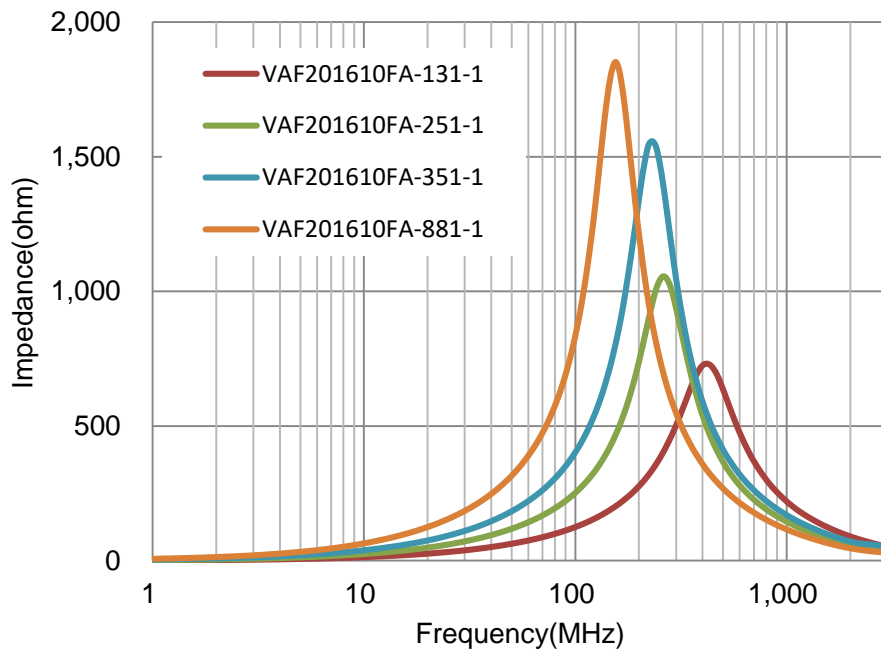


VAF201610FA SERIESE CHARACTERISTICS

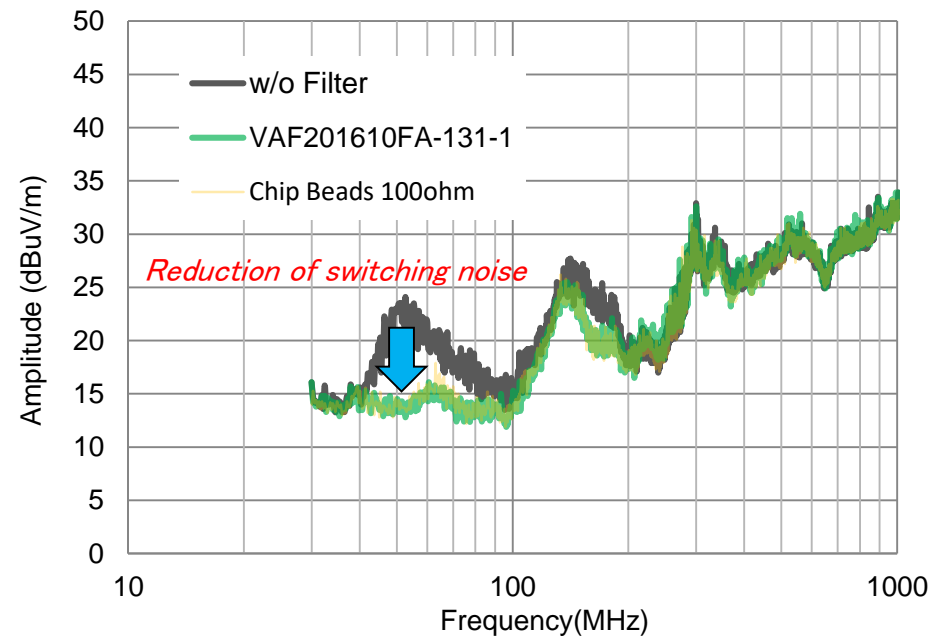
ITEM	Impedance [ohm] @100MHz Typ.	DC Resistance [ohm]		Rated Current [A]
		Typ.	Max.	Max.
VAF201610FA-131-1	130*	0.032	0.040	3.08
VAF201610FA-251-1	250*	0.042	0.050	2.69
VAF201610FA-351-1	350*	0.063	0.076	2.19
VAF201610FA-881-1	880*	0.066	0.079	2.14

*:Tentative SPEC

Impedance vs. Frequency

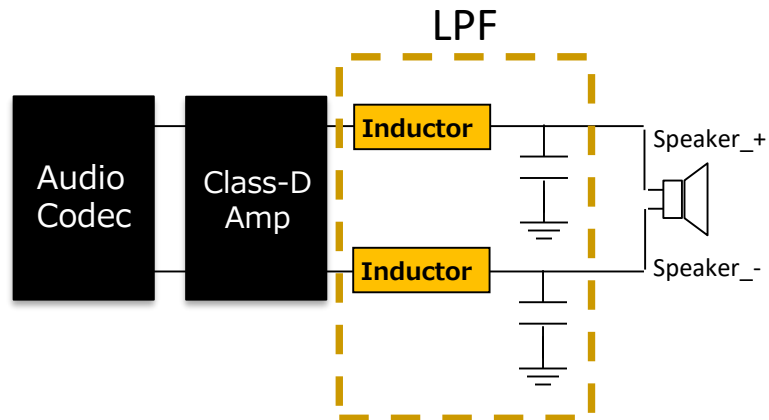


class-D Amp Radiated emission

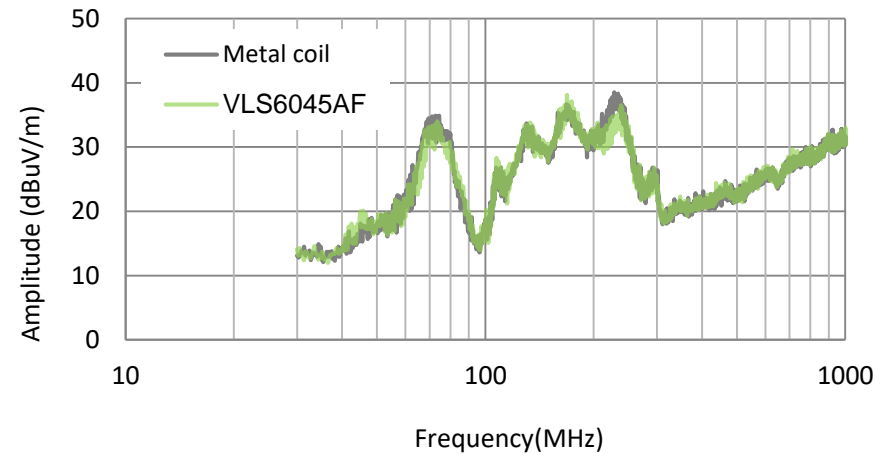


SUPPORTS HI-FI AUDIO

VLS6045AF series

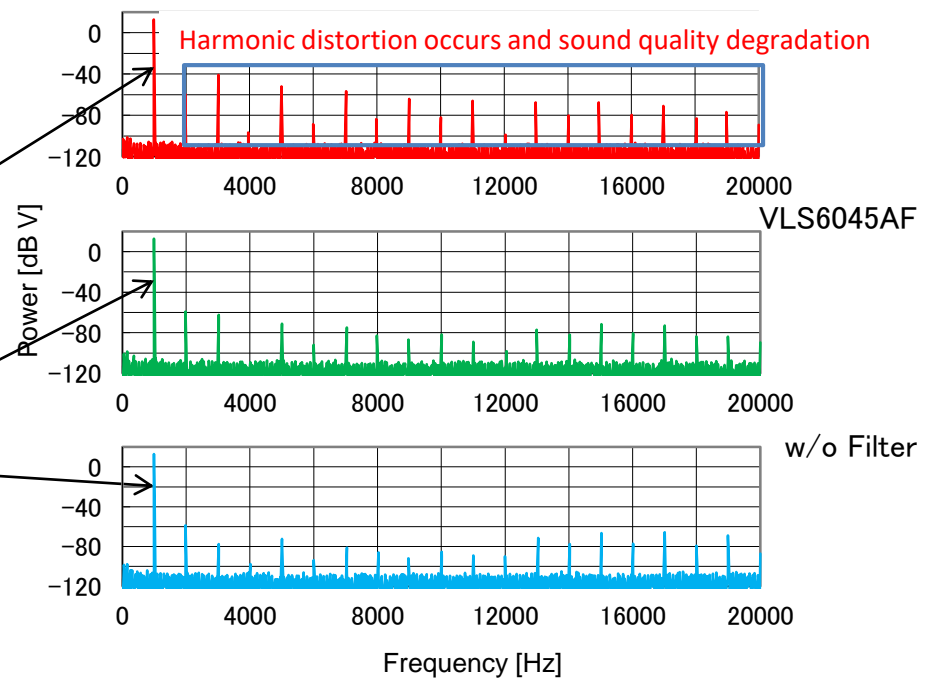


class-D Amp Radiated emission

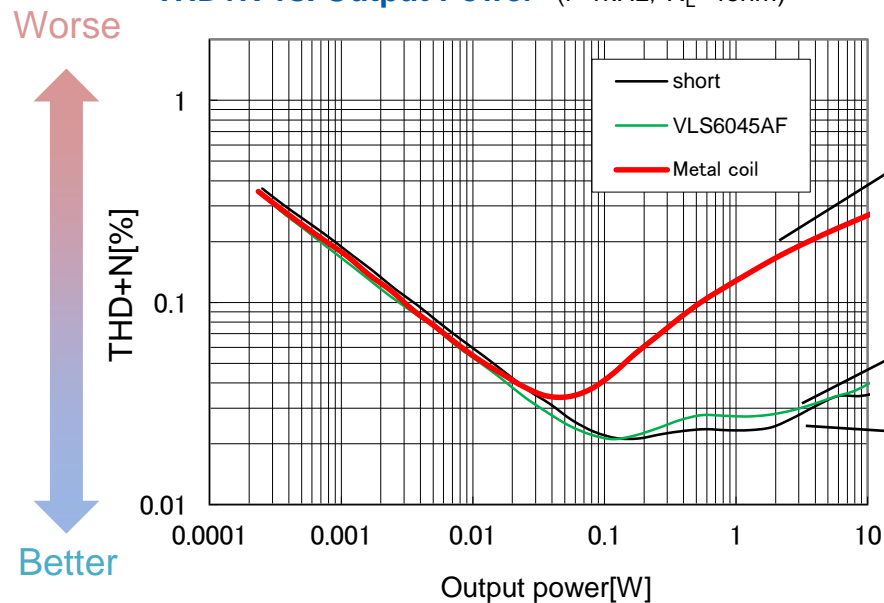


FFT Spectrum Analysis

f=1kHz, P_o=10W



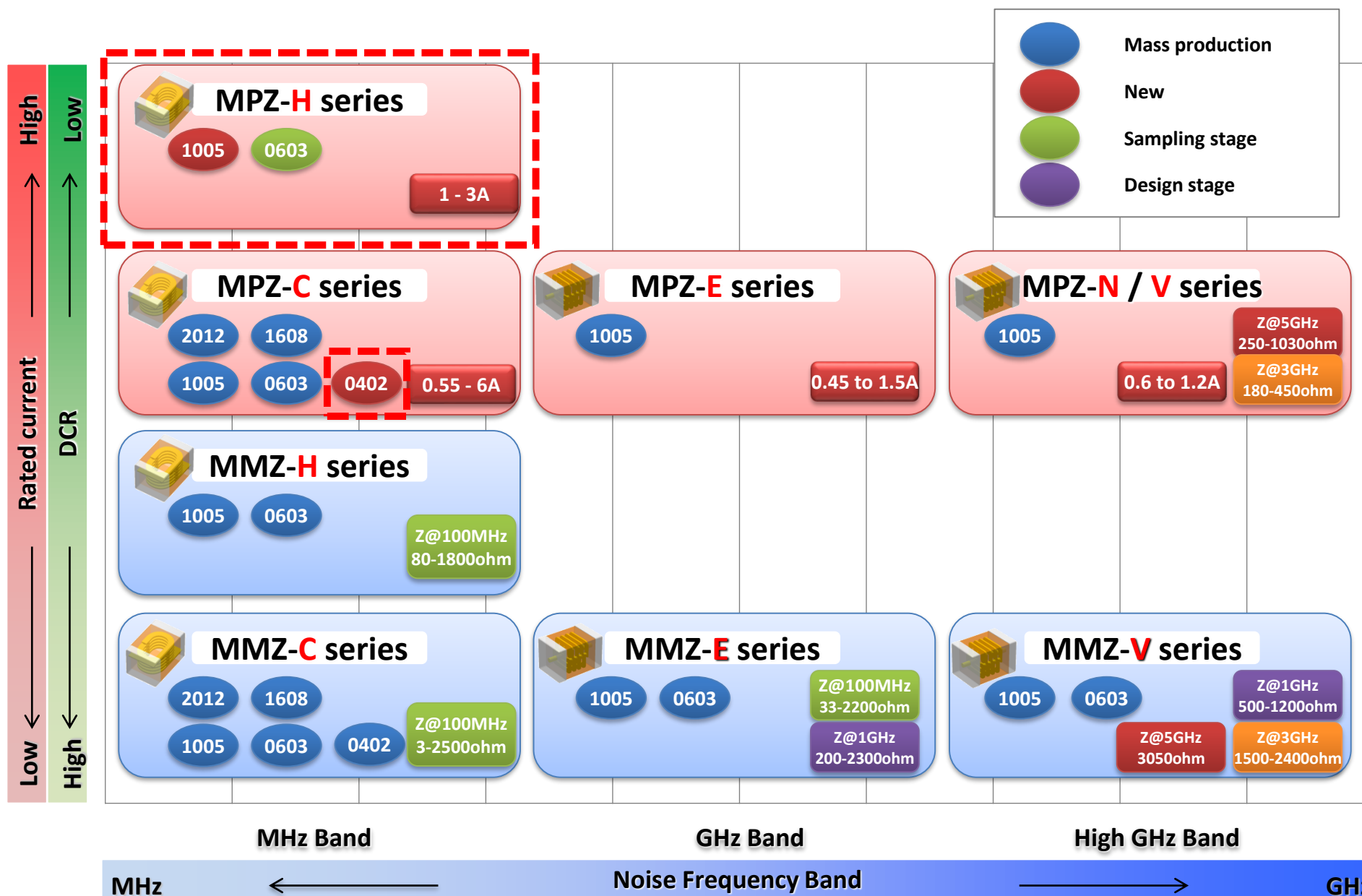
THD+N vs. Output Power (f=1kHz, R_L=4ohm)



VLS6045AF SERIESE CHARACTERISTICS

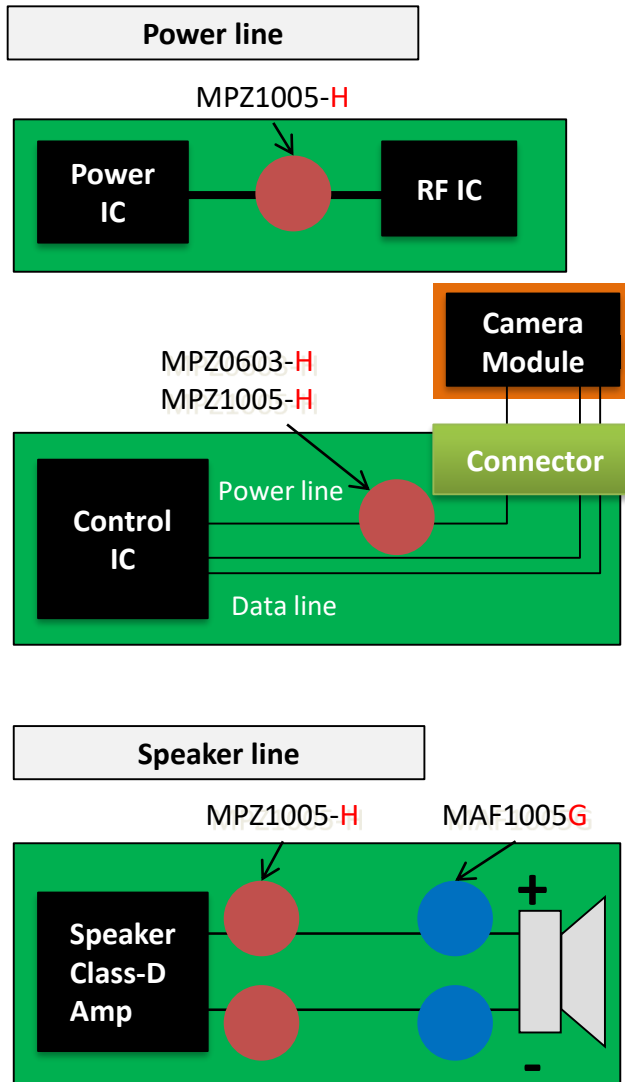
ITEM	Inductance [μ H]	DC Resistance [ohm]		Rated DC Current [A]		
		Typ.	Max.	Itemp	Isat	
VLS6045AF-3R3N	3.3	0.022	0.028	4.7	4.8	
VLS6045AF-4R7M	4.7	0.026	0.034	4.3	4.3	
VLS6045AF-8R2M	8.2	0.042	0.055	3.4	3.2	
VLS6045AF-100M	10	0.054	0.070	3.0	3.0	
VLS6045AF-150M	15	0.077	0.100	2.4	2.4	
VLS6045AF-220M	22	0.108	0.140	2.0	2.0	
VLS6045AF-330M	33	0.164	0.213	1.6	1.6	



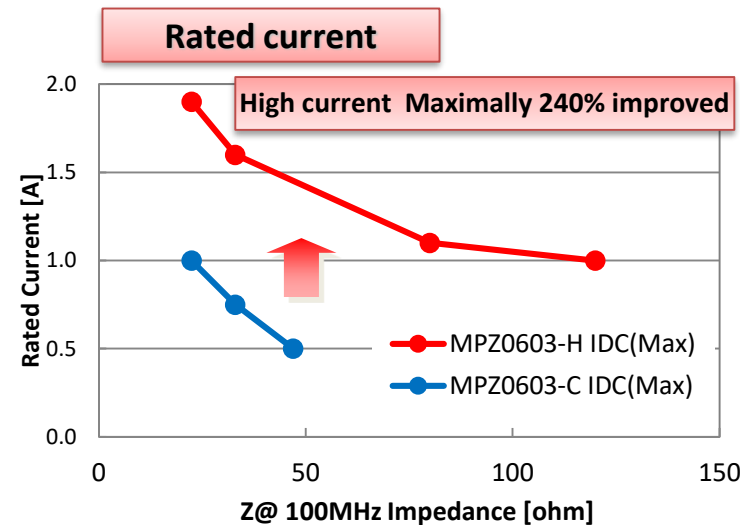
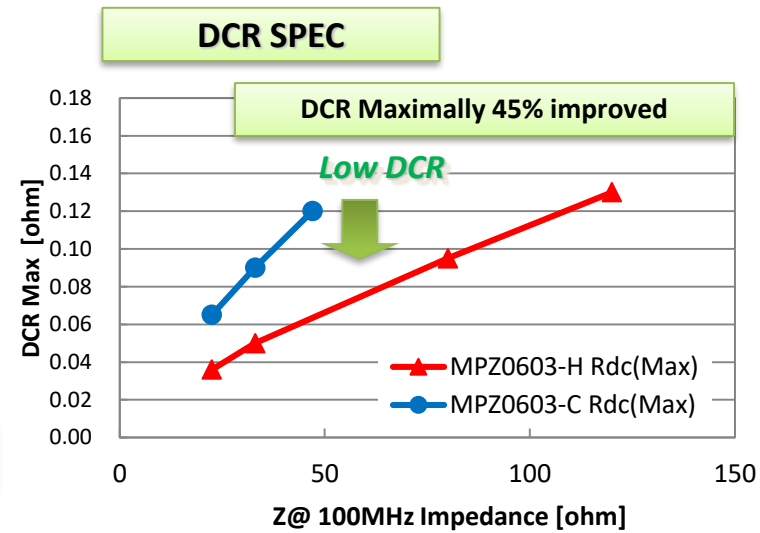


NEW MPZ-H SERIES

Example of use



MPZ-H vs MPZ-C

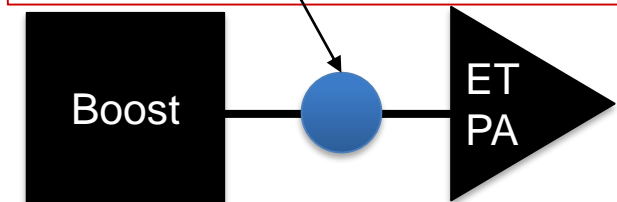


MPZ0402 / MMZ0402-C SERIES

Example of use

MMZ0402S100C

DCR:0.07ohm, Rated current: 750mA max.
It is mounted in power rail circuit between Boost and ET amp.
EMC countermeasure for power line of ET amp.



