Application guide

Surgical Robotics

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Market Trend

Expanding Role in Modern Society

Surgical robotics has transitioned from an emerging technology into a core platform for advanced minimally invasive surgeries. Leading hospitals worldwide are increasingly investing in robotic-assisted surgery (RAS) systems to enhance precision, reduce operative trauma, and accelerate patient recovery timelines.

By the end of 2022, approximately **7,500 RAS systems** were installed globally, performing over **11 million procedures** since their introduction in the late 1990s (Marchegiani et al., 2023, European Urology Open Science). The global surgical robotics market was valued at **USD $11.98 billion in 2024**, stood at **US $13.9 billion in 2025**, and is projected to reach **USD $27.14 billion by 2030**, representing a robust **CAGR of 14.7%** (MarketsandMarkets™, Surgical Robots Market Size, Growth Share and Trends Analysis, December 2025).

Growth drivers include:

- Rising demand for minimally invasive procedures with better surgical outcomes
- Technological advancements in **AI-driven real-time feedback, augmented and mixed-reality visualization, and haptic sensing for tactile feedback**
- Increasing adoption across multiple surgical specialties (urology, cardiothoracic, orthopedics, gynecology, neurosurgery)
- Workforce support — alleviating surgeon fatigue and expanding training opportunities via robotic simulation platforms

Next-generation surgical robots are evolving beyond mechanical assistance into intelligent operator aids — capable of error reduction, decision support, and enhanced intra-operative visualization. This is creating opportunities for advanced sensors, miniaturized components, and robust electronics to improve reliability, accuracy, and connectivity in high-stakes medical environments.

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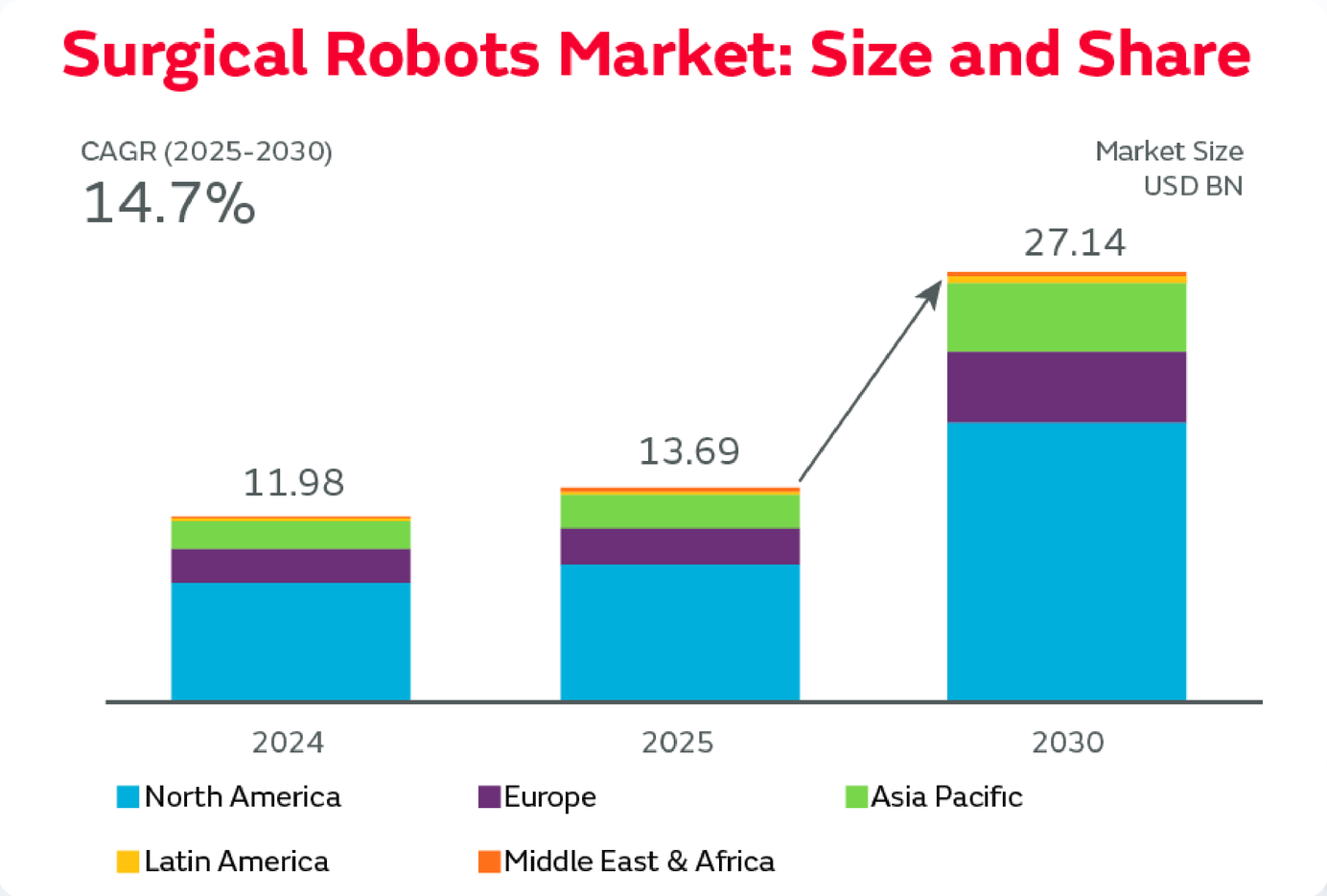
Market Trend

Expanding Role in Modern Society



Source: MarketsandMarkets™, "Surgical Robots Market Size, Growth Share and Trends Analysis," December 2025.

Figure 1 – Surgical Robots Market: Size & Share (2025-2030)

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Challenges

Precision and Motor Control

1

- Replicating a surgeon's hand motion with sub-millimeter accuracy requires smooth, coordinated movement across multiple robotic arms. Actuators and servomotors must respond instantly without overshoot or oscillation.

- Murata's high-performance ceramic capacitors, low-inductance noise filters, and precision NTC/PTC thermistors support stable motor drive circuits by reducing electrical noise, improving signal fidelity to control systems, and enabling precise thermal feedback for motors.

Impact: This enhances force and position control stability, reduces jitter, and maintains repeatable positioning during delicate surgeries.

Miniaturization and Component Integration

2

- Surgical robots are becoming more compact and modular for easier sterilization, operating room space efficiency, and procedural flexibility. Engineers must integrate more functions into smaller mechanical housing without sacrificing performance.

- Murata is an industry leader in ultra-compact passive components, multi-layer ceramic capacitors (MLCCs), noise filters, inductors, and high-density sensor modules (e.g., MEMS-based pressure, inertial, and environmental sensors).

Impact: Enables designers to add sensing and connectivity capabilities into tight spaces inside robotic arms or surgical end-effectors, facilitating more advanced features without increasing footprint.

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Challenges Continued

EMI Mitigation and Signal Integrity

3

- Operating rooms are electromagnetically noisy environments due to imaging equipment (MRI, CT, X-ray), cauterization tools, and wireless communications. Internal high-frequency control signals must be preserved to avoid data errors or motor glitches.
- Murata's EMI suppression filters, ferrite beads, and common mode choke coils protect sensitive control electronics from conducted and radiated interference.

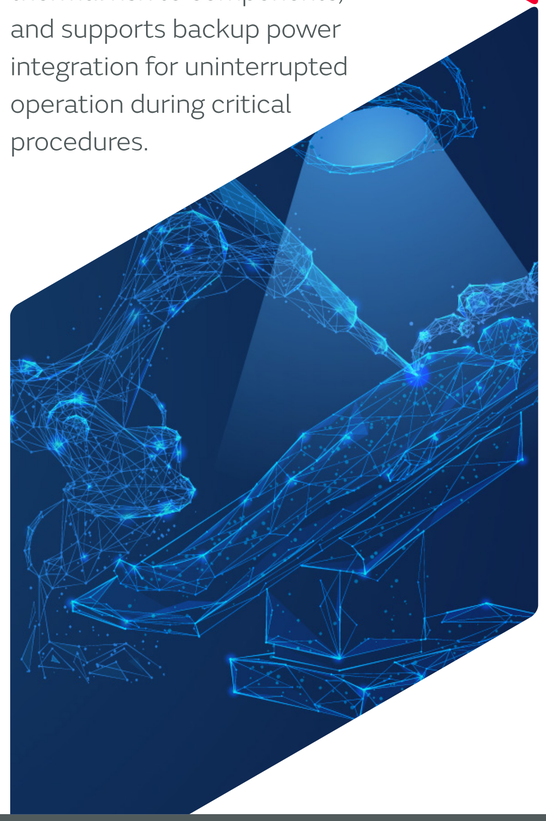
Impact: Maintains clean data lines and reliable sensor readings, ensuring surgical precision is unaffected by external or internal noise.

Power Management and Energy Efficiency

4

- Surgical robots require consistent, regulated power for precise operation. Voltage fluctuations or power interruptions could cause performance degradation or system faults. Systems must remain functional during grid disturbances.
- Murata's high-efficiency DC-DC and AC-DC converters, low-ESR capacitors, and power modules provide stable voltage regulation underload changes while minimizing heat generation.

Impact: Improves motor and electronics reliability, reduces thermal risk to components, and supports backup power integration for uninterrupted operation during critical procedures.



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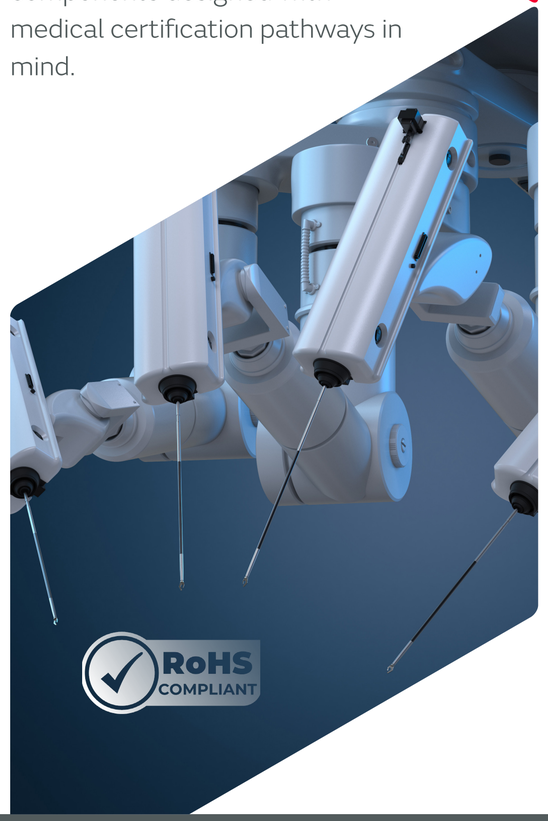
Challenges Continued

Regulatory Compliance

5

- Surgical robotic systems must meet stringent standards, such as IEC 60601 for medical electrical safety, ISO 13485 for quality management, and FDA Class II/III device regulations.
- Murata components are developed with medical-grade reliability, and can be specified to meet creepage/clearance, insulation, and biocompatibility requirements aligned with IEC 60601-1 safety standards.