VDD AMP

SPEC Table

Category	Part name	Z @ 100MHz [ohm] ± 25%	DCR [ohm] MAX.	Rated Current [mA] MAX.
Power	MPZ0402S100C	10 (*1)	0.050	1100
	MPZ0402S220C	22	0.150	750
	MPZ0402S330C	33	0.200	550
Signal	MMZ0402S100C	10 (*1)	0.070	750
	MMZ0402S700C	70	0.360	300
	MMZ0402S121C	120	0.700	210
	MMZ0402S151C	150	0.700	200
	MMZ0402S241C	240	1.000	200
	MMZ0402Y750C	75	0.700	250
	MMZ0402D220C	22	0.700	250

*1 : Impedance = 10±5 ohm



Type	Feature	Size mm [Inch]	Series	Photo	Status	Inductance line up									
						0.1nH	1nH	10nH	100nH	1000nH	10uH	100uH			
High Freq.	Super High Q	0402 [01005]	MHQ0402PSA		NEW	0.2nH	22nH								
		0402 [01005]	MHQ0402PTJ		U.D	0.2nH	22nH								
		0603 [0201]	MHQ0603P		M.P	0.6nH	39nH								
		1005 [0402]	MHQ1005P		M.P	0.7nH	150nH		560nH						
	High Q	0402 [01005]	MLG0402P		M.P	0.2nH	33nH								
		0603 [0201]	MLG0603P		M.P	0.6nH	120nH								
	STD	0603 [0201]	MLG0603S		M.P	0.3nH	180nH								
		1005 [0402]	MLG1005S		M.P	0.3nH	390nH								
Ultra High Freq.	STD	0603 [0201]	MLK0603		M.P	1nH	33nH								
		1005 [0402]	MLK1005		M.P	1nH	330nH								
Low Freq.	High Q High Current	1005 [0402]	MLJ1005		M.P				120nH	560nH					
		1608 [0603]	MLJ1608		M.P				120nH	560nH					
Low Freq.	High Q	1005 [0402]	MLF1005		M.P				0.10uH	2.2uH					
		1608 [0603]	MLF1608		M.P			0.047uH	33uH						
		2012 [0805]	MLF2012		M.P			0.047uH	100uH						



D.S : Design Stage



S.S* : Sampling Stage

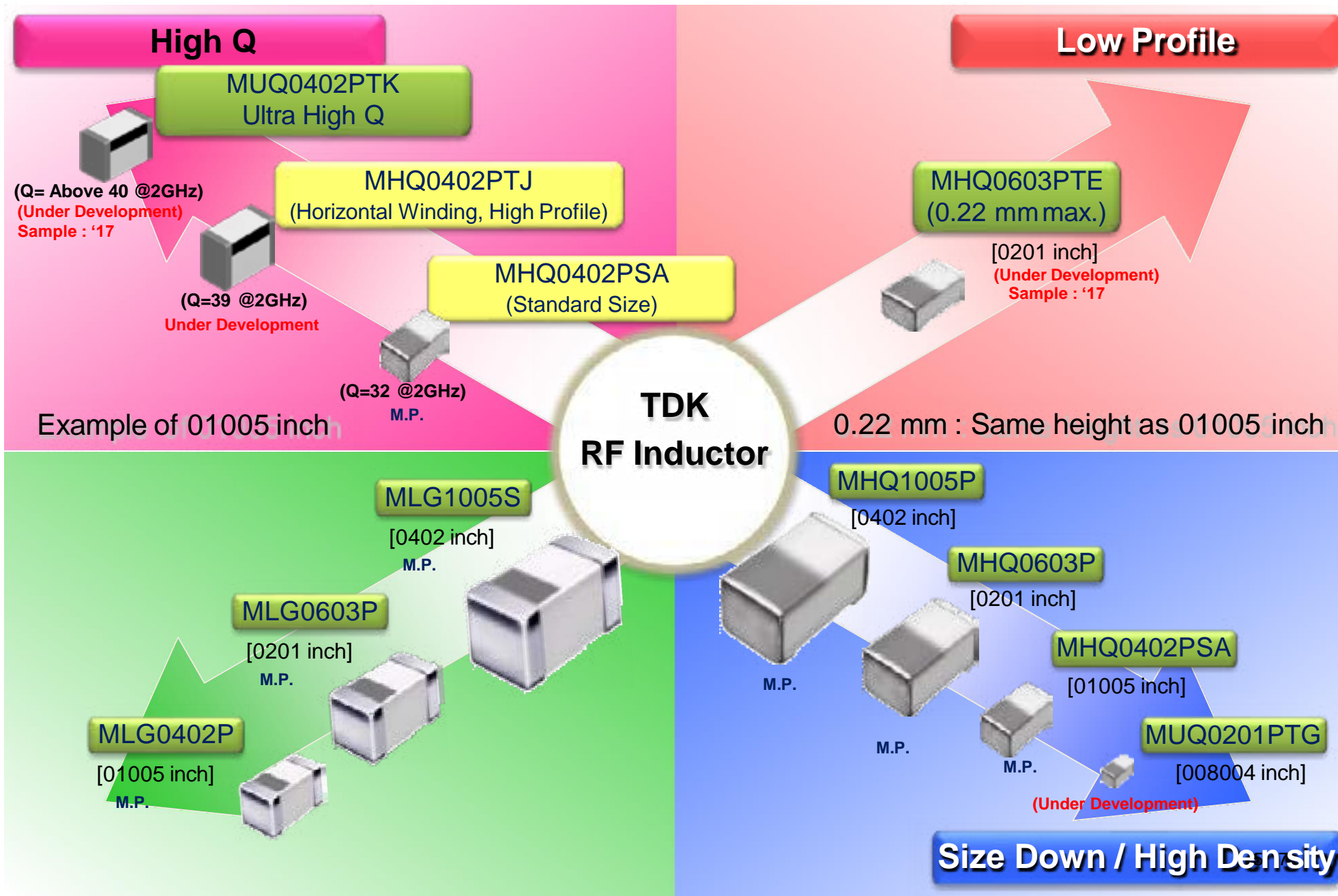


M.P : Mass Production



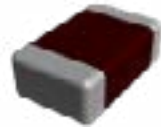
U.D* : Under Development





Multi-layer

MLP series



Light-load, Buck

- Solid magnetic shielding
- Better efficiency @Light load



Wire-wound Type

VLS series



Mid-load, Boost / Buck

- Plentiful design variation
(case size, height, material, etc..)
- Hi performance w/ Hi-inductance
- Better efficiency for Boost converter

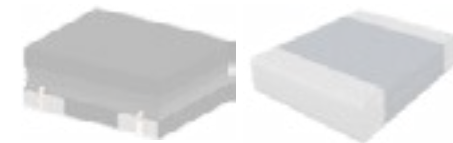
Metal material

VLS-HBX series

TFM series

Heavy-load, Buck

- Higher saturation w/ better magnetic density
- Better efficiency @Heavy load



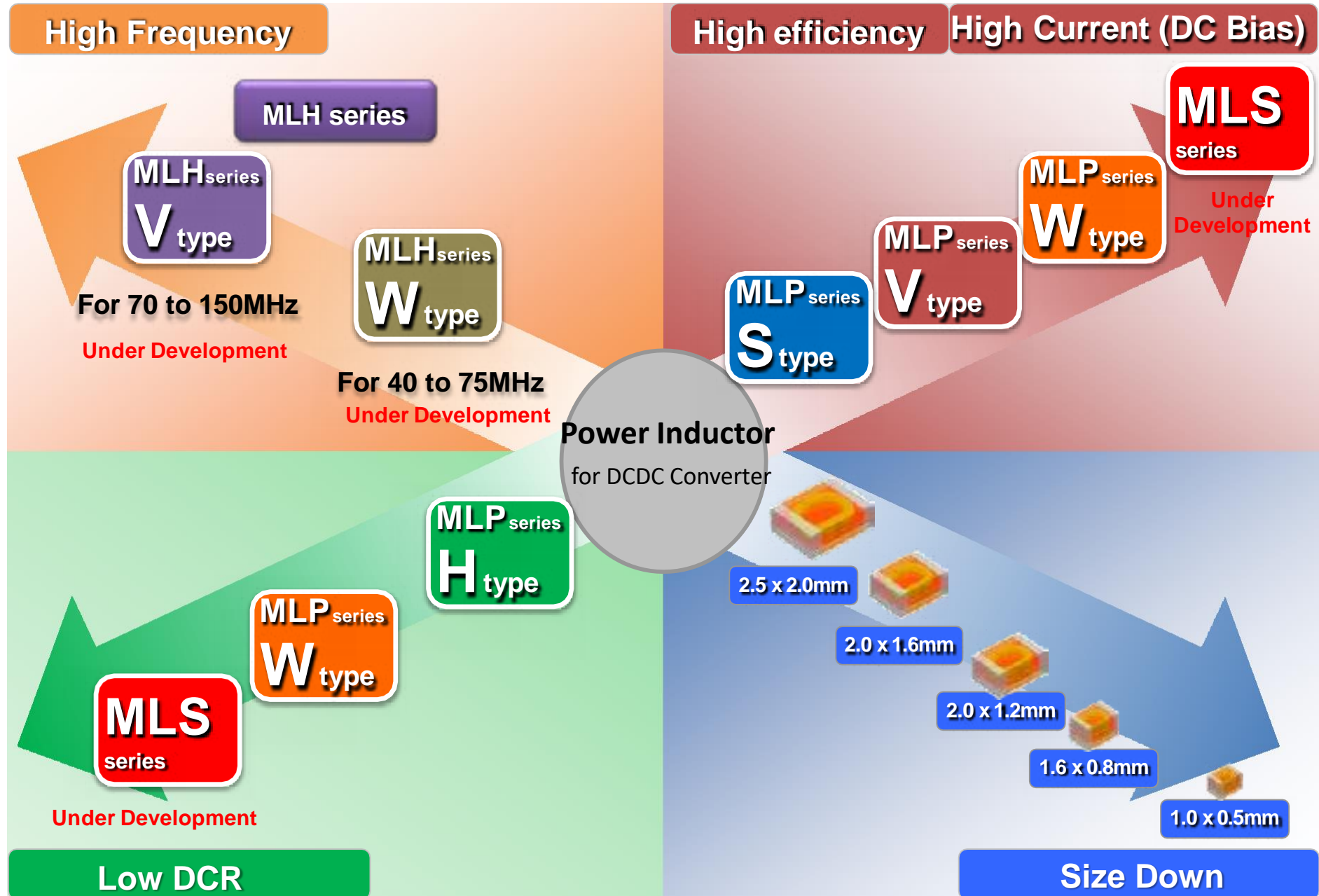
Isat & Itemp LIST

Size mm		Characteristics type.		Series	IDC [A]	Inductance [uH]													
LxW	T Max					0.22	0.24	0.33	0.47	0.54	0.56	0.68	0.82	1.0	1.5	2.2	3.3	4.7	10
1005	0.55mm	Low core loss	High Current	MLP1005V-T	Isat													0.08	
	Itemp																		
	0.75mm	High Frequency		MLP1005M-D	Isat			0.62	0.6		0.4		0.3						
					Itemp			0.7	0.6		0.6		0.5						
1608	0.75mm	Low core loss	Low DCR	MLP1608H-D	Isat				0.6										
			Itemp				0.9												
		High Current	MLP1608V-D	Isat								0.6	0.45	0.15					
	Itemp											0.7	0.55	0.6					
0.95mm	Low core loss	Low DCR	MLP1608H-B	Isat													0.18		
		Itemp															0.75		
	High Current	MLP1608V-B	Isat	1.8		1.3	1.0					0.7	0.5	0.2					
Itemp				1.25		0.9	0.8					0.7	0.5	0.6					
2012	0.55mm	STD		MLP2012S-T	Isat							0.5	0.7	0.35	0.25				
		Itemp										1.2	0.8	0.7	0.6				
	1.00mm	STD		MLP2012S-M	Isat				1.4				1.5	0.8	0.7	0.3	0.15		
		Itemp						1.2				1.0	1.0	0.8	0.9	0.7			
		Low core loss	Low DCR	MLP2012H-M	Isat				1.4	1.1			1.0	0.5	0.4				
			Itemp						1.3	1.3			1.1	1.1	1.0				
	High Current	MLP2012V-M	Isat				1.7				1.5	0.9	0.6			0.2			
Itemp							1.1				0.9	0.8	0.7			0.6			
2016	1.00mm	High Current & Low DCR		MLP2016W-M	Isat		3.2	3.0	2.6				1.6						
		Itemp					3.1	2.7	2.5				1.8						
		STD		MLP2016S-M	Isat				1.6				1.4	0.8	0.4			0.3	
		Itemp						1.6				1.4	1.2	1.2			0.8		
		Low core loss	Low DCR	MLP2016H-M	Isat				1.7				1.4	0.9	0.55	0.3	0.2		
			Itemp						1.7				1.3	1.2	1.2	1.2	1.1		
	High Current	MLP2016V-M	Isat				2.4				1.75	1.25	0.8						
Itemp							1.5				1.20	1.15	1.0						
2520	1.00mm	High Current & Low DCR		MLP2520S-M	Isat								2.3	1.4	0.6	0.4	0.2	0.15	
		Itemp										1.5	1.2	1.2	1.0	1.0	0.7		
		STD		MLP2520W-M	Isat				3.3		2.5		2.5	1.5	1.6	0.85	0.5		
		Itemp						2.9		2.5		2.3	1.8	1.2	1.2	1.2			
		Low core loss	Low DCR	MLP2520H-M	Isat				2.3				1.3		0.6	0.5	0.3		
			Itemp						2.1				1.5		1.3	1.1	1.0		
	High Current	MLP2520V-M	Isat								2.2	1.2	0.9	0.7	0.45				
Itemp											1.3	1.4	1.1	0.9	0.8				

Isat : Depend on the Inductance Saturation. (-30% Reduction from Nominal value).

Itemp : Depend on the self temperature rise. (40deg.C Max.)





Multi-layer

MLP series



Light-load, Buck

- Solid magnetic shielding
- Better efficiency @Light load



Wire-wound Type

VLS series



Mid-load, Boost / Buck

- Plentiful design variation
(case size, height, material, etc..)
- Hi performance w/ Hi-inductance
- Better efficiency for Boost converter

Metal material

VLS-HBX series





TFM series

Heavy-load, Buck

- Higher saturation w/ better magnetic density
- Better efficiency @Heavy load



FOR MOBILE APPLICATIONS



				
	VLS-ET series	VLS-MNT series	VLS-CX series	VLS-HBX series
0806-1uH (2.0mm x 1.6mm) Typ. Specs				
DCR	99m ^	99m ^	60m ^	60m ^
Rated Current (\otimes L: -30%)	1.5A	1.8A	2.1A	2.9A
	Ferrite core	Ferrite core	Ferrite core	Metal core



[VLS-CX & VLS-HBX](#)
 Change point : Material (Ferrite & Metal)
 Facilities : Same
 Process : Same



DEVELOPMENT ROADMAP

						Development Stage		Mass Production		
	ITEM Name	Case Size LxWxH	L (uH)	DCR (mohm)	Isat (A)	Development Schedule in 2018				
						CY_Q1	CY_Q2	CY_Q3	CY_Q4	
General	High Power 	VLS201610HBX-1	2.0x1.6x1.0	0.24~10	23~640	5.15~0.75				
		VLS201612HBX-1	2.0x1.6x1.2	0.24~10	22~630	6.50~0.89				
		VLS252010HBX-1	2.5x2.0x1.0	0.24~10	22~460	7.10~1.13				
		VLS252010HBU	2.5x2.0x1.0	3.3~22	225~1670	2.3~0.9				
		VLS252012HBX-1	2.5x2.0x1.2	0.24~10	22~450	7.10~1.30				
		VLS252012HBU	2.5x2.0x1.2	3.3~22	180~1400	2.62~0.95				
		VLS3012HBX	3.0x3.0x1.2	0.33~22	23~662	10.12~1.21				
		VLS4012HBX	4.0x4.0x1.2	0.68~22	31~640	7.39~1.42				
	Low DCR High Ind. 	VLS201610CX-1	2.0x1.6x1.0	0.24~22	32~1318	4.35~0.42				
		VLS201612CX-1	2.0x1.6x1.2	0.24~22	25~1100	3.80~0.45				
		VLS252010CX-1	2.5x2.0x1.0	0.47~22	32~1137	3.42~0.56				
		VLS252012CX-1	2.5x2.0x1.2	1.0~22	52~796	2.65~0.60				
		VLS3010CX-1	3.0x3.0x1.0	4.7~100	T.B.D.	T.B.D.				
		VLS3012CX-1	3.0x3.0x1.2	10~22(MP) 47~100(add)	270~557	1.1~0.62				
		VLS3015CX-1	3.0x3.0x1.5	4.7~100	T.B.D.	T.B.D.				
		VLS4012CX-1	4.0x4.0x1.2	4.7~100	T.B.D.	T.B.D.				
		VLS4020CX-1	4.0x4.0x2.0	4.7~100	T.B.D.	T.B.D.				
		VLS5045EX	5.0x5.0x4.5	1.0~220	15~1050	8.9~0.45				
		VLS6045EX	6.0x6.0x4.5	0.47~220	10~1150	13.5~0.8				



Multi-layer

MLP series



Light-load, Buck

- Solid magnetic shielding
- Better efficiency @Light load



Wire-wound Type

VLS series



Mid-load, Boost / Buck

- Plentiful design variation
(case size, height, material, etc..)
- Hi performance w/ Hi-inductance
- Better efficiency for Boost converter