Impact: Reduces compliance risk for manufacturers by integrating components designed with medical certification pathways in mind.



Wireless Communication and Data Security

6

- As remote surgery and intraoperative data sharing become more prevalent, robots require low-latency, secure wireless connections for diagnostics, monitoring, and real-time teleoperation.
- Murata RFID/NFC tags for tracking and authenticating individual items along with miniaturized wireless modules (Bluetooth®, Wi-Fi®, LoRa®) designed for medical device-grade reliability and low power operation — including hardware-based encryption support for secure data transmission.

Impact: Enables robotic systems to maintain stable wireless connectivity without sacrificing signal reliability or patient privacy.

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Capacitors

Multi-layer Ceramic Capacitors

Learn More

Overview

Murata provides a large capacitor product line to meet the needs of various functional circuits, including safety capacitors, standard MLCC, soft/metal termination capacitors, epoxy coating with lead and polymer aluminum capacitors.

Features

- Ultra-small capacitors allow for ultra-compact design products
- High-quality capacitors make your products highly reliable
- Excellent electrical characteristics of capacitors can increase energy conversion efficiency and cope with changing environmental conditions

	GRM	GJM	GCM	NFM
Size (EIA)	008004 - 2220	01005 - 0402	0201 - 2220	0402 - 1806
Rated Voltage	2.5Vdc - 3,150Vdc	6.3Vdc - 100Vdc	2.5Vdc - 1,250Vdc	2.5Vdc - 100Vdc
Capacitance	0.1pF - 330µF	0.1pF - 47pF	0.1pF - 220µF	100pF - 27µF
Operating Temperature	-55˚C - +125˚C	-55˚C to +150˚C		-55˚C to +125˚C

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Connectivity modules

Learn More

Overview

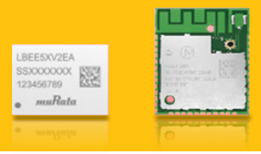
Murata connectivity modules are designed to simplify wireless development and certification by minimizing the amount of RF expertise required.

Our range includes a broad range of modules supporting various wireless communication standards.

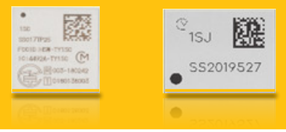
Features

- Ultra small size
- Internal antenna external antenna option
- Rich peripheral interface
- Regulatory certificated: FCC/ISED/ETSI/MIC
- RoHS compliant

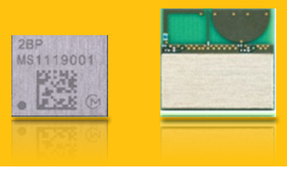
Wi-Fi™/Bluetooth®



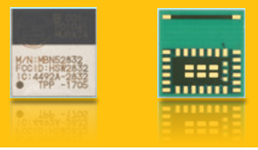
LPWA



UWB



Bluetooth® Low Energy



A wide variety of modules

- Wi-Fi™/Bluetooth®
- Bluetooth® Low Energy
- Cellular LPWA
- LoRa
- UWB (Ultra Wide Band)

Small size

- Make a contribution to smaller implantable devices

Antenna design support

- Antenna simulation
- Measure antenna performance
- Propose modified antenna design

Quality

- Selected by world-wide customers

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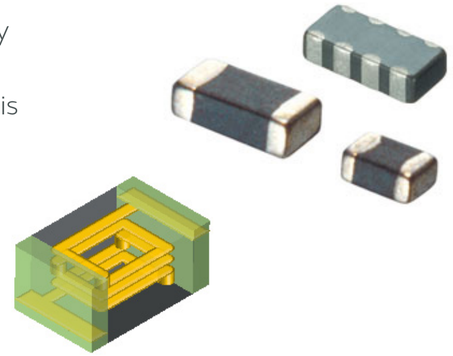
Noise Suppression/EMI Suppression Filters

Chip Ferrite Beads

Learn More

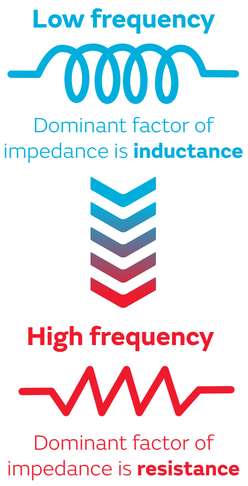
Overview

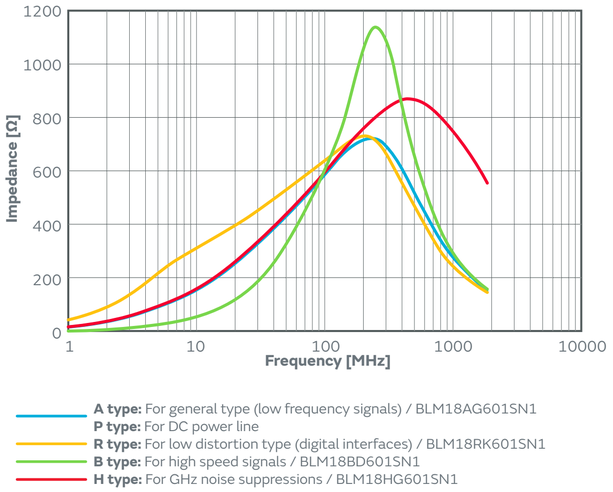
Ferrite beads are inductive EMI suppression filters that are effective from several MHz to several GHz. They can be widely used as general purpose noise suppression components. Inductive EMI filters work as inductors at low frequencies, but impedance caused by resistance increase at high frequencies. When inserted in series into the noise conduction path, this resistance component prevents and absorbs noise conduction.

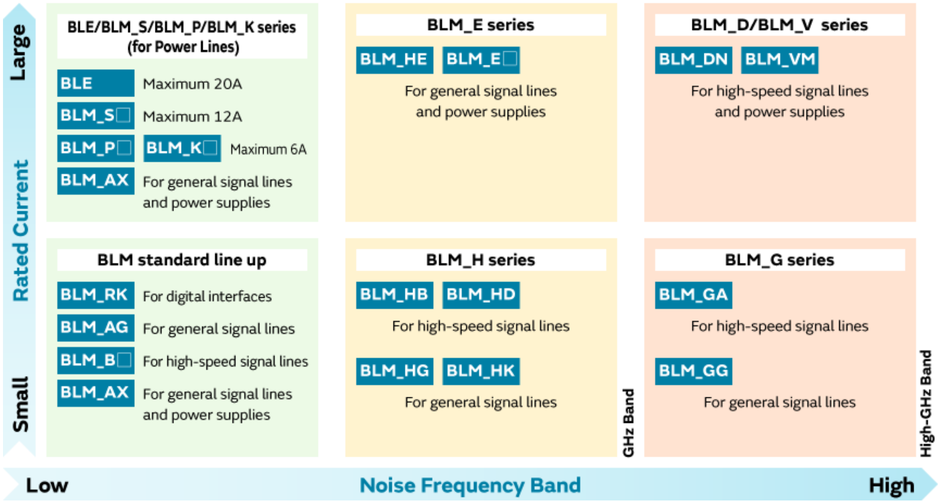


Features

- Small size
- High performance
- Wide temperature range
- Extensive product range







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Noise Suppression/EMI Suppression Filters

Common Mode Choke Coils

Overview

Common mode choke coils (CMCC) are filters that reduce common mode noise that is problematic in differential transmission lines (non-automotive use: USB, HDMI, Mipi, etc.), power lines and audio lines. They are ideal for suppressing common mode noise with frequencies ranging from several megahertz to several hundred megahertz with no adverse effect on the signals (upper cut-off frequency).

Common-mode chokes/filters

Find out more - PLT10H

Technology case study

For signal circuits

	Signal speed									
	USB 2.0 (480Mbps)	**MIPI D-phy Ver1.1** (1.5Gbps)	**HDMI 1.4** (1.7Gbps)	**MIPI C-phy Ver1.0** (2.5Gsym/s)	**MIPI D-phy Ver1.2** (2.5Gbps)	**USB 3.1 Gen1** (5Gbps)	**HDMI 2.0** (6Gbps)	**Display Port 1.4** (8.1Gbps)	**USB 3.1 Gen2** (10Gbps)	**HDMI 2.1** (12Gbps)
0.45 x 0.3mm (018012/0403)	NFP0RSA242HL2				NFP0RSA 242HL2	**NFP0RSA 242HL2**				
0.65 x 0.5mm (025020/0605)	DLM0QSN 900HY2	DLM0QSN 500HY2	DLM0QSB 350HY2 NFG0QHB 372HS2		DLM0QSB 500HY2	DLM0QSB350HY2 **NFG0QHB 372HS2**	NFG0QHB372HS2		DLM0QSB 350HY2 NFG0QHB 542HS2	NFG0QHB 542HS2 DLM0QSB 120HY2
0.85 x 0.65mm (03025/0806)	DLM0NSN900HY2			NFG0NCN 162HL3	DLM0NSN 500HY2	**DLM0NSN 500HY2**	DLM0NSB280HY2			DLM0NSB 120HY2
2.0 x 1.2mm (0805/2012)	DLW21HN 900SQ2		DLW21SN 900HQ2			DLW21SN900HQ2 **DLW21HN 900HQ2**				