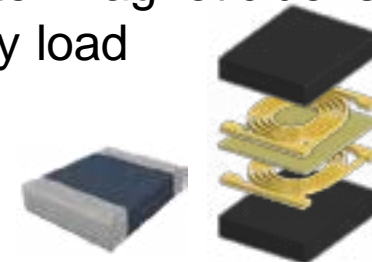
Metal material

VLS-HBX series

IFM series

Heavy-load, Buck

- Higher saturation w/ better magnetic density
- Better efficiency @Heavy load

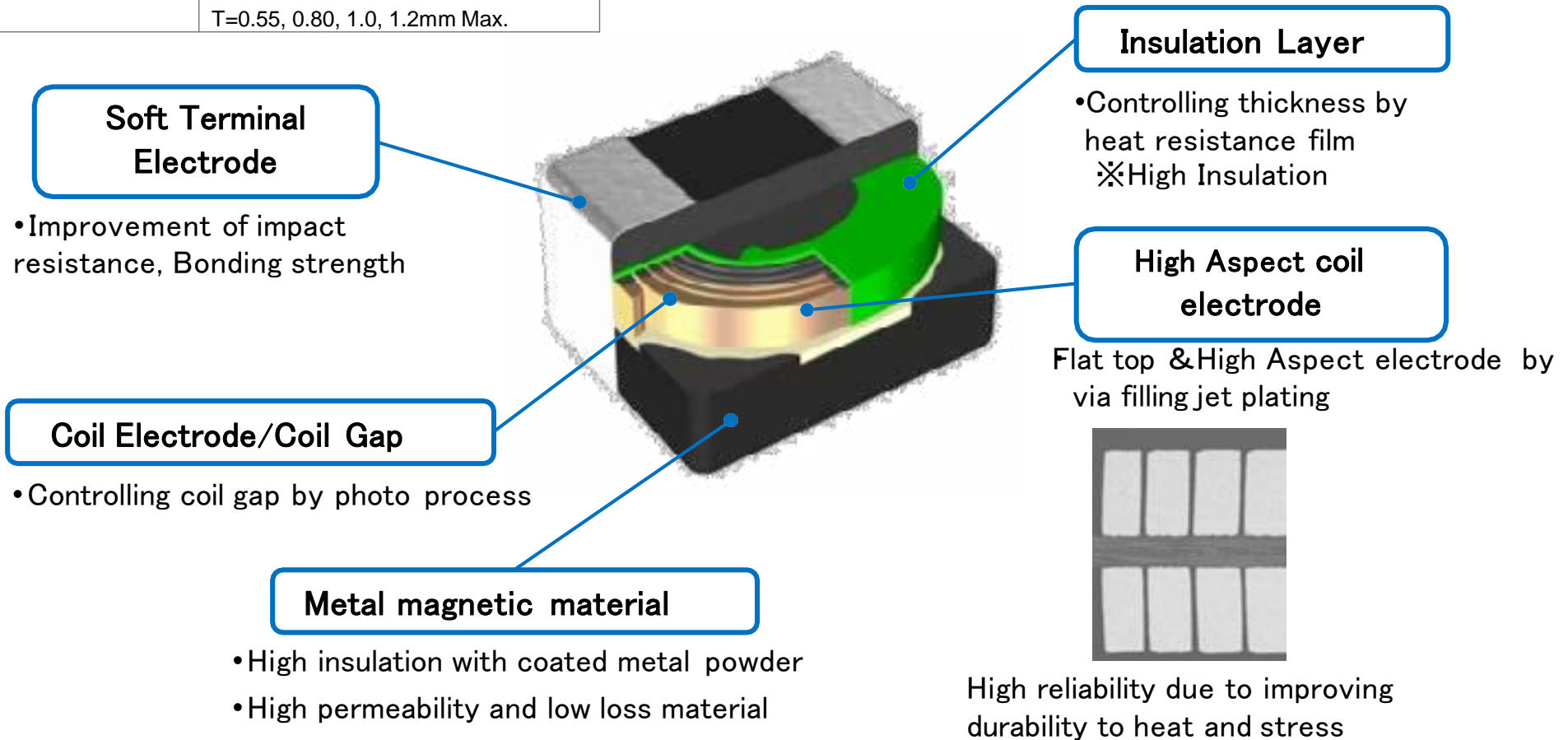


CONCEPT OF TFM-ALC

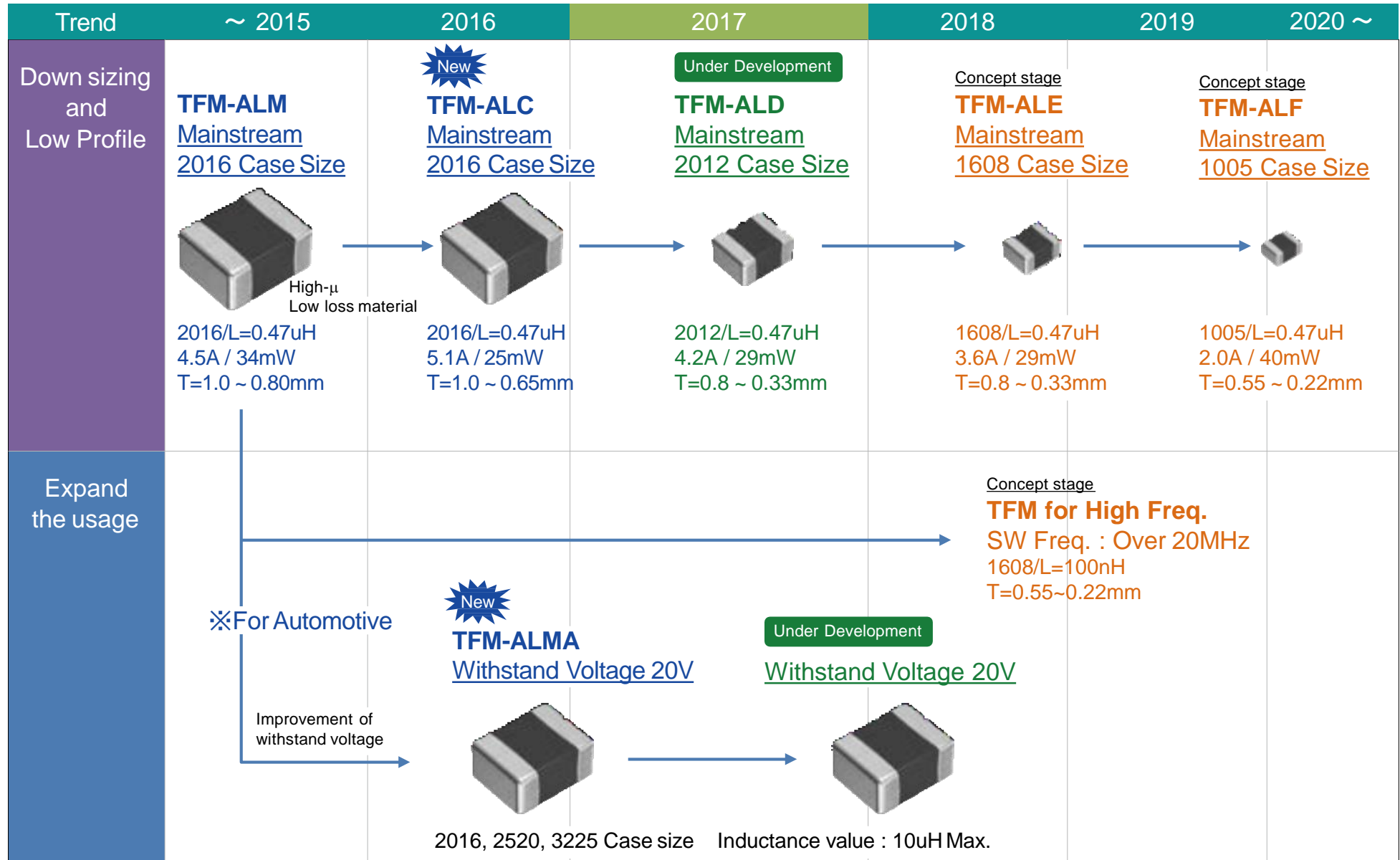
Target Spec	
Item	Target
Characteristics	L : 0.10 ~ 2.2uH Rdc : 56mOhm (1.0uH) Idc1 : 3.9A / Idc2 : 3.1A
Size & Height	1608, 2012, 2016, 2520 T=0.55, 0.80, 1.0, 1.2mm Max.

Key technology

- Controlling coil gap by photo process
- Heat resistance material(Decomposition Temp. 320C)
- Improving impact resistance by soft terminal electrode



DEVELOPMENT ROADMAP



CHARACTERISTICS TABLE OF TFM-ALC SERIES

Case Size	Identification	Inductance [uH]	DC Resistance [mOhm]		Isat [A]		Itemp [A]	
			Max	Typ.	Max	Typ.	Max	Typ.
1608 T=0.8mm Max.	TFM160808ALC-R47MTAA	0.47 +/-20%	62	55	2.0	2.4	2.6	2.7
	TFM160808ALC-1R0MTAA	1.0 +/-20%	145	127	1.5	1.7	2.0	2.2
2012 T=0.8mm Max.	TFM201208ALC-R47MTAA	0.47 +/-20%	33	27	4.1	4.3	3.9	4.3
	TFM201208ALC-1R0MTAA	1.0 +/-20%	90	78	2.8	3.1	2.3	2.5
2016 T=0.8mm Max.	TFM201608ALC-R47MTAA	0.47 +/-20%	27	24	4.4	4.7	4.3	4.6
	TFM201608ALC-1R0MTAA	1.0 +/-20%	66	56	2.5	2.8	2.8	3.1
2016 T=1.0mm Max.	TFM201610ALC-R47MTAA	0.47 +/-20%	25	20	5.1	5.2	4.9	5.2
	TFM201610ALC-1R0MTAA	1.0 +/-20%	47	43	3.0	3.3	3.4	3.6
	TFM201610ALC-2R2MTAA	2.2 +/-20%	102	92	1.7	1.9	2.3	2.5

Isat : Depend on the Inductance Saturation. (-30% Reduction from Initial L Value/ Test Freq. 1MHz)

Itemp : Depend on the Self Temperature Rise. (40deg.C Typ.)



- All systems use carrier frequencies that can propagate through the media (generally air). The antenna should be matched to the media at the chosen carrier frequency to ensure good sensitivity.
- Modern systems will also impose requirements on its size, directional sensitivity, and possibly its sensitivity to out-of-band signals.
- Chip Antenna Characteristics
 - A quarter-wave ($\lambda/4$) monopole system
 - Works with GND plane to form dipole system
 - Certain “No-GND” metal-free space necessary

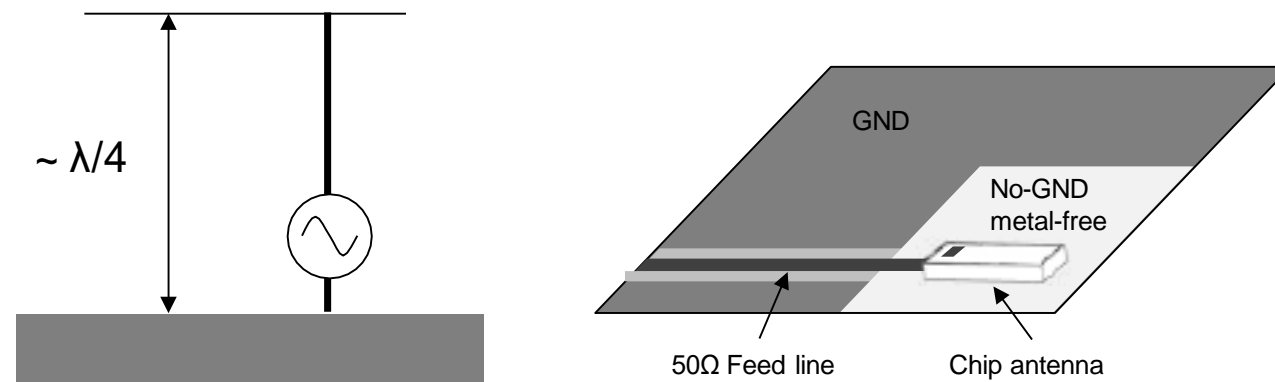


Figure 9 $\lambda/4$ monopole antenna

FEATURES

- Ultra Small
- Low Profile
- High Performance
- Small Keep-out Area

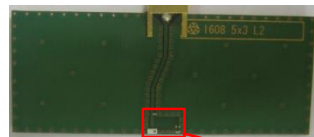
APPLICATIONS

- Wearable Device
- Smartphone
- Automotive
- Home Entertainment

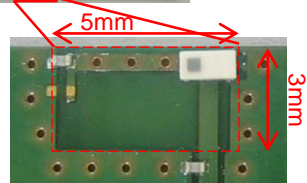
SHAPE

L = 1.6 +/- 0.1mm
 W = 0.8 +/- 0.1mm
 T = 0.4mm Max

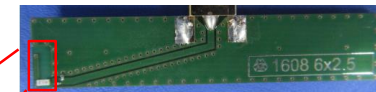
■ ANT016008LCS2442MA1 (for Center Location)



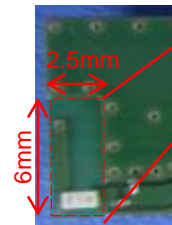
STD Board size: 50x20x1mm²
 Antenna keep out area: 5 x 3mm²



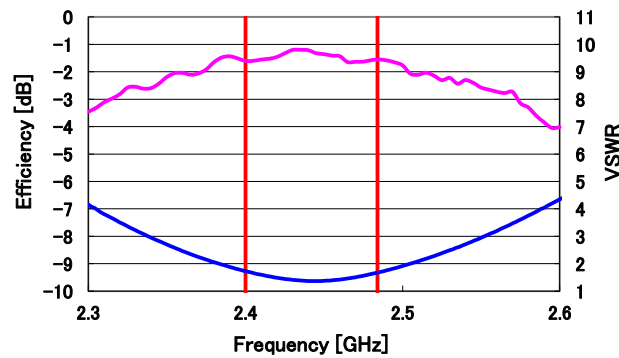
■ ANT016008LCS2442MA2 (for Corner Location)



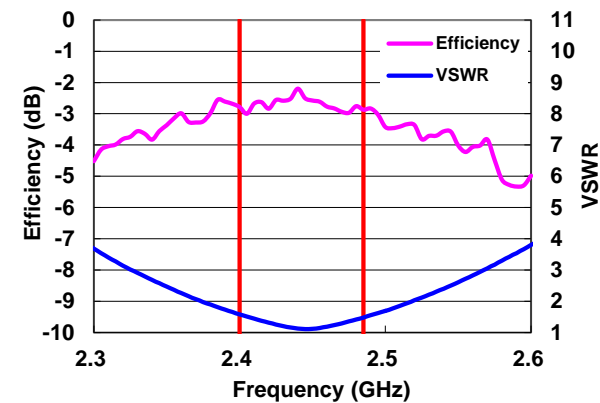
STD Board size: 50x10x1mm²
 Antenna keep out area: 6 x 2.5mm²



■ VSWR & Efficiency



■ VSWR & Efficiency



PRODUCTS

Application	Part Number	Recommend Location	Chip Size(mm ³)	Standard Keep out area(mm ²)
2.4GHz	ANT016008LCS2442MA1	Middle	1.6x0.8x0.4	5x3
2.4GHz	ANT016008LCS2442MA2	Corner	1.6x0.8x0.4	6x2.5
GPS+2.4GHz	ANT016008LCD1575MA1	Middle	1.6x0.8x0.4	10.5x6
GNSS	ANT161575ST-1202A1	Corner	1.6x0.8x0.4	6x5
2.4+5GHz	ANT162442DT-2001A2	Middle	1.6x0.8x0.4	8x5
2.4+5GHz MP : available	ANT162442DT-2200A1	Corner	1.6x0.8x0.4	8x5
920MHz MP : available	ANT160920ST-1204A1	Corner	1.6x0.8x0.4	20x10
GPS+2.4+5GHz MP : available	ANT025020LCT1575MA1	Corner	2.5x2.0x0.6	16x6
GPS+2.4+5GHz MP : available	ANT161575TT-3000A1 *Dual feed(P1:GPS P2:2.4+5GHz)	Middle	1.6x0.8x0.4	13x6



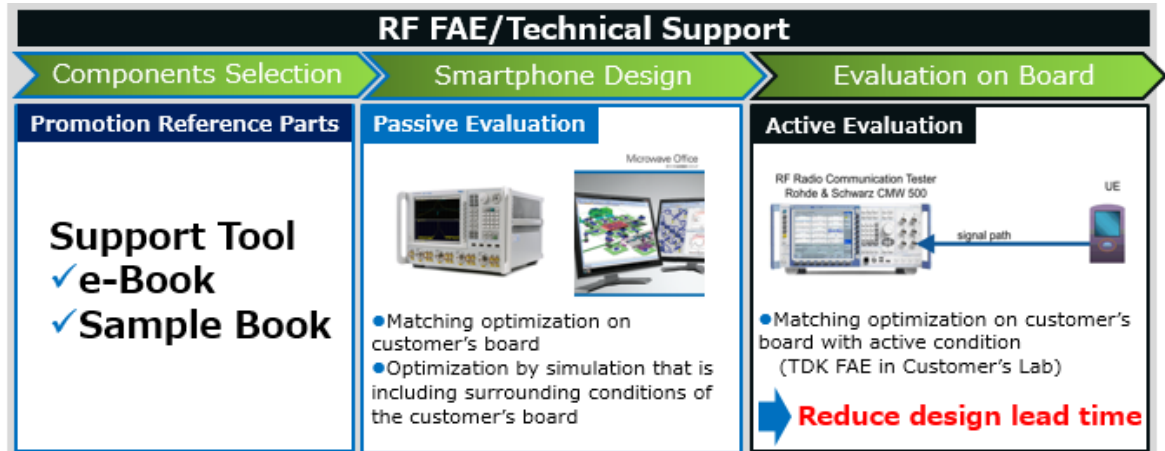
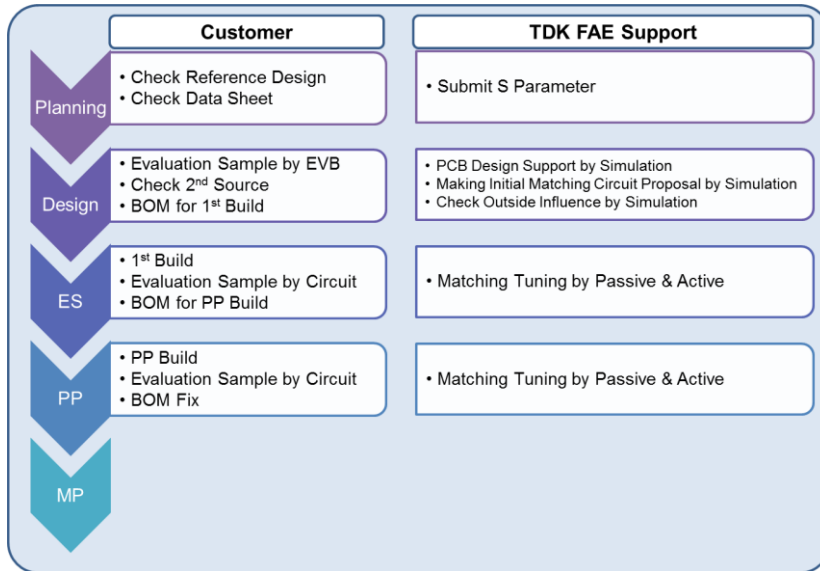
	Function	Series	Cellular	Connectivity	WiMAX
LTCC	Band Pass Filter	DEA-B	X	X	X
	Low Pass Filter	DEA-L	X	X	X
	High Pass Filter	DEA-H		X	
	Diplexer	DPX	X	X	X
	Triplexer	TPX	X	X	
	Directional Coupler	HHM2	X	X	X
	Balun	HHM1	X	X	X
	Antenna	ANT		X	
TFS	Band Pass Filter	TFSB		X	X
	Low Pass Filter	TFSL	X	X	
	High Pass Filter	TFSH		X	
	Diplexer	TFSD		X	
	Directional Coupler	TFSC	X	X	X
	Balun	TFSZ	X	X	X

FEATURES

LTCC: High-Q, Low cost and Short Lead-time

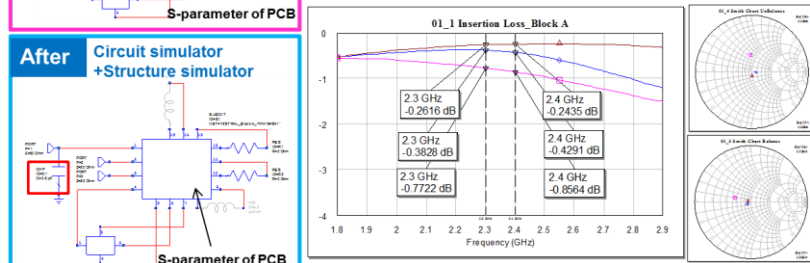
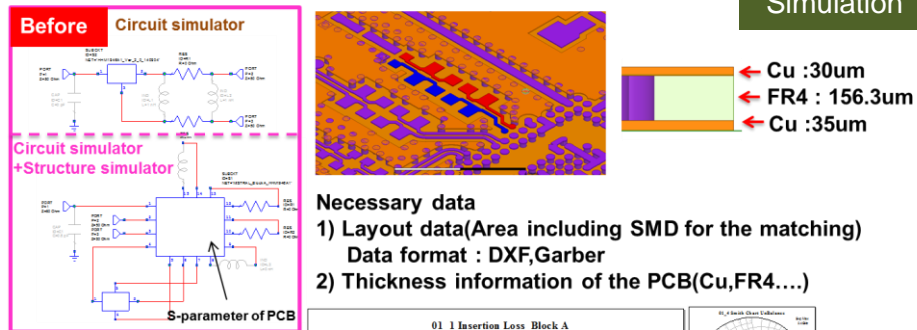
TFS: Smaller, Thinner Package and High-Q in Higher Freq.





Design Stage

(Example) Matching adjustment using the simulation

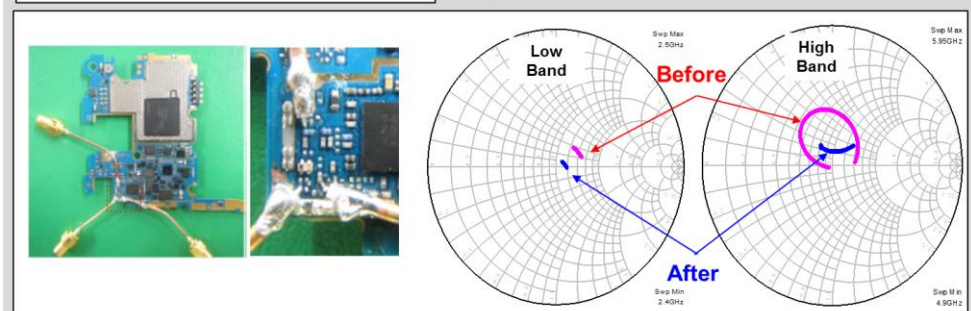
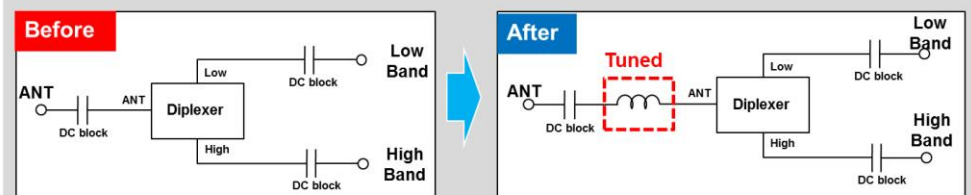


This simulation is available for the matching adjustment of the filter (DPX, LPF...).

ES Stage

(Example) Diplexer Matching Optimization

- Recommending best solution under 50ohm
- Optimizing impedance matching with 50ohm



Actual Evaluation



Diplexer's application in RF transceivers is where two RF bands share the same antenna. And it is called duplexer when used between the transmitter and receiver bands. It is made up by filter combination.