Red = NEW

Bold = Devices with equalization functions

For power circuits

	Rated current								
	2A	4A	6A	8A	10A	12A	14A	16A	18A
4.0 x 4.0 x 1.5 max.mm (1515/4040)	**DLW44SM_SK2** (-40 to +105°C)								
5.0 x 3.6 x 2.4 max.mm (2014/5036)	**DLW5ATN_SQ2** (-40 to +85°C) **DLW5ATN_MQ2** (-40 to +105°C) **DLW5ATN_TQ2** (-40 to +105°C)								
5.0 x 3.6 x 4.3 max.mm (2014/5036)	**DLW5AHNSQ2** (-40 to +85°C)								
5.0 x 5.0 x 2.5 max.mm (2020/5050)	**DLW5BTM_SQ2** (-40 to +85°C) **DLW5BTM_TQ2** (-40 to +105°C)								
5.0 x 5.0 x 4.5 max.mm (2020/5050)	**DLW5BSM_SQ2** (-40 to +85°C) **DLW5BSM_TQ2** (-40 to +105°C)								
5.0 x 5.0 x 5.0 max.mm (2020/5050)			**PLT5BPH** (-55 to +150°C)						
12.9 x 6.6 x 9.3 max.mm					**PLT10HH** (-55 to +105°C) **PLT10HH** (-55 to +125°C) **PLT10HN_P0** (-55 to +125°C) - leaded type				

Note: In regard to the rated current, derating may be necessary, depending on the operating temperature.

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Noise Suppression/EMI Suppression Filters

EMIFIL

Learn More

Overview

The EMIFIL BNX and NFE series are high-performance EMI suppression filters designed to protect sensitive electronic circuits from conducted and radiated noise. BNX filters deliver low impedance over a broad frequency range for effective noise suppression in power lines. NFE chip-type filters offer compact, surface-mount designs that provide excellent high-frequency attenuation for signal and control lines. Together, they enhance system stability, signal integrity, and overall electromagnetic compatibility.

Features

- Wide-band EMI suppression for power and signal lines
- Low impedance design for efficient noise reduction
- High-current handling capability
- Compact, space-saving form factors for dense PCB layouts
- Low insertion loss to maintain signal quality

	NFE31PT	NFE61PT
Size Code (mm)	3216	6816
Capacitance	22pF to 2200pF	33pF to 4700pF
Rated Current	6A	2A

	BNX00*	BNX01*	BNX02*
Size (mm)	W12 x D11 x H12.5 / H13	W12 x D11 x H8	L12.1 x W9.1 x T3.1 /T3.5
Type	Standard Type	Lower Profile	SMD Type
Rated Voltage	50Vdc to 150 Vdc	25Vdc to 50Vdc	6.3Vdc to 100Vdc
Rated Current	10A to 15A	15A	20A

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Inductors

Power Inductors

Learn More

Overview

We have an extensive lineup of inductors covering a wide range of sizes from 1.6 mm x 0.8 mm to 12 mm square. These power inductors are manufactured using multiple techniques that include metal alloy wire wound construction technique and ferrite multilayer technique.

Structure	Description	Series
Wound Metal Alloy	Metal alloy inductors are also called "metal composite inductors."Supports high current by using metal materials in which magnetic saturation does not occur so easily. This product can be used for a wide range of high current power circuits from smart phones to industrial electronics and automotive device applications.	DFEC/DFES Series
MultilayerType	The features of this product is its small size and low profile. For example, 2012 or smaller footprint and 0.6mm height. This is ideal for low power circuits, including wearable devices and smartphones.	LQM Series
Wound Ferrite Core	A feature of this product is the extensive lineup which supports an inductance of 100 uH or more. It is suitable for step-up power supply circuits in backlights, and choke applications.	LQH Series

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RF Inductors

Overview

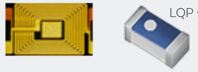
Murata's lineup of inductors for high-frequency circuits features ultra-compact film-type inductors, general-purpose multilayer inductors, and high-Q, high-current supporting wire-wound type inductors, all of which are used in high-frequency circuits.

Wire wound type

Excellent Q characteristics

More than twice the performance of the same size

Film type



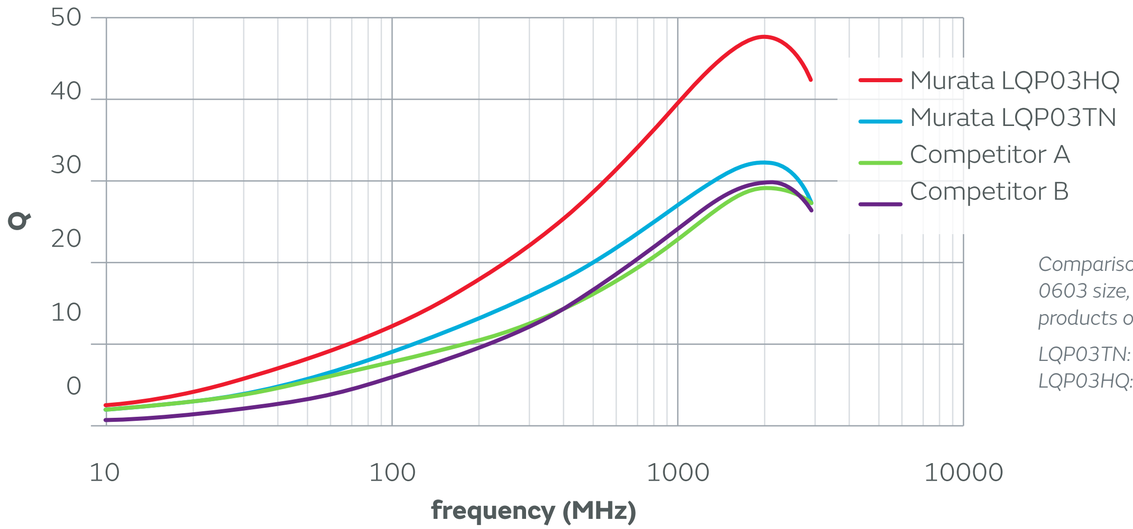
Unique manufacturing method

Manufacturing method commercialized only

Multilayer type

A history of miniaturization

Murata's speciality, the multilayer manufacturing method has commercialized up



Comparison of Q characteristics between 0603 size, Murata products and multilayer products of other companies (both 10 nH)

LQP03TN: multilayer type
LQP03HQ: film type

Find out more

See all Murata RF inductors

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RF Filters

LTCC Filters

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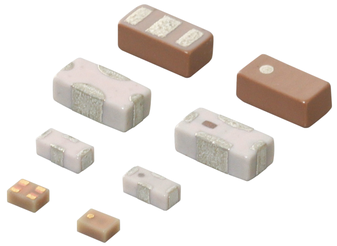
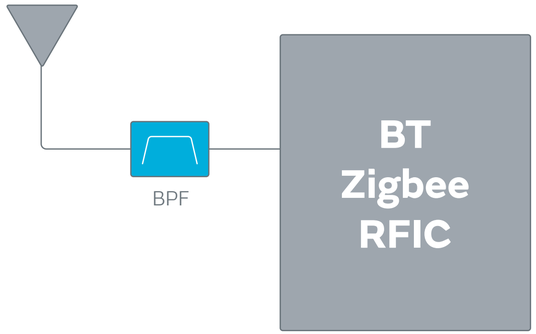


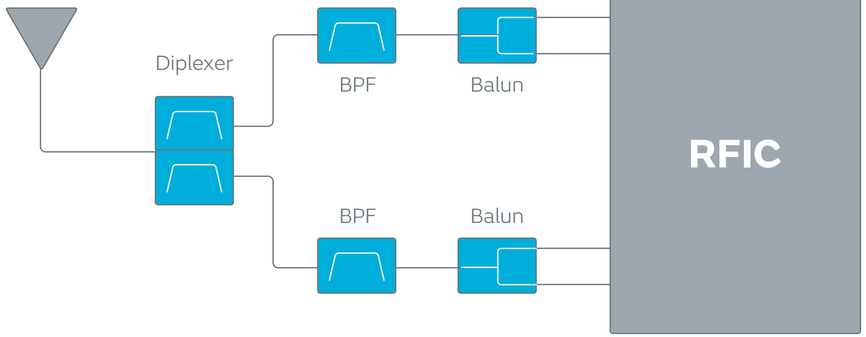
Overview

LC filters are passive components which are used for extracting the specific frequency band or rejecting the noise reduction.

Couplers are RF passive devices used for coupling a specific frequency from an inputted RF signal, used for power level control or transmitters.

LC Diplexers are components with branch circuits for two different frequency bands using one antenna.The frequency is divided into two paths at the receiving circuit, and two paths are combined into one path at the transmitting circuit.





Features

- **Wide range line-up**
  - Baluns/BPFs/couplers/diplexers
- **Smallest size**
  - Integrate several L&C 0605/1005 size
- **Excellent performance**
  - Good insertion loss
  - High attenuation at high frequency

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RFID Tags

UHF and HF Bands

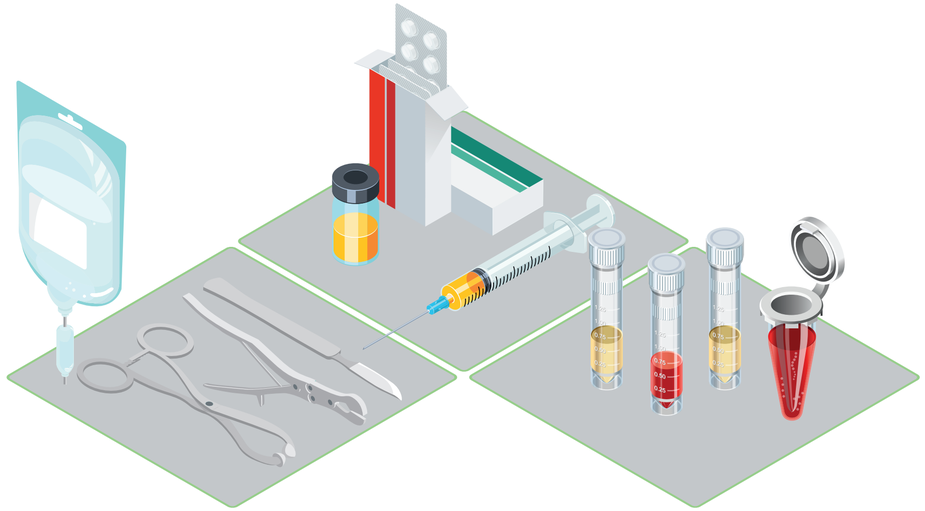
Learn More

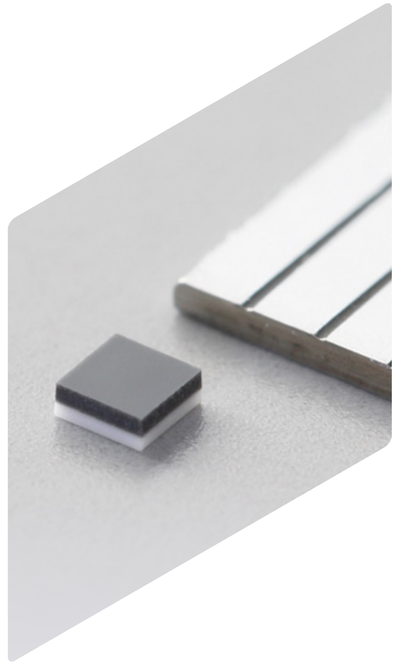
Overview

Murata's RFID & NFC micro tags are providing the next generation of medical products and devices with the intelligence required for item tracking, system automation and enhanced security features.