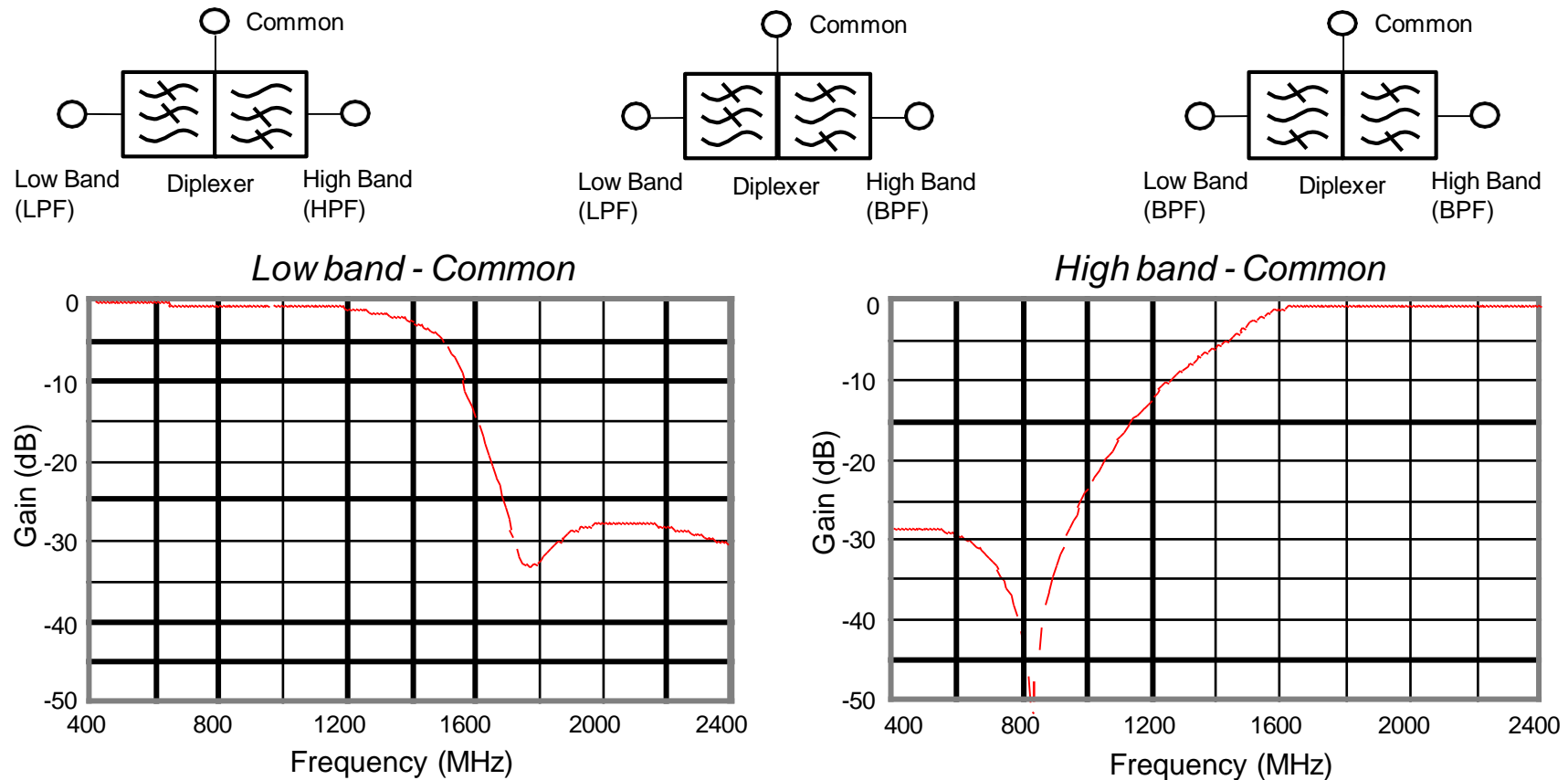


Figure 6 Frequency response of Diplexer



PRODUCTS

For LTE

Component	Frequency (MHz)		Insertion Loss (dB)		Attenuation (dB)		Chip Size(mm) LxWxT	TDK P/N
	LB	HB	LB	HB	LB	HB		
Diplexer	699-960	1710-2690	0.34	0.65	15	5	2.5x2.0x1.0	DPX252690DT-5032A1
	698-960	1710-2690	0.65	0.7	22	25	2.0x1.25x1.0	DPX202690DT-4057A1
	698-960	1570-2690	0.73	0.7	20	25	1.6x0.8x0.8	DPX162690DT-8058A1
	698-746 / 746-960	1710-2700	0.4 / 0.5	0.5	30	25	2.0x1.25x1.0	DPX202700DT-4062A1
	824-960	1710-2170	0.3	0.5	15	20	2.0x1.25x1.0	DPX202170DT-4049A1
	1930-1990	2110-2155	3	3	7	7	2.0x1.25x1.0	DPX202155DT-4068A1
	704-960	1710-1990 / 2110-2170	0.5	0.7/0.6	15	20	1.6x0.8x0.7	DPX162170DT-8022B1
	806-941	1574.42- 1576.42	0.6	0.7	18	20	1.6x0.8x0.7	DPX161576DT-8011B1

For Bluetooth /WLAN

Component	Frequency (MHz)		Insertion Loss (dB)		Attenuation (dB)		Chip Size(mm) LxWxT	TDK P/N
	LB	HB	LB	HB	LB	HB		
Diplexer	704-960 / 1572-1578	2400-2500	0.40	0.55	15	12	1.6x0.8x0.7	DPX165950DT-8144A1
	1570-1610	2500-2690	0.40	0.55	10	20		
	4900-5950	4900-5950	0.45	0.50	16	20		
	2400-2500	4900-5950	0.5	0.65	20	20	2.0x1.25x0.6	DPX205950DT-9126A1
	2400-2500	5150-5850	0.75	1.90	23	25	1.6x0.8x0.7	DPX165850DT-8040A3
	2400-2496	4900-5950	0.60	1.40	-	28	1.6x0.8x0.7	DPX165950DT-8126A1
	2400-2500	4900-5950	0.50	0.80	23	20	1.0x0.5x0.33	DPX105950DT-6012A1
	2400-2500	4900-5950	0.50	1.50	18	35	1.0x0.5x0.44	DPX105850DT-6019A1



The simplest form is realized as a ladder network with series inductors and shunt capacitors. At low frequencies the series reactances and the shunt susceptances are insignificant. As the frequency increase the reactances and susceptances become more significant and the frequency response gradually rolls off.

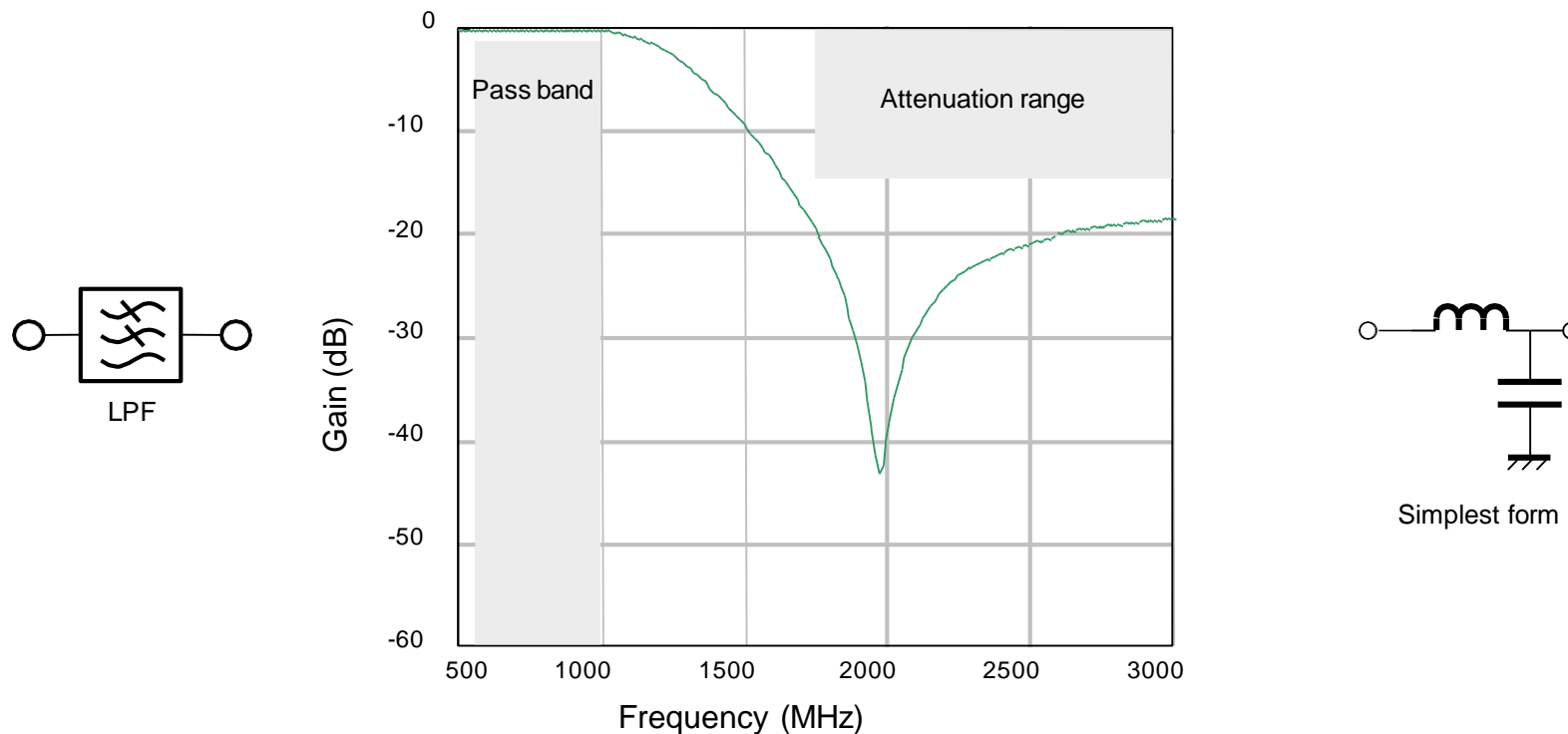


Figure 3 Frequency response of LPF

PRODUCTS

For LTE

Component	Frequency (MHz)	Ins. Loss (dB)	Attenuation (dB) 2f	Chip Size(mm) LxWxT	TDK P/N
LPF	1710-1980 / 2025-2690	0.35	17	1.6x0.8x0.7	DEA162690LT-5057C1
	470-787	0.65	26	1.6x0.8x0.7	DEA160787LT-5032A1
	699-787 / 787-960	0.60 / 0.70	30	1.6x0.8x0.7	DEA160960LT-5044C1
	1710-1990	0.5	30.5	1.6x0.8x0.9	DEA161990LT-1182A8
	704-746 / 842-894	0.50	18	1.0x0.5x0.4	DEA100894LT-6319A3
	824-915	0.5	18	1.0x0.5x0.4	DEA100915LT-6319A1
	777-787	0.6	30	0.65x0.5x0.3	DEA070787LT-4002A1
	824-915 / 915-960	0.60 / 0.70	20/25	0.65x0.5x0.3	DEA070960LT-4006B1
	1710-1990	0.55	30	0.65x0.5x0.3	DEA071910LT-4003B1

For Bluetooth /WLAN

Component	Frequency (MHz)	Ins. Loss (dB)	Attenuation (dB) 2f	Chip Size(mm) LxWxT	TDK P/N
LPF	2400-2500	0.45	21	1.0x0.5x0.4	DEA102500LT-6307A1



If we replace the series inductors with series capacitors and the shunt capacitors with shunt inductors, the response of the filter changes from a low-pass to a high-pass type.

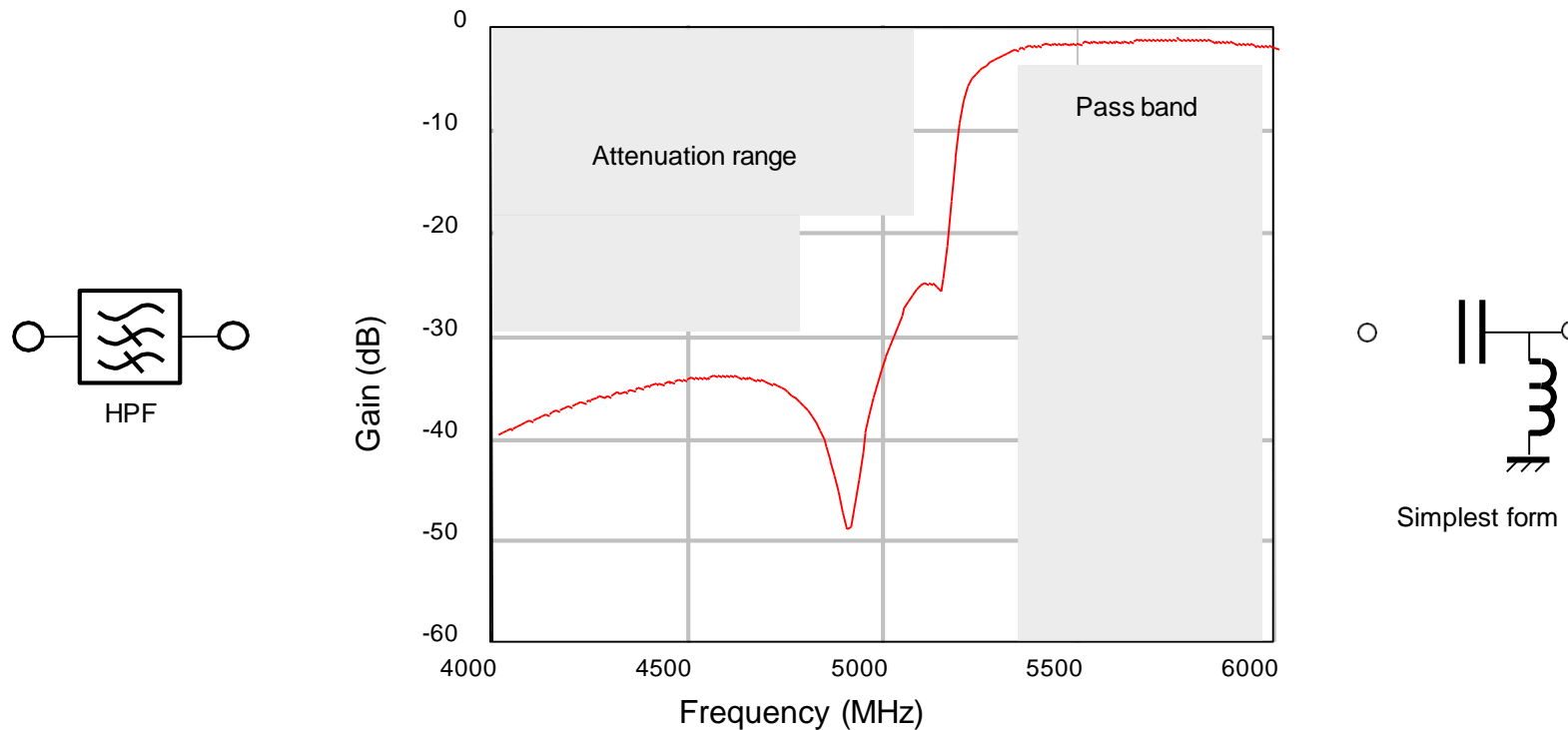


Figure 4 Frequency response of HPF

PRODUCTS

For LTE

Component	Frequency (MHz)	Ins. Loss (dB)	Attenuation (dB) LB	Chip Size(mm) LxWxT	TDK P/N
HPF	1710-2025	0.8	30	1.0x0.5x0.45	DEA101710HT-8031A1
	2300-2690	0.5	13	1.6x0.8x0.65	DEA162300HT-8047A1

For Bluetooth /WLAN

Component	Frequency (MHz)	Ins. Loss (dB)	Attenuation (dB) LB	Chip Size(mm) LxWxT	TDK P/N
HPF	2400-2500	1.4	25	1.6x0.8x0.65	DEA162400HT-8004B1
	2400-2500	0.75	25	2.0x1.25x1.1	DEA202484HT-8002A1
	2400-5850	0.5	30	2.0x1.25x1.0	DEA202400HT-8037A1
	5150-5850	0.5	15	0.65x0.5x0.3	DEA075150HT-8036A1
	5150-5850	0.5	25	1.6x0.8x0.8	DEA165150HT-8025C2



The simplest form of a band-pass filter consists of cascaded series and parallel resonators. More complex filters can be designed with inductively and capacitively coupled resonator sections.

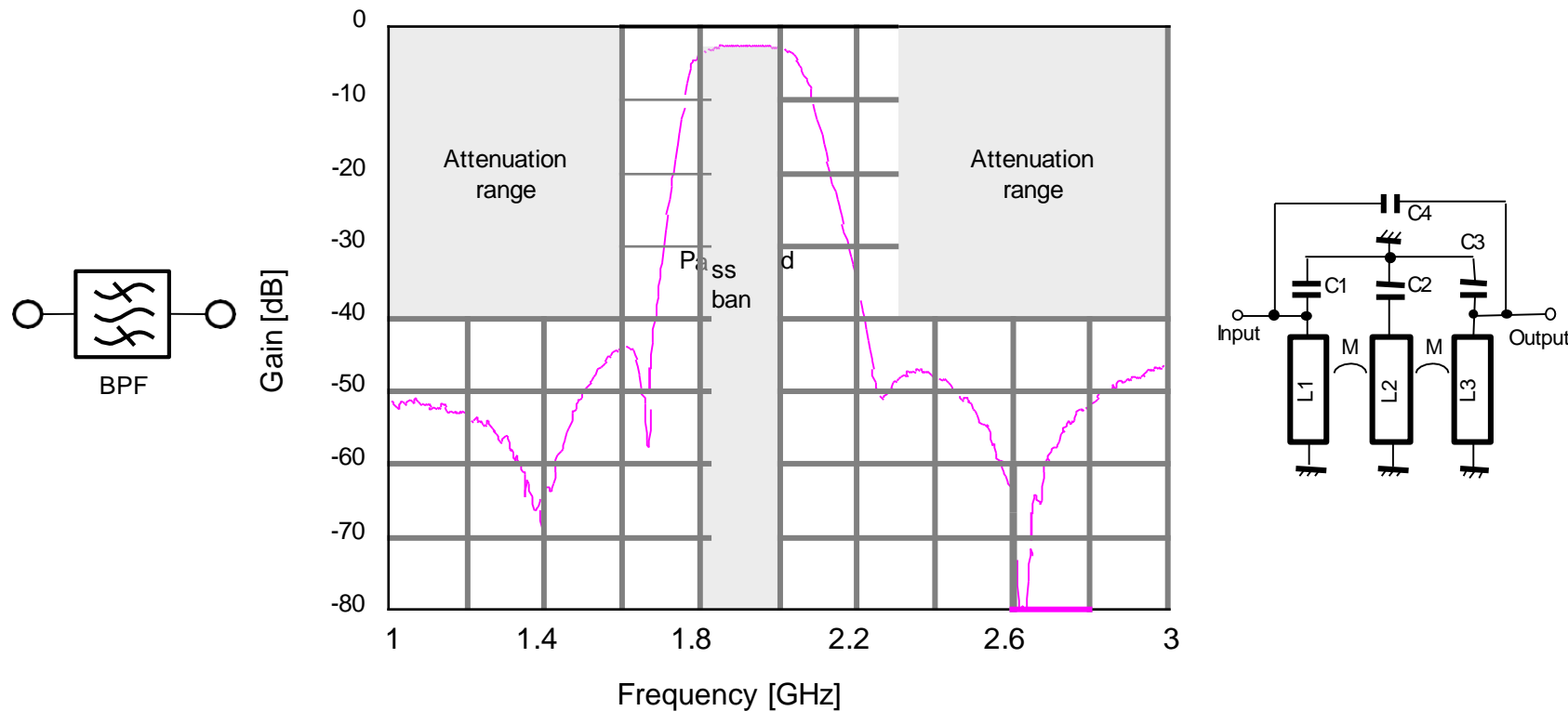
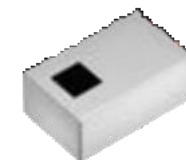


Figure 5 Frequency response of BPF

PRODUCTS



For Bluetooth /WLAN

Component	Frequency (MHz)	Ins. Loss (dB)	Attenuation (dB) 2f	Chip Size(mm) LxWxT	TDK P/N
BPF	2400-2500	2.00	30	2.0x1.25x1.0	DEA202450BT-2175A1-H
	2412-2484	1.35	20	2.0x1.25x0.8	DEA202450BT-1294C1-H
	2400-2500	3.20	30	1.6x0.8x0.6	DEA162450BT-2092A1-H
	2400-2500	2.50	30	1.6x0.8x0.6	DEA162450BT-2096A1-H
	2400-2500	1.05	30	1.4x1.1x0.6	DEA142450BT-3028A1
	4900-5850	1.70	25	1.6x0.8x0.7	DEA165375BT-2122A1
	4900-5950	1.00	12	1.0x0.5x0.45	DEA105425BT-1293A1