Features

- Available in UHF & HF technology
- **Ultra small size:**
  - UHF - 1.2 x 1.2mm
  - HF/NFC - 3.2 x 3.2mm
- Fully integrated antenna
- Suitable for injection molding process
- Durable design
- Adheres to global standards





Applications

- Manufacturing traceability
- Brand protection
- Product authentication
- Inventory management
- Surgery tool management
- Medication control system
- Asset management
- Consumable product validation

Smart products
Embedded directly into the product during the molding process

Surgical tool tracking
Patented technology uses metal objects as the antenna for RFID tags

Product authentication
Item identification allows validation of the contents

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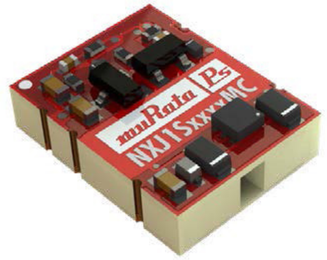
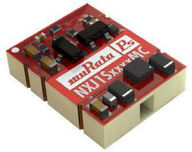
NXE & NXJ Series Isolated DC-DC Converters

Learn More

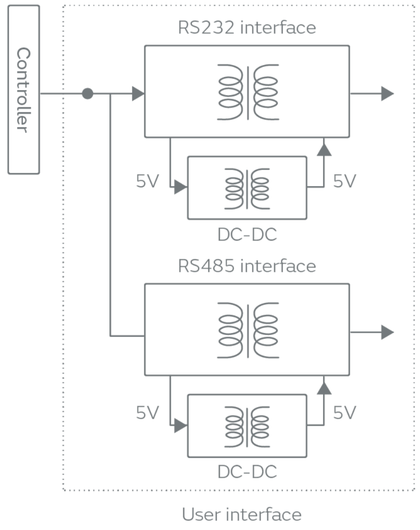
Features

- 1W & 2W versions
- Lowest profile isolated converters
- Highest isolation for footprint size (up to 5.2kVDC)
- Allows peak reflow temperature of 260°C as per J-STD-020
- Operating Temperature -40 up to +110°C
- UL60950 Approval





	NXE1	NXE2	NXJ1	NXJ2
Vin / Vout:	3.3,5 3.3,5	5,12 5,12,15	3.3,5,12 3.3,5,12,15	5,12,24 5,12,15
Wattage:	1W	2W	1W	2W
Isolation test voltage:	3kVDC	3kVDC	4.2kVDC	5.2kVDC
Operating Temp:	-40 up to 110˚C			
Safety:	ANSI/AAMI ES60601-1, UL60950			
	1 MOOP	1 MOOP	1 MOOP	1 MOOP & 2 MOOP



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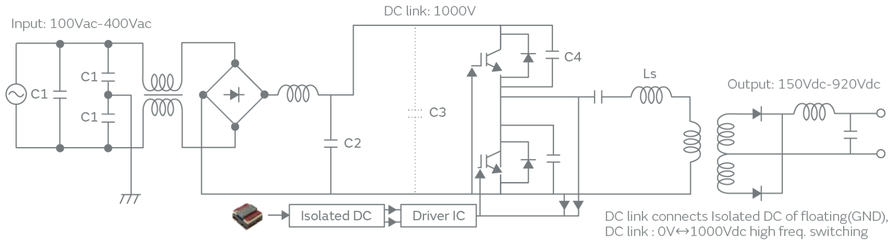
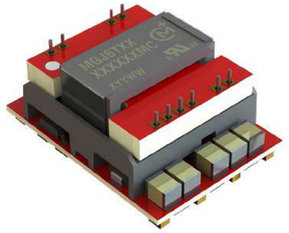
MG* Series (1-6W) Isolated DC-DC Converters for Gate Drive Power

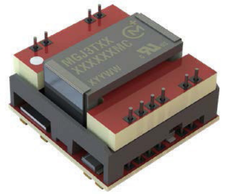
Learn More

Features

- Optimized (bipolar) output voltages for MOS, IGBT, SiC & GaN gate drives
- Ultra low isolation capacitance
- High Continuous barrier withstand voltage
- Characterized partial discharge performance
- High dv/dt immunity







	MGN 1W	MGJ 1-2W	MGJ 3-6W
Isolation capacitance	2.5pF	≤ 4pF	15pF
Continuous barrier withstand voltage	1.1kVDC	3kVDC	3kVDC
Characterised CMTI	>200kV/µs	>200kV/µs	>100kV/µs
Isolation (up to)	3KVAC	5.2KVDC	10.2kVDC
Operating temp.	-40 up to 105˚C	-40 up to 105˚C	-40 up to 105˚C
Insulation	UL62368 Reinforced (pending)	UL60950 Reinforced	UL60950 Reinforced