- Microstrip and coaxial cables use conductors of different dimensions. These are “unbalanced”.
- Two conductors having equal and opposite potential constitute a “balanced” line. Advantage of balanced line is good noise immunity.
- Important terms
 - Amplitude balance – how closely matched are the amplitudes of the two output signals.
 - Phase balance – how well does the phase of one output track the phase of the second output.
 - Insertion loss

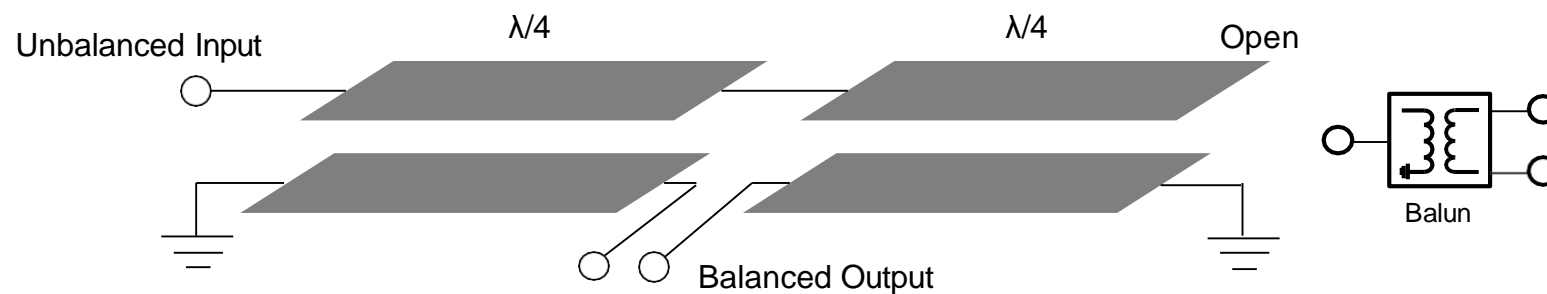
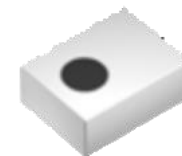


Figure 8 Coupled-line Marchand Balun



PRODUCTS



For LTE

Component	Frequency (MHz)	Balance Imp. (ohm)	Return Loss (dB)	Chip Size(mm) LxWxT	TDK P/N
Balun	673-2700	100	8	1.6x0.8x0.65	HHM17147A1
	698-960	100	10	1.6x0.8x0.7	HHM1726T4
	703-803	100	10	1.0x0.5x0.5	HHM1942A3
	17101990	100	10	1.0x0.5x0.5	HHM1930A2
	1805-2170	100	10	1.0x0.5x0.4	HHM1927A4
	2300-2700	100	10	1.0x0.5x0.4	HHM1918A2
	2300 - 2700	100	10	0.65x0.5x0.3	HHM1603A1



- If a signal is incident at the Input port, the coupled wave exists at the Coupled port. With proper design and terminations, no signal exists at the Isolated port.
- Important directional coupler properties are low insertion loss and high directivity, which is a measure of the coupler's capability to detect power flow in only one direction.

$$\text{Insertion loss} = 10 \cdot \log \frac{P_{\text{out}}}{P_{\text{input}}} \text{ (dB)}$$

$$\text{Coupling} = 10 \cdot \log \frac{P_{\text{coupled}}}{P_{\text{input}}} \text{ (dB)}$$

$$\text{Directivity} = 10 \cdot \log \frac{P_{\text{coupled}}}{P_{\text{isolated}}} \text{ (dB)}$$

$$\text{Isolation} = 10 \cdot \log \frac{P_{\text{isolated}}}{P_{\text{input}}} \text{ (dB)}$$

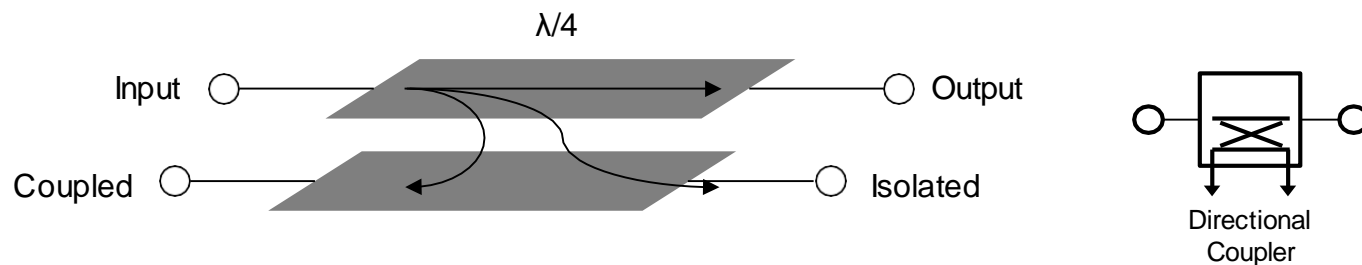


Figure 7 Coupled $\lambda/4$ transmission line directional coupler



PRODUCTS

For LTE

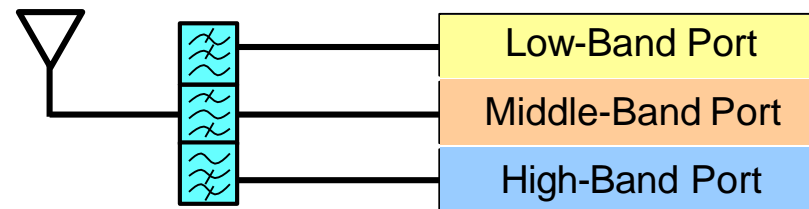
Component	Frequency (MHz)	Ins. Loss (dB)	Coupling (dB)	Directivity (dB)	Chip Size(mm) LxWxT	TDK P/N
Coupler	698 - 915 1710 - 2025 2300 - 2620	0.20	25.0 +/- 2.0 24.0 +/- 2.5 25.0 +/- 2.5	(20)	1.6x0.8x0.7	HHM22137A2
	699-960 / 1427.9 – 2170 / 2300-2700	0.12 / 0.17 / 0.18	25.2+/- 1.5 / 24.5 +/- 1.9 / 25.8+/- 1.5	(20)	1.0x0.5x0.35	TFSC10051700-2306A2X

For Bluetooth /WLAN

Component	Frequency (MHz)	Ins. Loss (dB)	Coupling (dB)	Directivity (dB)	Chip Size(mm) LxWxT	TDK P/N
Coupler	2400-2500 / 4900-5850	0.25 0.45	18.2+/-1.0 11.7+/-1.5	(15) (15)	1.0x0.5x0.4	HHM2942A2
	2400-2500 / 4900-5850	0.25 0.45	19.0+/-1.5 12.5+/-1.5	(11) (12.5)	0.65x0.5x0.3	HHM2510B1
	2400-2500 / 5150-5850	0.20 0.50	19.3+/-0.7 13.0+/-1.0	(16) (20)	0.65x0.5x0.3	TFSC06054125-2120A1X



COMBINATION OF FREQUENCY BANDS



No.	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11
TDK P#	7004A1 7010A1	7037B1	7008A4	7007A1	7017C1	7013A3	7021A1	7019B2	7014A1	7015B1	7025A1
Status	MP	Sample	MP	MP	MP	MP	MP	MP	Sample	Sample	MP
Low-Band Port	1560-1606	1560-1606	699-960	698-960	698-960	450-960	698-960	698-960	698-960	1427-1511	2400-2500
Middle-Band Port	2400-2500	2400-2500	1559-1606	1710-2170	1710-2170	1710-2690	1427-1511	1427-2170	1427-2690	2300-2690	3400-3800
High-Band Port	4900-5950	4900-5950	1805-2690	2500-2690	2300-2690	3400-5850	1710-2690	2500-3600	3400-3800	3400-3800	5150-5850
Band	Freq. [MHz]										
Low	...960	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
B11/B21	1427-1511							Mid	Mid	Mid	
GPS/GNSS	1560-1607			Mid							
Band3	1710-1880				Mid	Mid	High	Mid	Mid		
Band2	1850-1990										
Band1	1920-2170										
Band40	2300-2400			High		High	High		Mid		
2.4GHz	2400-2500	Mid	Mid					High			
Band7	2500-2690				High					High	
B42/B43	3400-3800					High		High	High	High	Mid
5GHz	4900-5950	High	High								



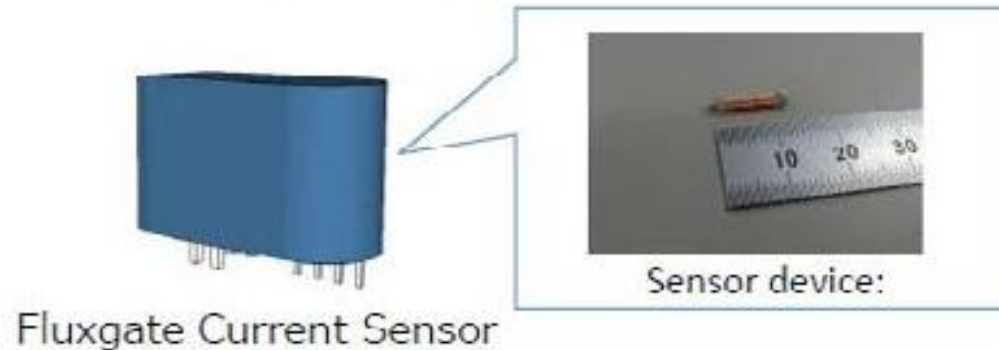
ELECTRICAL CHARACTERISTICS SUMMARY TABLE

No.		Size (mm)		Low-Band Port				Middle-Band Port				High-Band Port			
		LxW	T	IL		ATT		IL		ATT		IL		ATT	
				Freq.(MHz)	Max(dB)	Freq.(MHz)	Min(dB)	Freq.(MHz)	Max(dB)	Freq.(MHz)	Min(dB)	Freq.(MHz)	Max(dB)	Freq.(MHz)	Min(dB)
#1-1	TPX205950MT-7004A1 (MP)	2.0x1.25	1.0	1560-1606	0.65	2400-2500	13	2400-2500	0.80	1560-1606	13	4900-5950	0.80	1560-1606	20
						4900-5950	15			4900-5950	15			2400-2500	25
														9800-11900	20
#1-2	TPX205950MT-7010A1 (MP)	2.0x1.25	1.0	1560-1606	0.60	2400-2500	14	2400-2500	0.73	1545-1605	13	4900-5950	0.80	1545-1605	24
						4800-6000	15			4800-5000	20			1710-1990	25
										7200-7500	10			9800-11800	25
#2	TPX205950MT-7037B1 (Sample)	2.0x1.25	0.7	1560-1606	0.56	2400-2500	15	2400-2500	1.22	1545-1605	25	4900-5950	0.70	1560-1606	25
						4800-6000	28			4800-5000	35			2400-2500	25
										7200-7500	15			10300-11700	25
#3	TPX252690MT-7008A4 (MP)	2.5x2.0	1.3	699-960	1.00	1559-1606	15	1559-1606	2.00	699-960	13	1805-2690	2.40	699-960	17
						1805-2690	20			1805-2690	10			1559-1606	13
#4	TPX252690MT-7007A1 (MP)	2.5x2.0	1.0	698-960	0.70	1710-2170	15	1710-2170	1.20	698-960	14	2500-2690	1.80	698-960	14
						2500-2690	15			2500-2690	10			1710-2170	15
#5	TPX322690MT-7017C1 (MP)	3.2x2.5	1.0	698-960	0.70	1710-2170	25	1710-2170	2.40	698-960	25	2300-2690	2.80	698-960	25
						2300-2690	25			2300-2690	8			1710-2170	13
#6	TPX255850MT-7013A3 (MP)	2.5x2.0	1.0	450-960	0.45	1710-2690	15	1710-2690	0.75	450-960	15	3400-5850	0.90	450-960	17
						3400-3800	20			3400-3800	13			1710-2690	15
						5150-5850	13			5150-5850	13				
#7	TPX252690MT-7021A1 (MP)	2.5x2.0	1.0	698-960	0.80	1427-1511	12	1427-1511	1.40	698-960	13	1710-2690	2.60	698-960	12
						1710-2690	20			1710-2690	7			1427-1511	10
#8	TPX252690MT-7019B2 (MP)	2.5x2.0	1.0	698-960	0.70	1427-1511	7	1427-2170	1.20	698-960	14	2500-3600	1.50	698-960	18
						1710-2170	12			2500-2690	10			1427-1511	16
						2500-2690	27			3400-3600	15			1710-2170	15
#9	TPX255850MT-7014A1 (Sample)	2.5x2.0	1.0	698-960	0.55	1427-2690	12	1427-2690	0.80	698-960	15	3400-5850	0.90	698-960	16
						3400-3800	18			3400-3800	12			1427-2690	15
						5150-5850	7			5150-5850	12				
#10	TPX255850MT-7015B1 (Sample)	2.5x2.0	0.9	699-1511	0.65	2300-2700	17	2300-2700	0.95	699-1511	15	3400-5850	0.90	699-1511	13
						3400-3800	20			3400-3800	17			2300-2690	15
						5150-5850	17			5150-5850	20				
#11	TPX255850MT-7025A1 (MP)	2.5x2.0	0.8	2400-2500	0.80	3400-3600	20	3400-3800	1.00	1447-1511	14	5150-5850	1.50	1447-1511	20
						3600-3800	25			2400-2500	13			2400-2500	17
						5150-5850	30			5150-5850	10			3400-3800	17



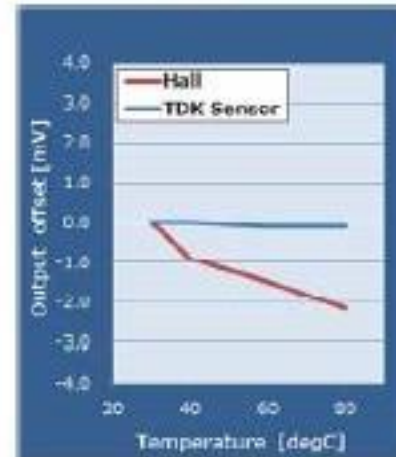
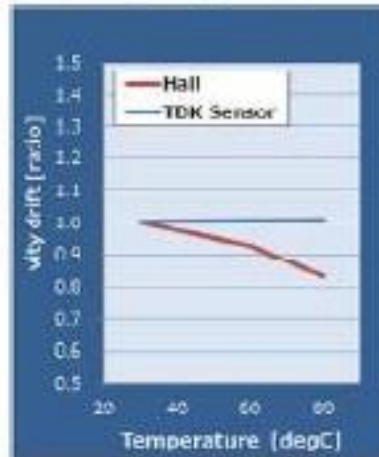
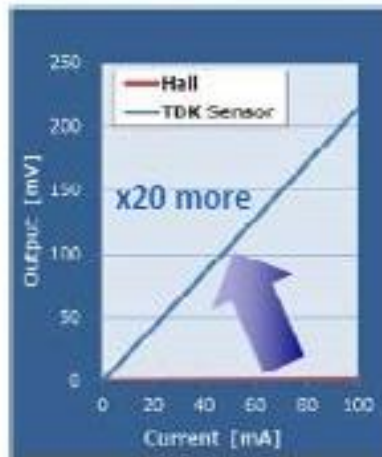
FEATURES

- Precision current sensing
- High sensitivity and low temperature drift compared with Hall sensor



CHARACTERISTICS

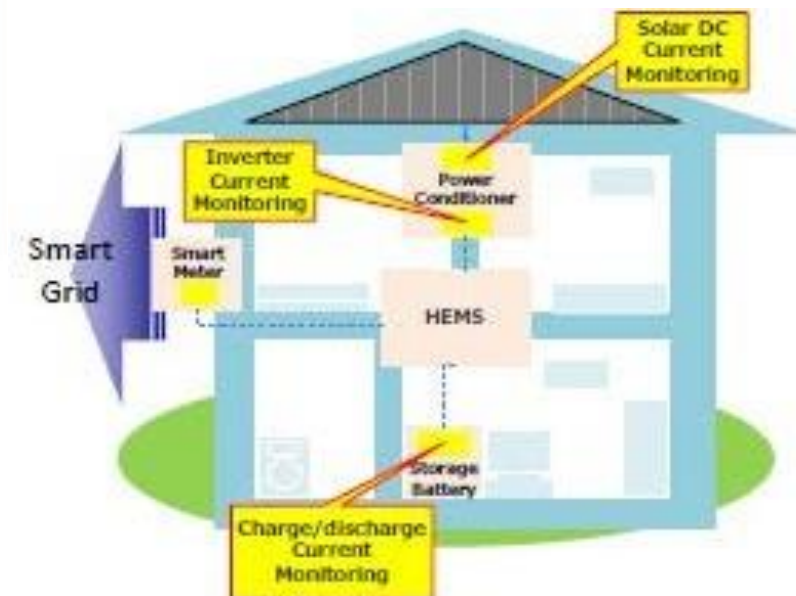
- Sensitivity
- Sensitivity drift
- Offset drift



APPLICATIONS

- Power conditioning systems for solar power generation
- Battery management systems

Key parameters	(*tentative)
Measurement range	±150A
Offset Temp. drift	±3 ppm/K
Accuracy	≦ 1.0%

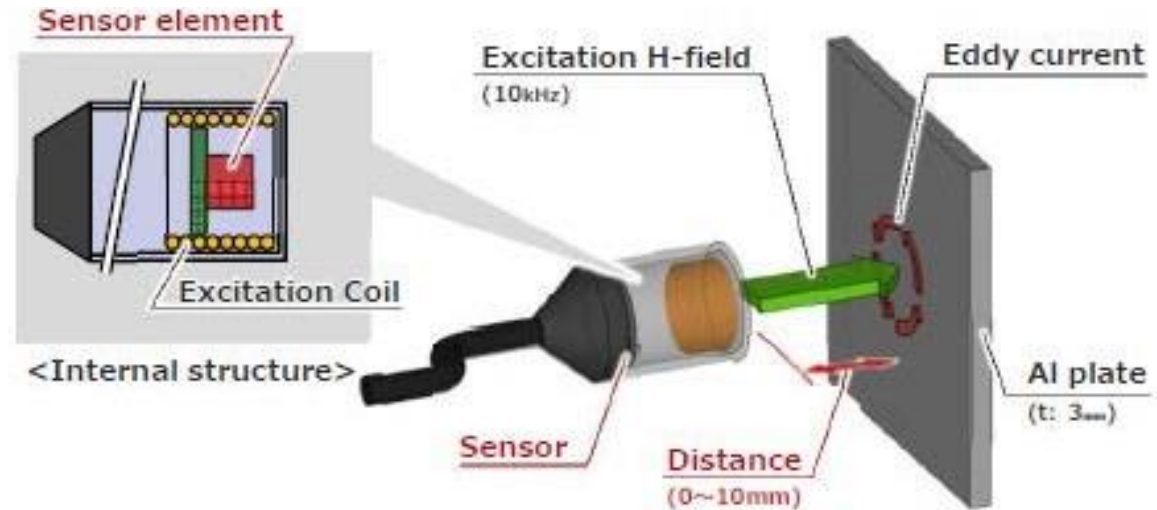


FEATURES

- High-Noise resistance : 10mTDC
- High S/N ratio
- Based on Low-Noise MR element
- Based on Eddy-Current method

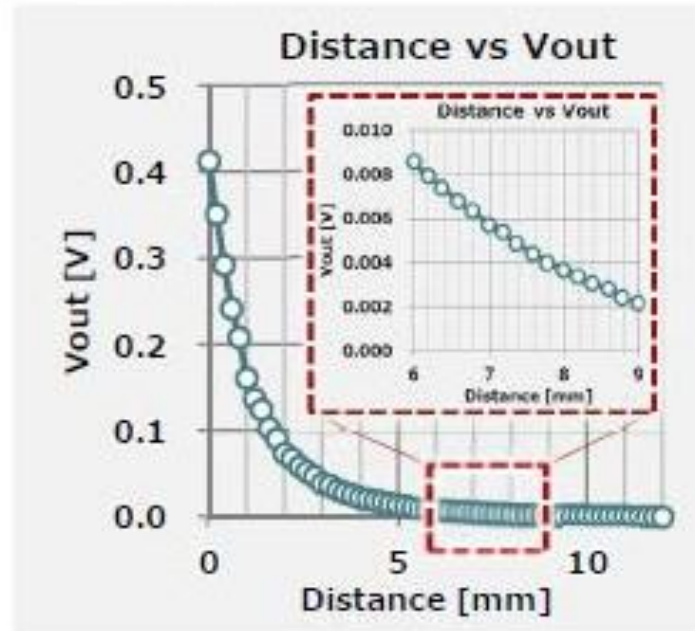
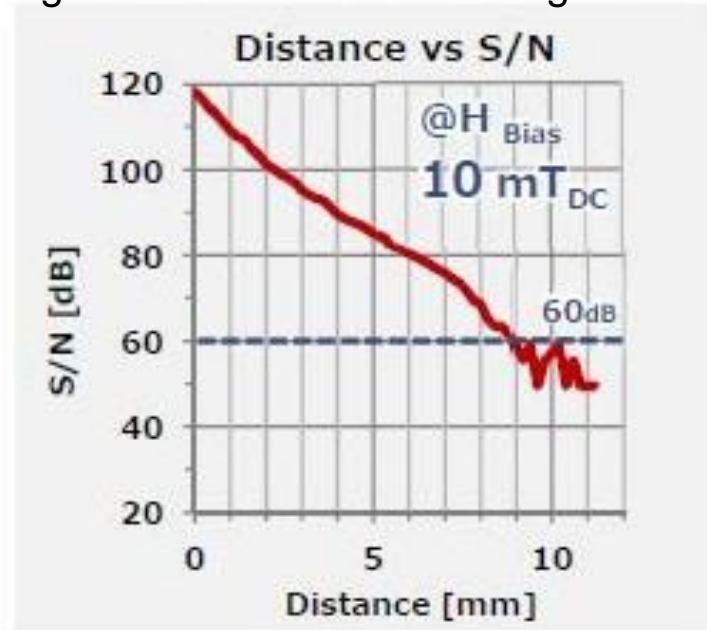
APPLICATIONS

- Measure about distance to material(Metal)
- Detection about object's exists



CHARACTERISTICS

High Noise resistance and High S/N ratio

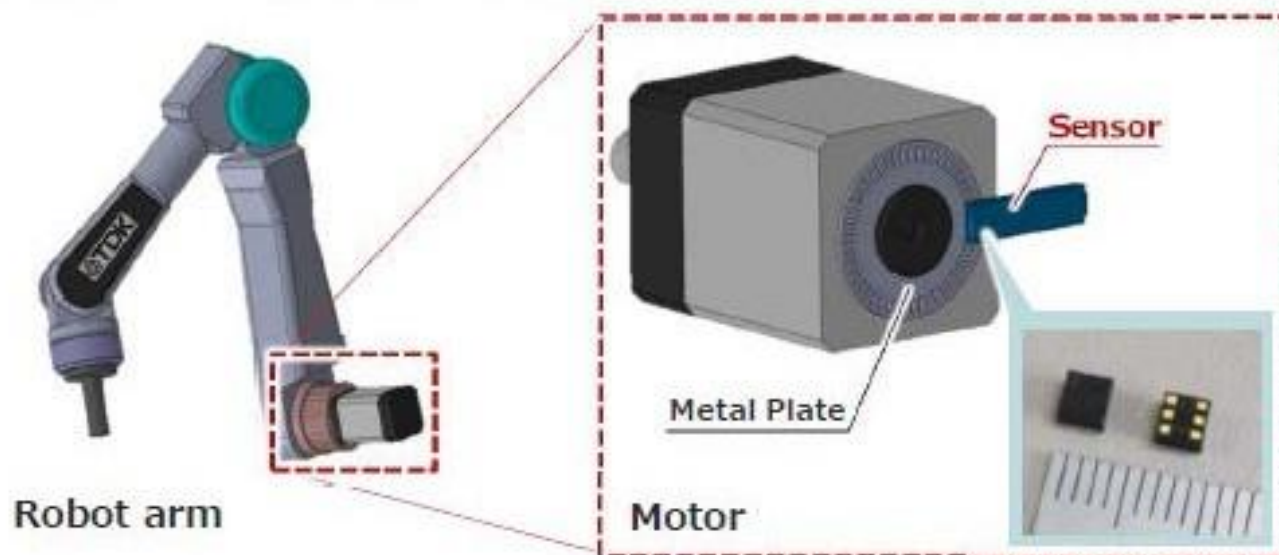


FEATURES

- Cancel environment magnetic noise
- Sensing rotation speed and direction with large gap
- Detect metal ring rotation instead of magnetic ring
- Very stable against temperature change
- Small size package (3Dx3Wx2Hmm LGA* *Land Grid Array)

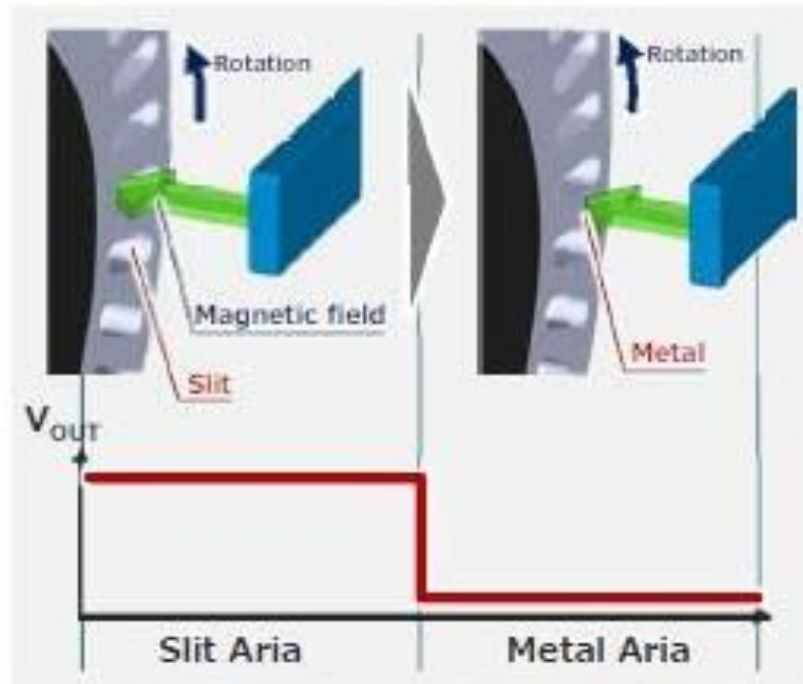
APPLICATIONS

- Motor Control Sensor
- Rotation's Speed and Direction Sensor

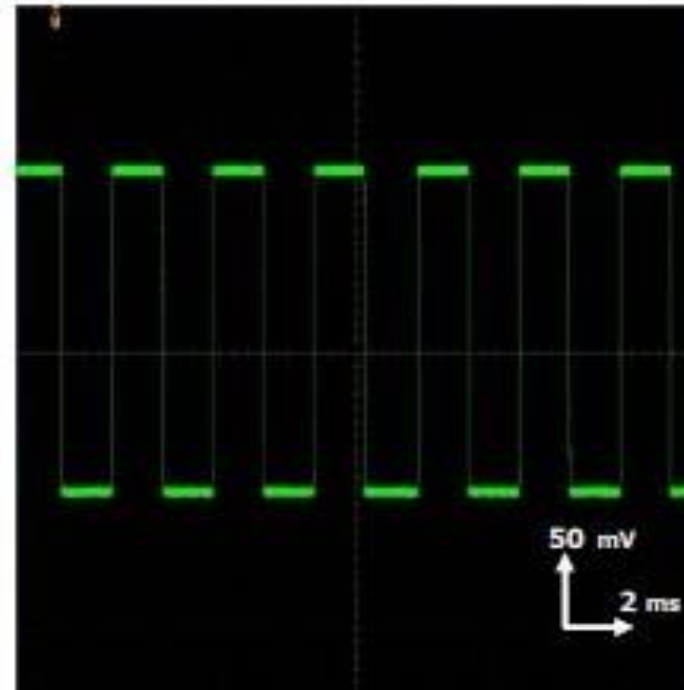


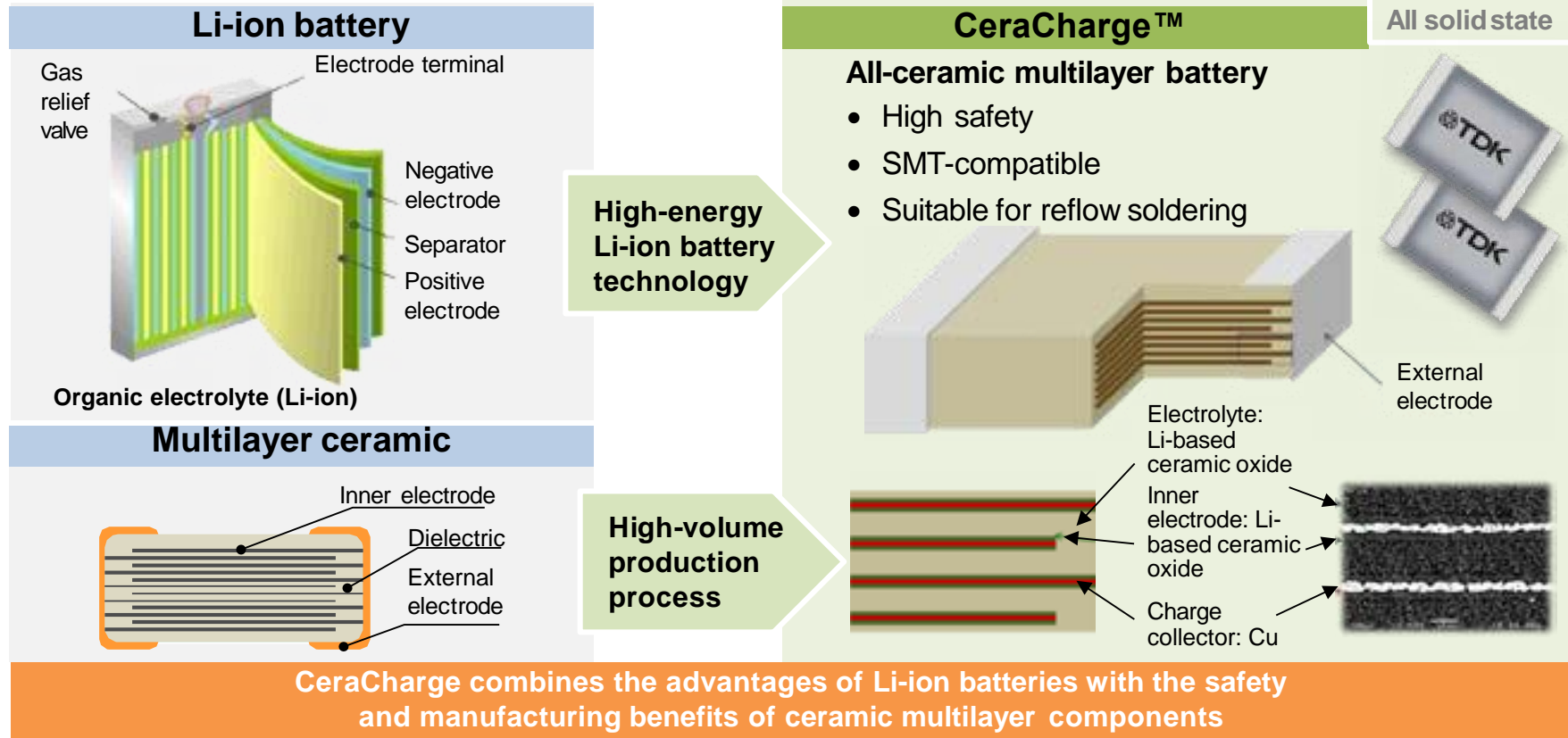
CHARACTERISTICS

Detection method



Sensor Output wave





CeraCharge 1812

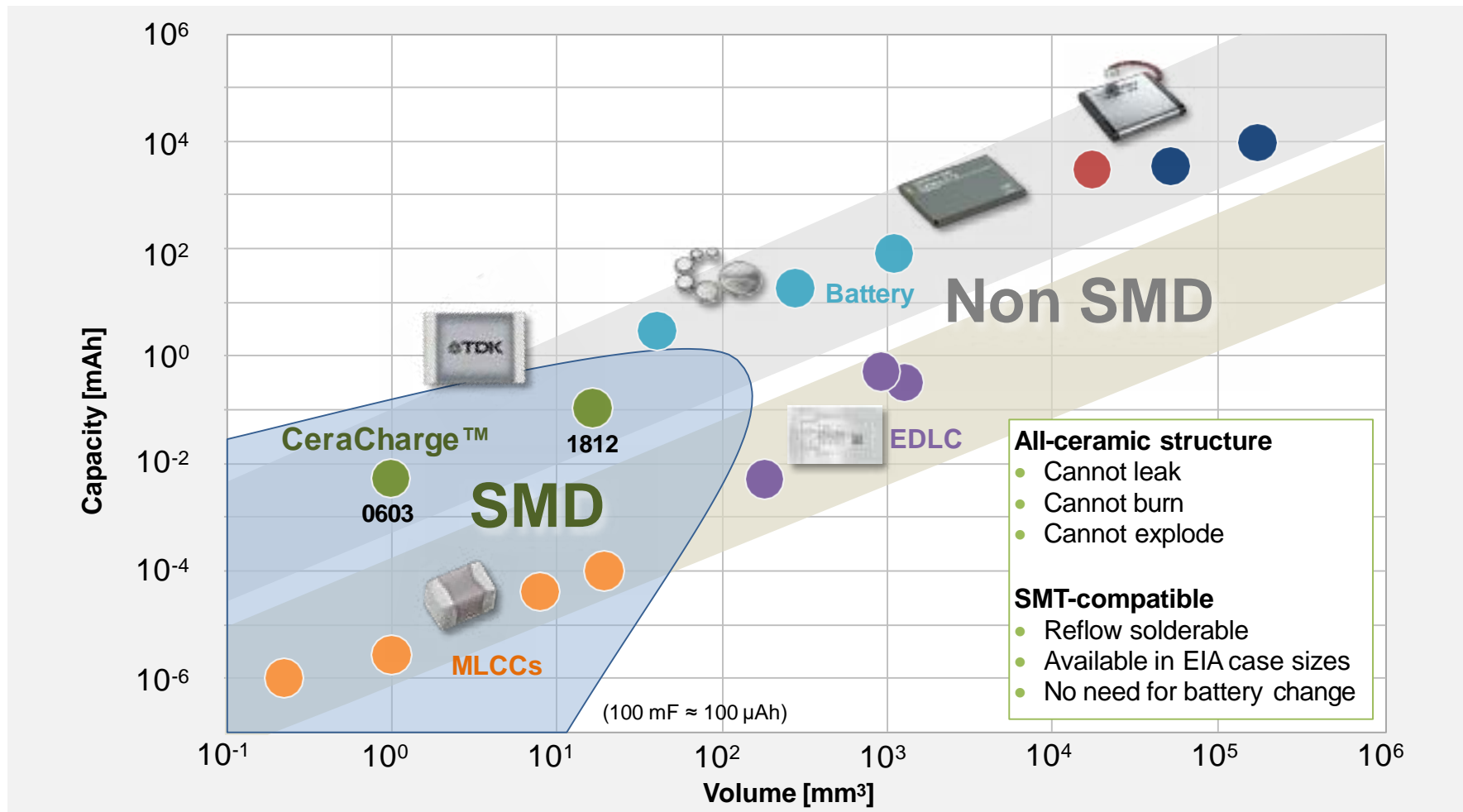
- World's first rechargeable solid-state SMD battery

CeraCharge offers 1000 times the capacity of a capacitor in the same case size

Nominal voltage	[V]	1.4
Operating voltage	[V _{op}]	0 to 1.6
Nominal capacity	[μAh]	100 ± 20
Nominal discharge current	[μA]	20
Operating temperature	[°C]	-20 to +80
Case size	[EIA]	1812
Dimensions	[mm]	4.5 x 3.2 x 1.1
Initial inner resistance	[Ω]	<200
Weight	[g]	0.045



Comparison of energy storage devices

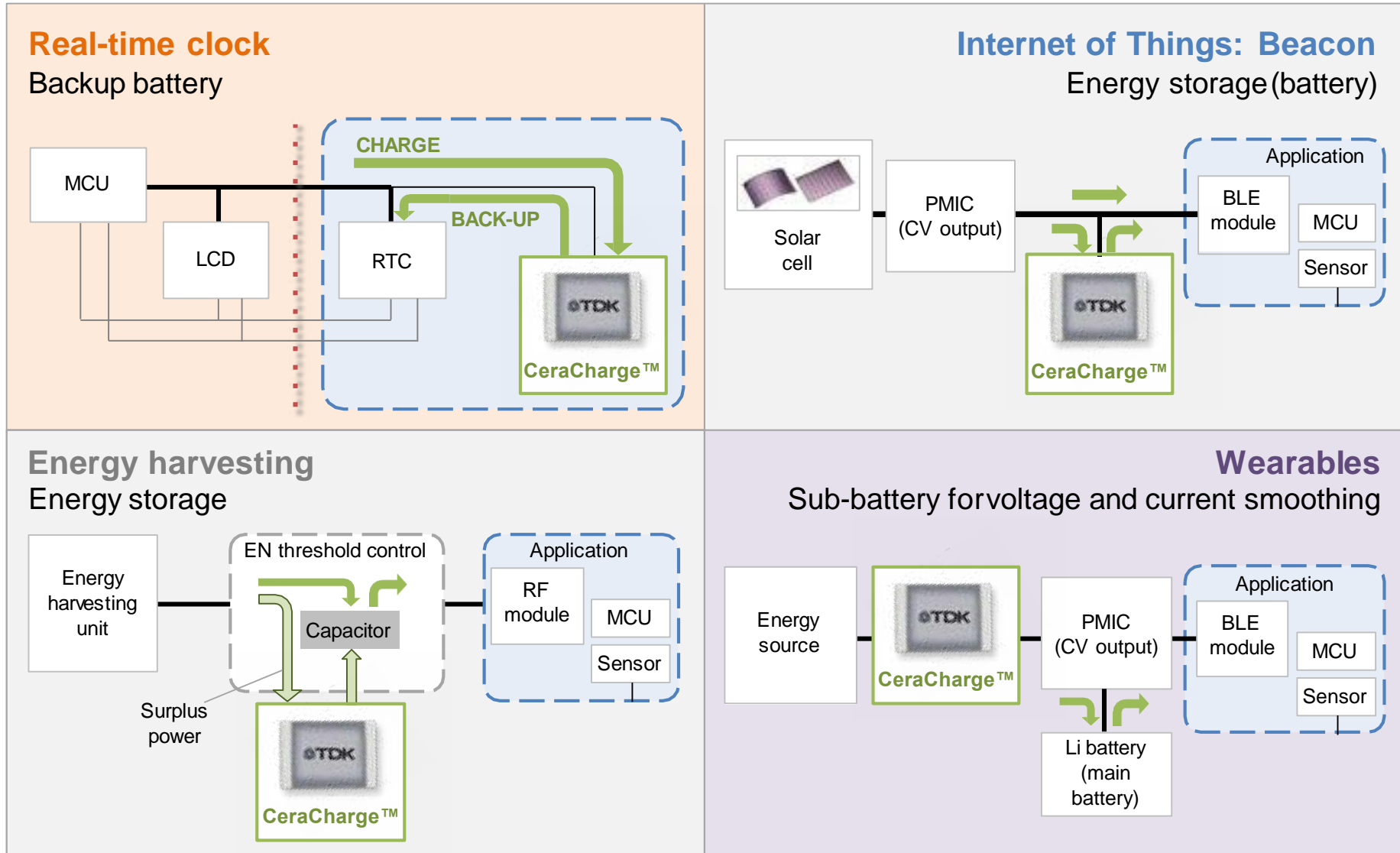


Outlook

- CeraCharge 1812 sample available
- Mass production starting 2018
- 0603 type in development



Main applications for CeraCharge



QUALCOMM

FOR WTR2K/3K/4K

- (1) [WTR3925 \(LTE-CA / Global\)](#)
- (2) [WTR2955 / WTR2965 \(LTE / 5mode\)](#)
- (3) [WTR4905 \(LTE / 5mode\)](#)

FOR WTR5K/SDR660/845

- (4) [WTR5975 \(Global\)](#)
- (5) [SDR660 \(Global\)](#)
- (6) [SDR845 \(Global\)](#)

FOR AUTOMOTIVE

- (7) [WTR3925+WTR4905 \(with MDM9x40/MSM8996\)](#)
- (8) [WTR2965 \(with MDM9x28\)](#)

INTEL

FOR SMARTI

- (9) [SMARTi4.5 \(M2M\)](#)
- (10) [SMARTi 5](#)
- (11) [SMARTi 5 \(M2M\)](#)
- (12) [SMARTi 7 \(M2M\)](#)



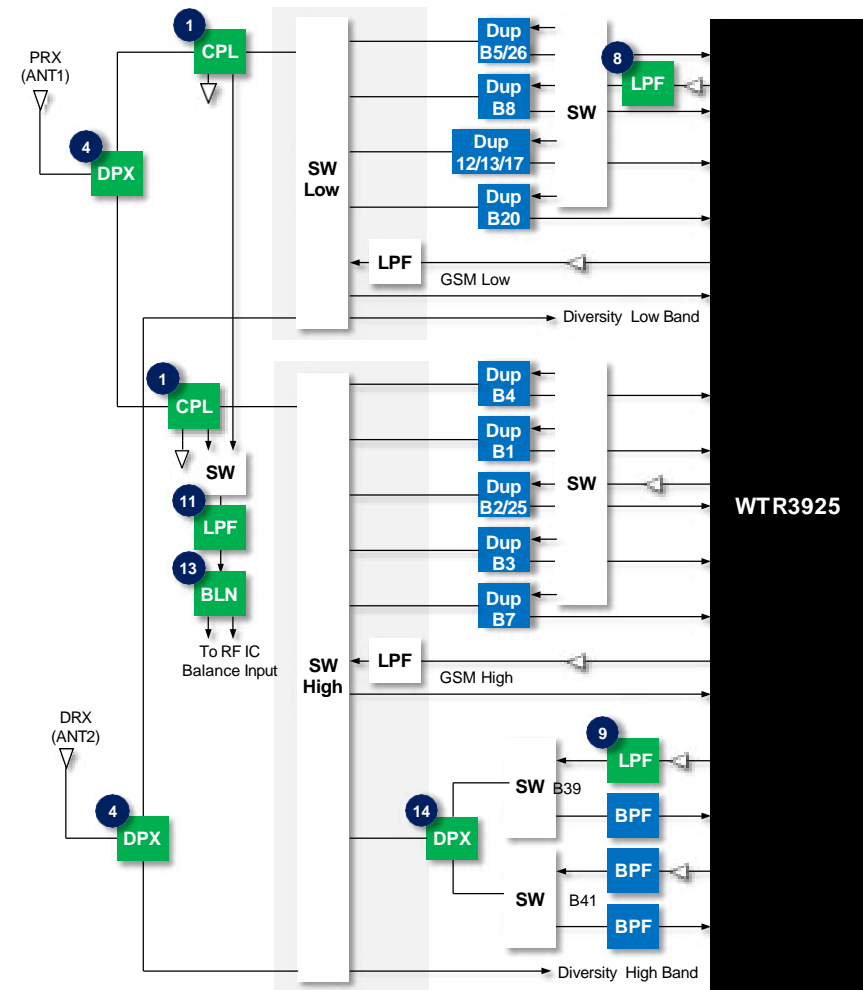
TDK RF Components for WTR3925

No.	Use	Size(mm)	TDK P/N	
4	Diplexer, LPF/BPF (699-960/1710-2690MHz)	2.5x2.0	DPX252690DT-5032A1	1
		2.0x1.25	DPX202690DT-4075J1	3
	Diplexer, LPF/HPF (699-960/1710-2690MHz)	2.0x1.25	DPX202700DT-4062A1	3
1	Coupler (Wide Band PRX)	1.0x0.5	TFSC102250-2325A2	3,4
		1.6x0.8	HHM22137A1	2,4
11	LPF (673-2690MHz) 5GHz rejection	1.6x0.8	DEA162690LT-5051B1	1
13	Balun (Wide Band)	1.6x0.8	HHM17147A1	1
8	LPF (Low Band)	1.6x0.8	DEA160960LT-5044C1	2
		1.0x0.5	DEA100915LT-6319A1	3
		0.65x0.5	DEA070960LT-4006B1	3
9	LPF (Band 34/39)	1.6x0.8	DEA162025LT-5046E1	2
14	Diplexer, LPF/HPF (698-1920/2496- 2690MHz)	2.0x1.25	DPX202690DT-4066B1	3

(*1) Reference items, (*2) Same performance as reference item,
 (*3) Alternate (*4) Available to Daisy chain

Block Diagram Example

TDK Estimation



LTCC / Thin Film Products

SAW/ BAW Products

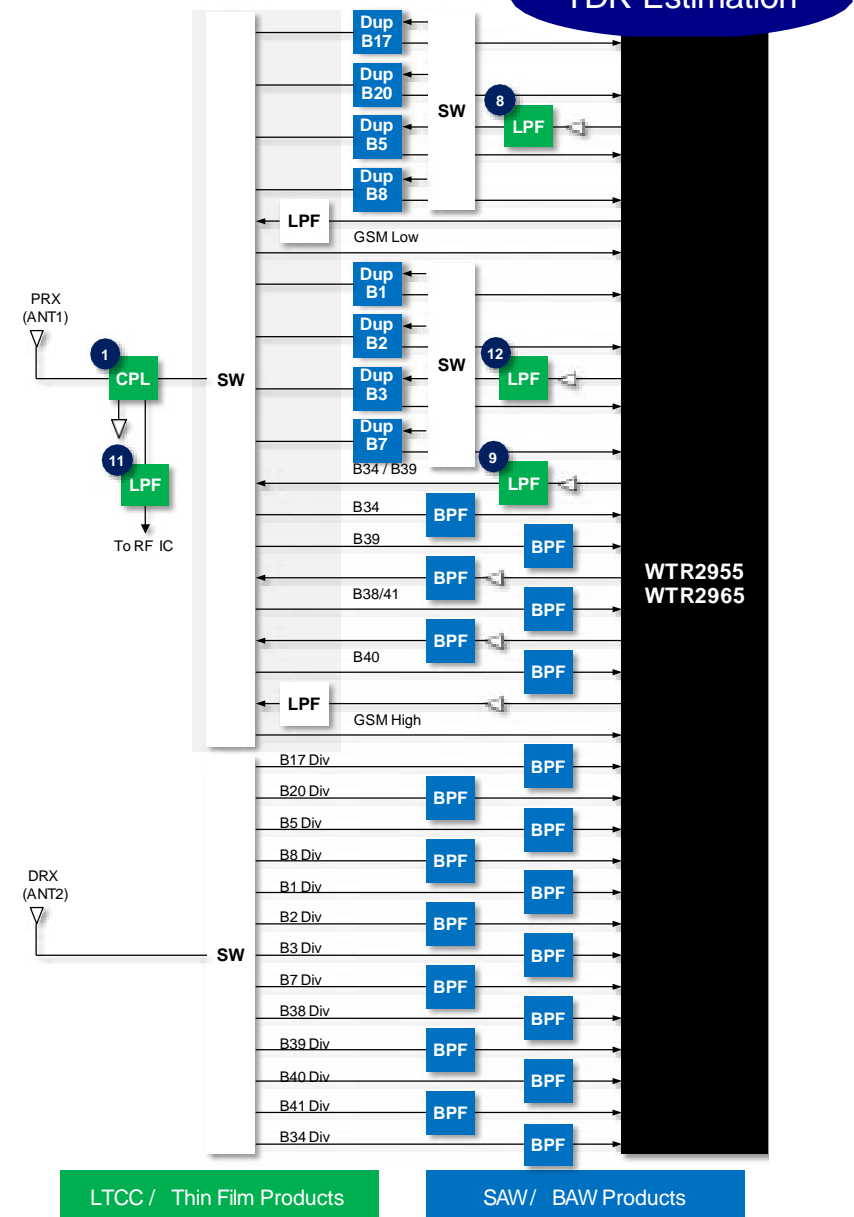


TDK RF Components for WTR2955 / WTR2965

No.	Use	Size(mm)	TDK P/N	
1	Coupler (Wide Band PRX)	1.0x0.5	TFSC102250-2325A2	3,4
		1.6x0.8	HHM22137A1	2,4
11	LPF (673-2690MHz) 5GHz rejection	1.6x0.8	DEA162690LT-5051B1	2
8	LPF (Low Band)	1.6x0.8	DEA160960LT-5044C1	3
		1.0x0.5	DEA100915LT-6319A1	2
		0.65x0.5	DEA070960LT-4006B1	3
12	LPF (699-2690MHz)	1.6x0.8	DEA162690LT-5064A1	1
	LPF (Band 34/39)	1.6x0.8	DEA162025LT-5046E1	2

(*1) Reference items, (*2) Same performance as reference item,
 (*3) Alternate (*4) Available to Daisy chain

Block Diagram Example

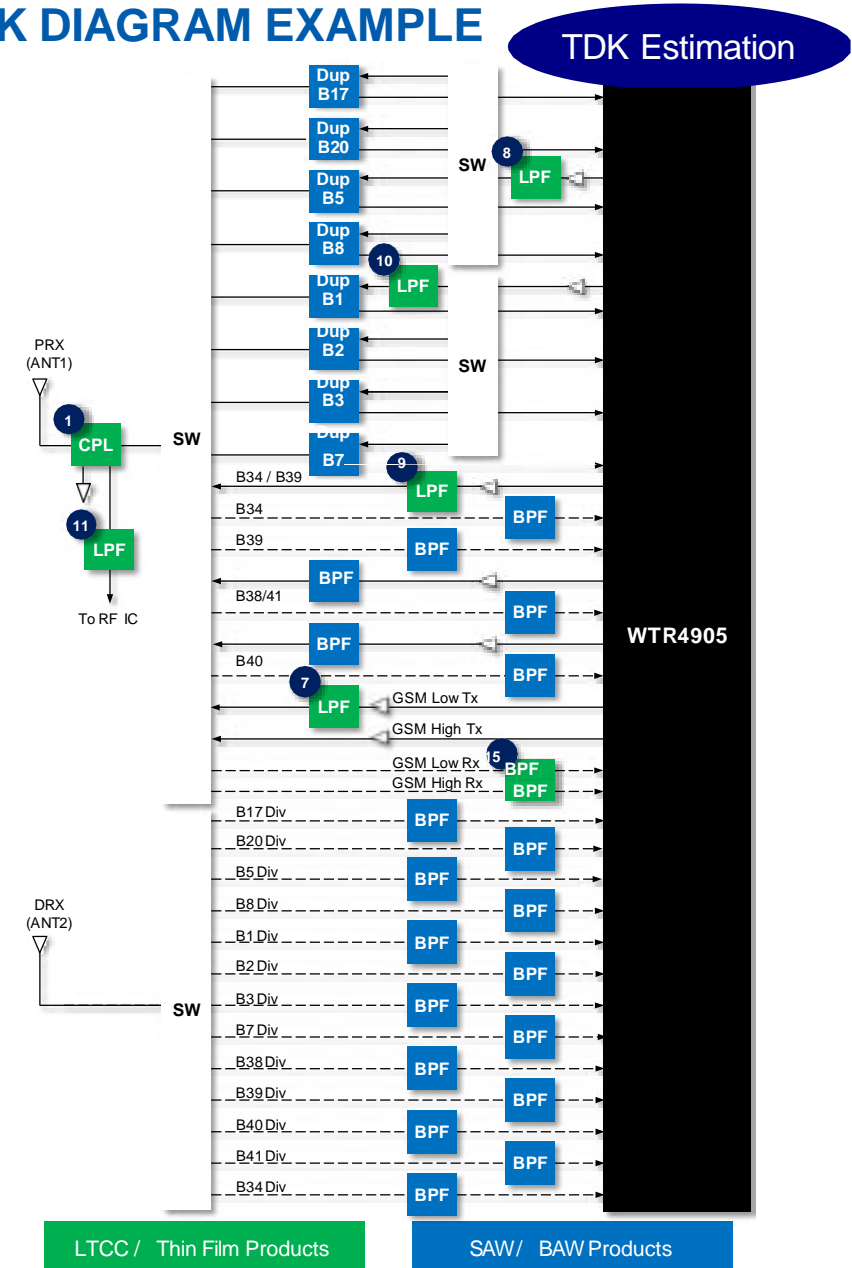


TDK RF Components for WTR4905

No.	Use	Size(mm)	TDK P/N	
1	Coupler (Wide Band PRX)	1.0x0.5	TFSC102250-2325A2	3,4
		1.6x0.8	HHM22137A1	2,4
11	LPF (673-2690MHz) 5GHz rejection	1.6x0.8	DEA162690LT-5051B1	2
8	LPF (Low Band)	1.6x0.8	DEA160960LT-5059A1	1
		1.0x0.5	DEA100915LT-6319A1	3
		0.65x0.5	DEA070960LT-4006B1	3
10	LPF (Band 1)	1.6x0.8	DEA162690LT-5057C1	1
9	LPF (Band 34/39)	1.6x0.8	DEA162025LT-5046E1	2
7	LPF (Low Band GSM)	0.65x0.5	TFSL06050915-4108B1X	1
15	BPF (2in1, GSM Band)	2.5x2.0	DEA252025MT-9042A1	1

(*1) Reference items, (*2) Same performance as reference item,
 (*3) Alternate (*4) Available to Daisy chain

BLOCK DIAGRAM EXAMPLE

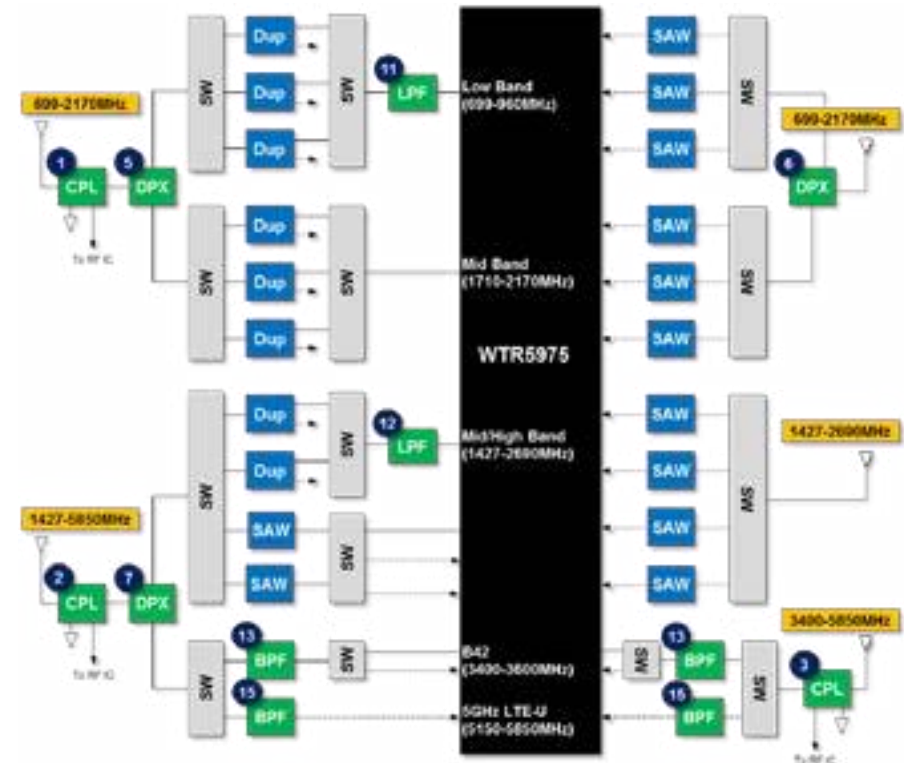


TDK RF Components for WTR5975

BLOCK DIAGRAM EXAMPLE

TDK Estimation

No.	Use	Size(mm)	TDK P/N	
1	Coupler (698-2690MHz)	1.6x0.8	HHM22137A1	*3, *4
		1.0x0.5	TFSC10051686-2306A1X	*3
2	Coupler (1427-5950MHz)	1.0x0.5	TFSC103688-2314C1Q	*1, *4
			HHM2955A1	*2, *4
3	Coupler (3400-5950MHz)	1.0x0.5	TFSC10054675-2317A1Q	*1, *4
			HHM2952A1	*2, *4
5	Diplexer, LPF/BPF type (698-960/1710-2170MHz)	2.5x2.0	DPX252170DT-5051D1	*2
6	Diplexer, LPF/BPF type "Mirrored LB&HB pin" (698-960/1710-2170MHz)	2.5x2.0	DPX252170DT-5152D1	*2
7	Diplexer, LPF/BPF type (698-2690/3400-5850MHz)	2.5x2.0	DPX255850DT-5045F1	*1
		1.6x0.8	DPX165850DT-8086A1	*3
11	LPF (698-960MHz)	2.0x1.25	DEA200960LT-5055B1	*1
		1.6x0.8	DEA160960LT-5059A1	*3
12	LPF (699-2690MHz)	1.6x0.8	DEA162690LT-5064A1	*1
13	BPF (3400-3600MHz)	2.0x1.25	DEA203500BT-2213A1-H	*2
15	BPF (5150-5850MHz)	1.6x0.8	DEA165500BT-2208A1	*1



(*1) Reference items, (*2) Same performance as reference item,
 (*3) Alternate (*4) Available to Daisy chain

LTCC/ Thin Film Products

SAW/ BAWProducts

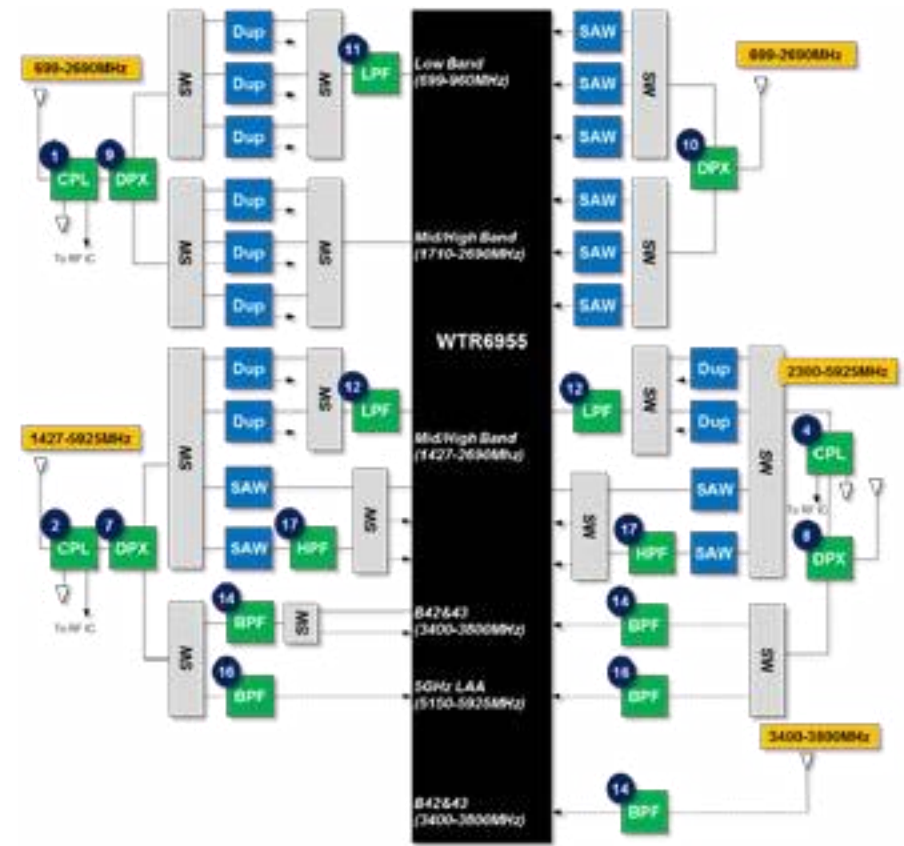


TDK RF Components for SDR660

BLOCK DIAGRAM EXAMPLE

TDK Estimation

No.	Use	Size(mm)	TDK P/N	
1	Coupler (698-2690MHz)	1.6x0.8	HHM22137A1	*3, *4
		1.0x0.5	TFSC10051686-2306A1X	*3
2	Coupler (1427-5950MHz)	1.0x0.5	TFSC103688-2314C1Q	*1, *4
			HHM2955A1	*2, *4
4	Coupler (2300-2700MHz)	1.0x0.5	TFSC102500-2318B1Q	*1, *4
7	Diplexer, LPF/BPF type (698-2690/3400-5850MHz)	2.5x2.0	DPX255850DT-5045F1	*1
		1.6x0.8	DPX165850DT-8086A1	*3
8	Diplexer, LPF/BPF type "Mirror pin" (698-2690/3400-5850MHz)	2.5x2.0	DPX255850DT-5145F1	*1
9	Diplexer, LPF/BPF type (698-960/1710-2690MHz)	2.5x2.0	DPX252690DT-5031D1	*2
		2.0x1.25	DPX202690DT-4075J1	*3
10	Diplexer, LPF/BPF type "Mirrored LB&HB pin" (698-960/1710-2690MHz)	2.5x2.0	DPX252690DT-5146D1	*2
11	LPF (698-960MHz)	2.0x1.25	DEA200960LT-5055B1	*1
		1.6x0.8	DEA160960LT-5059A1	*3
12	LPF (699-2690MHz)	1.6x0.8	DEA162690LT-5064A1	*1
14	BPF (3400-3800MHz)	2.0x1.25	DEA203600BT-2224A1-H	*2
16	BPF (5150-5925MHz)	1.6x0.8	DEA165538BT-2208F1	*1
17	HPF (2300-2400MHz)	1.6x0.8	DEA162300HT-8045A1	*2



(*1) Reference items, (*2) Same performance as reference item,
 (*3) Alternate (*4) Available to Daisy chain

LTCC/ Thin Film Products

SAW/ BAW Products

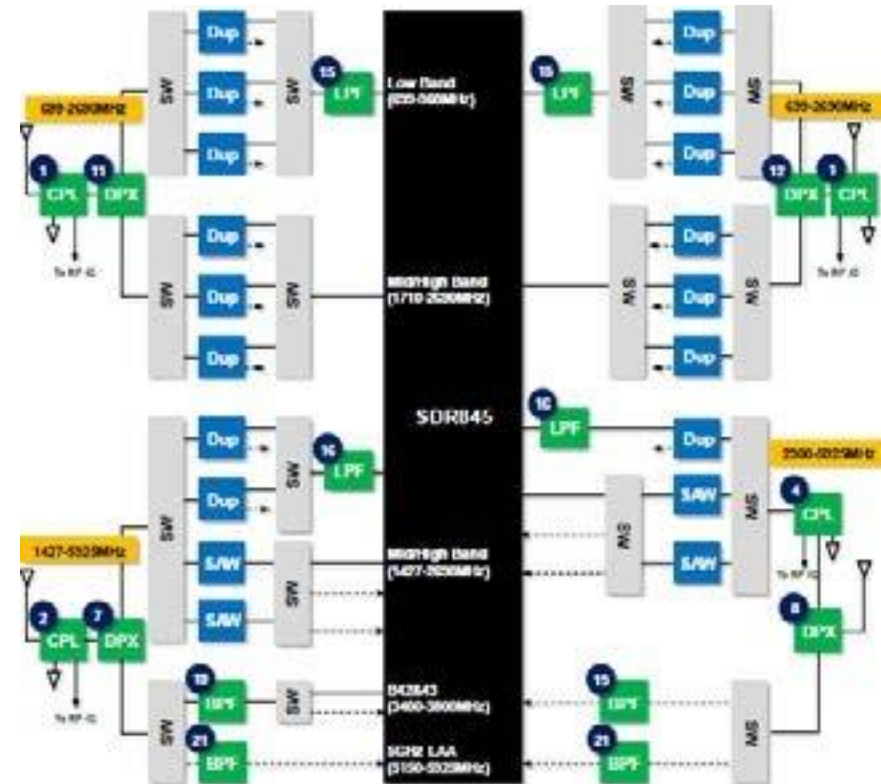


TDK RF Components for SDR845

BLOCK DIAGRAM EXAMPLE

TDK Estimation

No.	Use	Size(mm)	TDK P/N	
1	Coupler (698-2690MHz)	1.6x0.8	HHM22137A1	*3, *4
		1.0x0.5	TFSC10051686-2306A1X	*3
2	Coupler (1427-5950MHz)	1.0x0.5	TFSC103688-2314C1Q	*1, *4
			HHM2955A1	*2, *4
4	Coupler (2300-2700MHz)	1.0x0.5	TFSC102500-2318B1Q	*1, *4
7	Diplexer, LPF/BPF type (698-2690/3400-5850MHz)	2.5x2.0	DPX255850DT-5045F1	*1
		1.6x0.8	DPX165850DT-8086A1	*3
8	Diplexer, LPF/BPF type (698-2690/3400-5850MHz)	2.0x1.25	DPX205925DT-4213A1	*1
11	Diplexer, LPF/BPF type (698-960/1710-2690MHz)	2.5x2.0	DPX252690DT-5031D1	*2
		2.0x1.25	DPX202690DT-4075J1	*3
12	Diplexer, LPF/BPF type "Mirrored LB&HB pin" (698-960/1710-2690MHz)	2.5x2.0	DPX252690DT-5146D1	*2
15	LPF (698-960MHz)	2.0x1.25	DEA200960LT-5055B1	*1
		1.6x0.8	DEA160960LT-5059A1	*3
16	LPF (699-2690MHz)	1.6x0.8	DEA162690LT-5064A1	*1
19	BPF (3400-3800MHz)	2.0x1.25	DEA203600BT-2224A1-H	*2
21	BPF (5150-5925MHz)	1.6x0.8	DEA165538BT-2208F1	*1



(*1) Reference items, (*2) Same performance as reference item,
 (*3) Alternate (*4) Available to Daisy chain

LTCC / Thin Film Products

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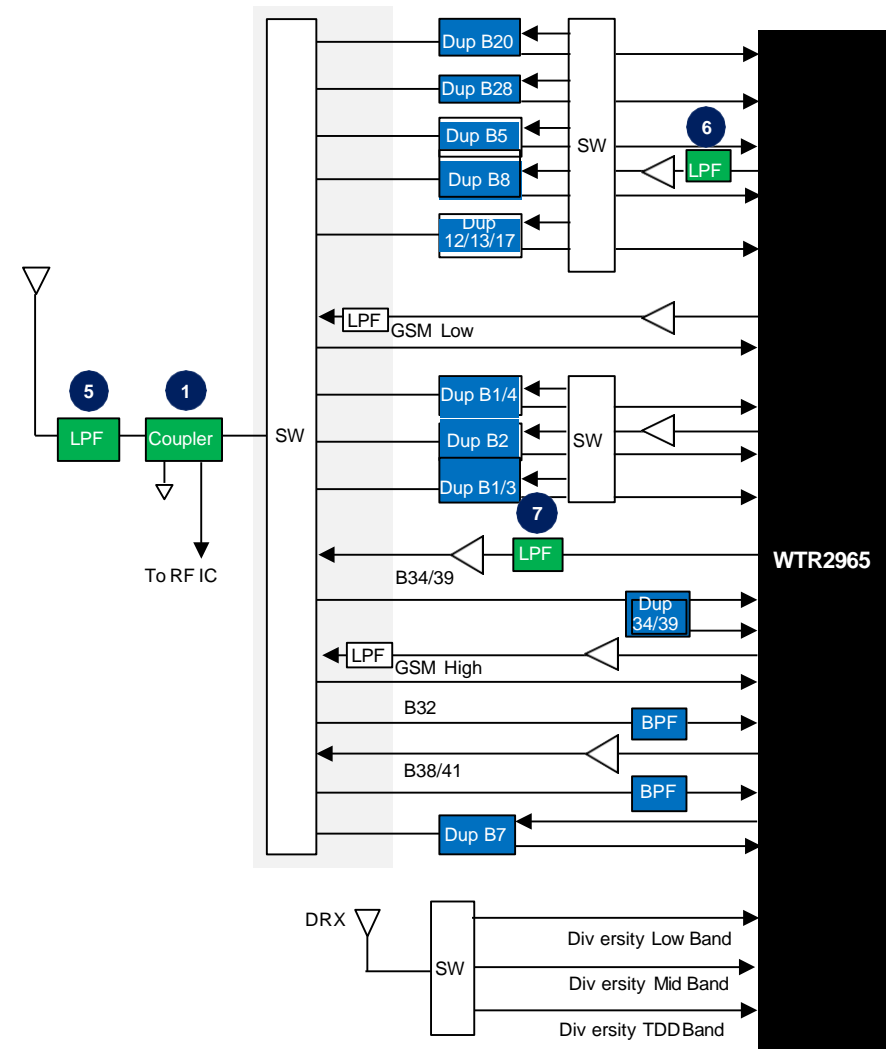
TDK RF Components

No.	Use	Size(mm)	TDK P/N
1	Coupler (Wide Band PRX)	1.6x0.8	HHM22137A1 (*1)
5	LPF (699-2690MHz) 5GHz Notch	1.6x0.8	DEA162690LT-5064A1 (*1)
6	LPF (698-960MHz)	1.6x0.8	DEA160960LT-5059A1 (*1)
7	LPF (Band 34/39)	1.6x0.8	DEA162025LT-5046E1 (*2)

(*1) Reference items, (*2) Same performance as reference item,
(*3) Alternate

BLOCK DIAGRAM EXAMPLE

TDK Estimation



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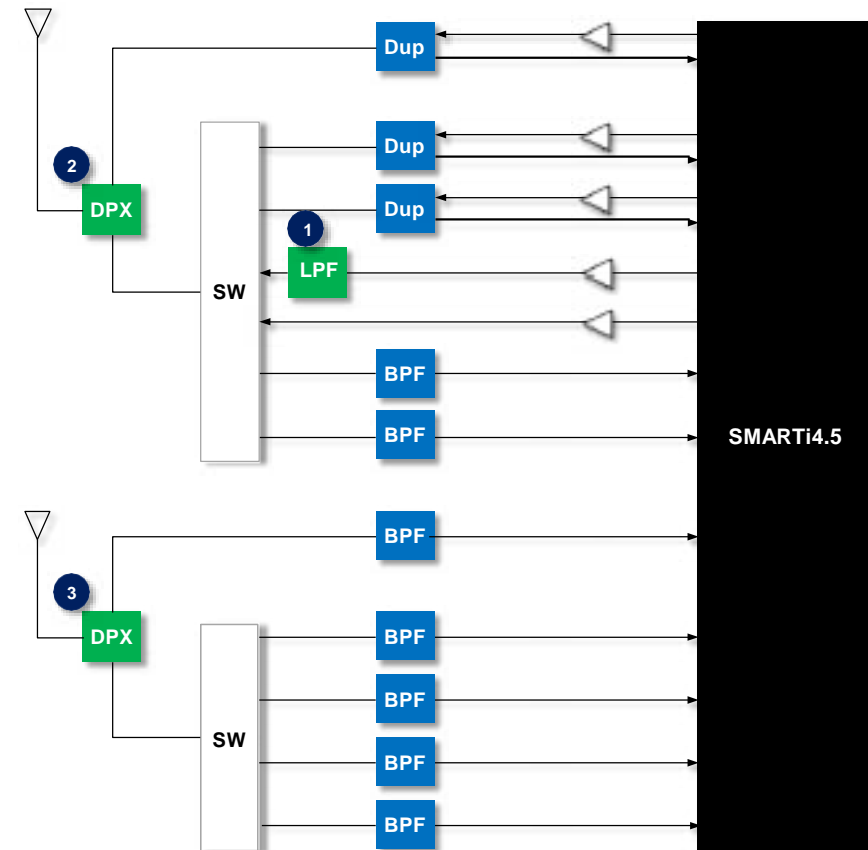
TDK RF Components

No.	Use	Size(mm)	TDK P/N
1	LPF (1880-2025MHz)	1.6x0.8	DEA162025LT-5046E1 (*1)
2	DPX , LPF/BPF (699-960/1710-2690MHz)	2.5x2.0	DPX252690DT-5032B1 (*1)
3	DPX , LPF/HPF (698-960/1710-2700MHz)	2.0x1.25	DPX202700DT-4062A1 (*1)

(*1) Reference items, (*2) Same performance as reference item, (*3) Alternate

BLOCK DIAGRAM EXAMPLE

TDK Estimation



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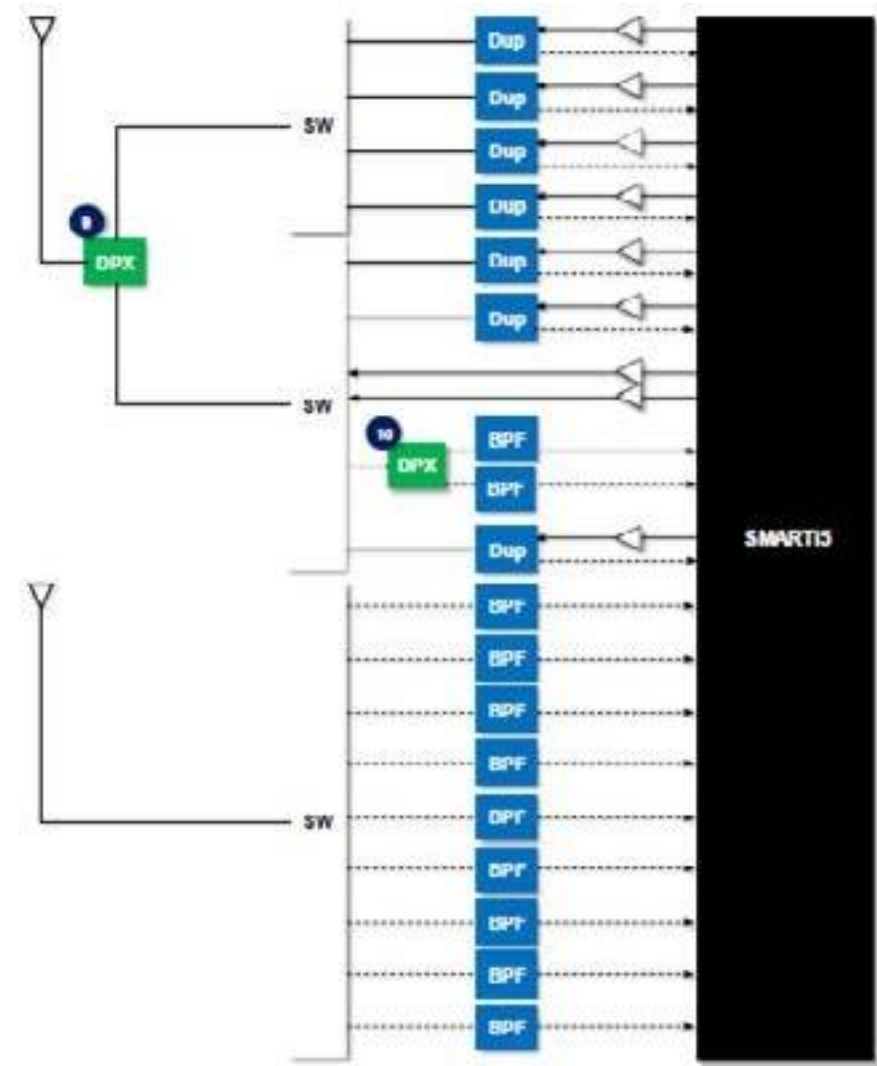
TDK RF Components

No.	Use	Size(mm)	TDK P/N
9	Diplexer (Low / High)	2.0x1.25	DPX202690DT-4082A1 (*1)
		2.0x1.25	DPX202690DT-4081B1 (*3)
10	Diplexer (B39 / B40+B41)	2.5x2.0	DPX252620DT-5218B1 (*1)

(*1) Reference items, (*2) Same performance as reference item, (*3) Alternate

BLOCK DIAGRAM EXAMPLE

TDK Estimation



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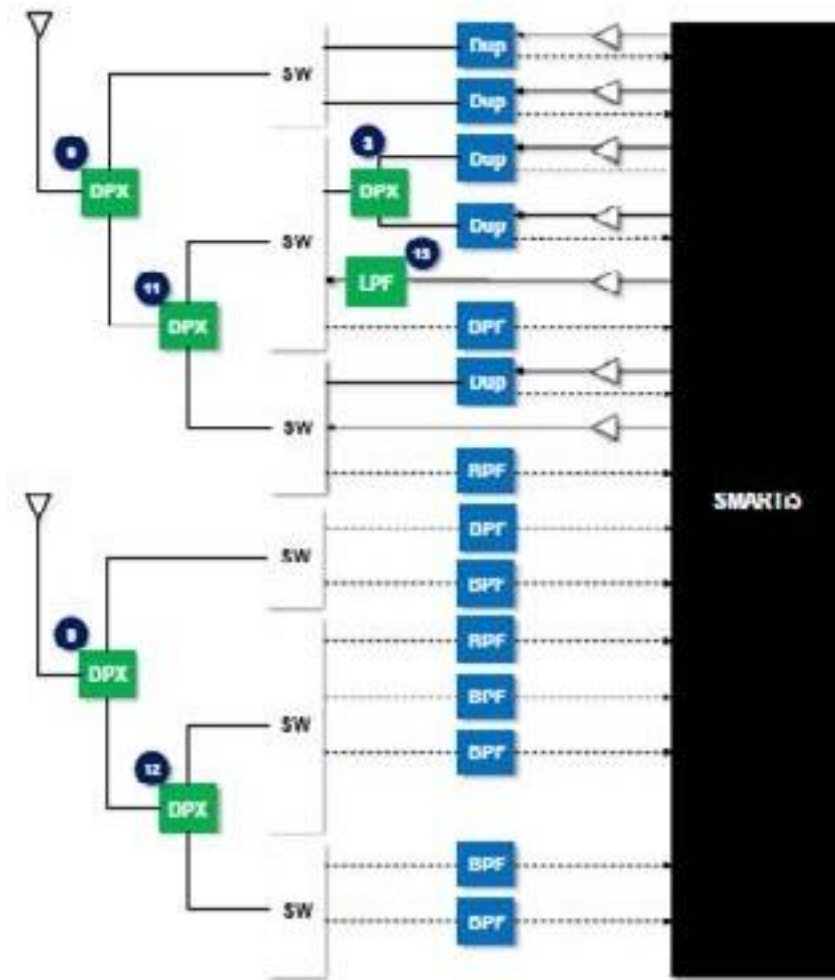
TDK RF Components

No.	Use	Size(mm)	TDK P/N
11	Diplexer (699-2170/2300-2690MHz)	2.5x2.0	DPX252690DT-5225A1 (*1)
3	Diplexer (699-1511/1710-2700MHz)	2.0x1.25	DPX201880DT-4061A2 (*1)
12	Diplexer (1710-2170/2500-2690MHz)	2.0x1.25	DPX202690DT-4084A1 (*1)
13	LPF (1880-2025MHz)	1.6x0.8	DEA162025LT-5046C1 (*1)
9	Diplexer (699-960/1427-2690MHz)	2.0x1.25	DPX202690DT-4082A1 (*1)

(*1) Reference items, (*2) Same performance as reference item,
(*3) Alternate

BLOCK DIAGRAM EXAMPLE

TDK Estimation



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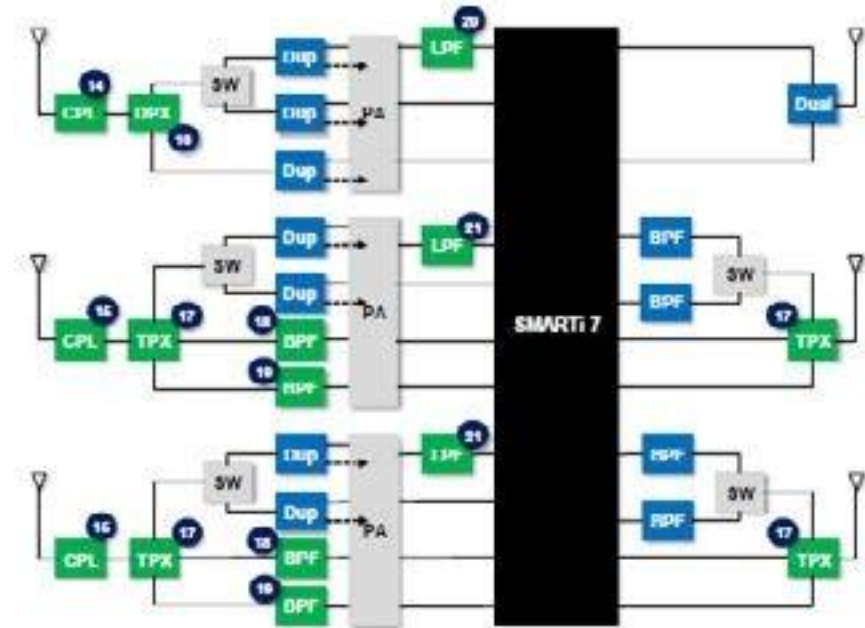


TDK RF Components

BLOCK DIAGRAM EXAMPLE

TDK Estimation

No.	Use	Size(mm)	TDK P/N
14	Coupler (698-2690MHz)	1.6x0.8	HHM22137A1 (*3)
		1.0x0.5	TFSC10051686-2306A1X (*3)
15	Coupler (1427-5950MHz)	1.0x0.5	HHM2955A1 (*3)
		1.0x0.5	TFSC103688-2314C1Q (*3)
16	Diplexer (698-1990/2300-5850MHz)	2.0x1.25	DPX205850DT-4055A8 (*1)
17	Triplexer (1428-2690/3400-3800/5150-5925MHz)	2.5x2.0	TPX255925MT-7025A2 (*1)
18	BPF (3400-3600MHz)	2.0x1.25	DEA203500BT-2213A1-H (*2)
	BPF (3400-3800MHz)	2.0x1.25	DEA203600BT-2224A1-H (*2)
19	BPF (5150-5925MHz)	1.6x0.8	DEA165538BT-2208F1 (*2)
20	LPF (698-960MHz)	1.6x0.8	DEA160960LT-5059A1 (*2)
21	LPF (2300-2690MHz)	1.6x0.8	DEA162690LT-1217A2 (*3)



(*1) Reference items, (*2) Same performance as reference item, (*3) Alternate

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