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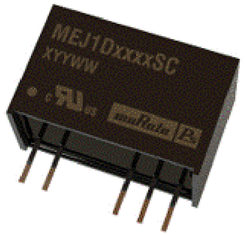
INNOVATOR IN ELECTRONICS

MEJ1 & MEJ2 Series Isolated DC-DC Converters

Learn More

Features

- **Medical-grade isolation:** Basic / supplementary insulation to UL60950 / UL60950-1 and ANSI/AAMI ES60601-1
- **High isolation robustness:** 5.2 kVDC Hi-Pot tested, 2.4 kVDC continuous barrier withstand
- **Excellent noise immunity:** Characterized CMTI > 200 kV/µs for fast-switching motor drives and precision control
- **Low isolation capacitance:** Minimizes common-mode noise in sensitive sensing and feedback paths
- **Flexible power options:** Multiple input/output voltages with single or dual isolated outputs
- **Compact, high-reliability construction:** SIP package, UL 94 V-0, fully encapsulated toroidal magnetics



	MEJ 1W	MEJ 2W
Isolation capacitance	Typical: 3 pF	Typical: 4 pF
Continuous barrier withstand voltage	2.4 kV DC	2.4 kV DC
Characterised CMTI	> 200 kV/µs	> 200 kV/µs
Isolation (up to)	5,200Vdc	5,200Vdc
Operating temp.	-40 up to 85˚C	-40 up to 85˚C
Insulation	UL60950-1, ANSI/AAMI ES60601-1	UL60950-1, ANSI/AAMI ES60601-1

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PQC & PQU Series AC-DC Converters

Learn More

Features

- **Medical-grade isolation:** IEC 60601-1 compliant, 2×MOPP primary-to-secondary
- **High isolation voltage:** ~4 kVAC primary-to-secondary
- **Wide AC input range:** 90–264 VAC, 47–63 Hz, with active PFC
- **Flexible power range:** 250 W → 1000 W, single or multi-output
- True zero-load operation & remote control (enable, power-OK, sense)
- **Robust, reliable design:** high efficiency, continuous duty, fully certified for medical environments

PQC250	PQC600	PQU650	PQU1000
250W convection coded @ 50°C	High density, 600W (fan), 350W (convection) @ 50°C	650W (fan), 450W (convection) @ 50°C	1,000W (fan), 800W (convection) @ 50°C
IEC62368/IEC60601 Certified, Medical 2xMOPP	IEC62368/IEC60601, 2xMOPP	Medical approved IEC60601-1, 2xMOPP certified	IEC62368/IEC60601 Certified, Medical 2xMOPP
Industry leading MTBF 4.5M hrs (fan less)	Applied Part Type B & BF Rated (Isolation & Patient Leakage Current Performance)	Applied Part Type B & BF Rated (Isolation & Patient Leakage Current Performance)	Applied Part Type B & BF Rated

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SCH16T-K01 6DoF Inertial Sensor

Learn More

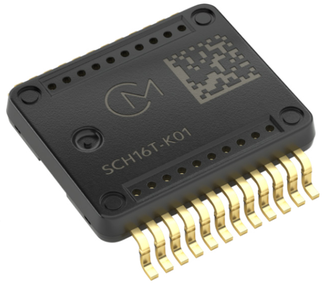
Overview

Combines an XYZ-axis gyroscope with an XYZ-axis accelerometer for precise, reliable machine control and positioning in demanding environments. Built on Murata's proven 3D MEMS process, it offers advanced time-synchronization features for easier system integration.

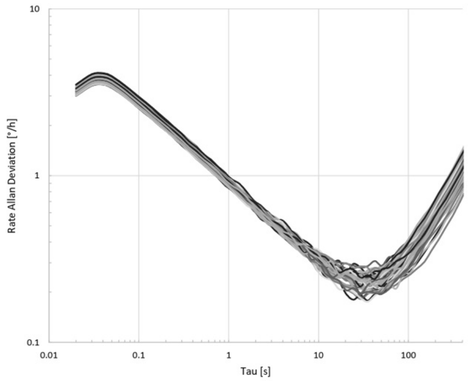
The gyroscope delivers low bias instability, while the accelerometer's wide dynamic range resists saturation and vibration. Cross-axis compensation and stable performance across temperatures minimize calibration needs, enabling accurate measurements across industrial applications such as construction machinery, agricultural equipment, material handling systems, and marine instrumentation.

Features

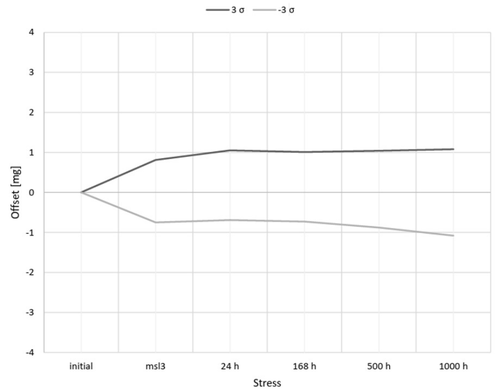
- **±300°/s angular rate measurement range**
- **±8 g acceleration measurement range**
  - -40°C to +110°C operating temperature range
  - RoHS compliant
  - 3.0 V to 3.6 V supply voltage, 1.7 V to 3.6 V I/O supply
  - Gyroscope bias instability down to 0.3°/h
  - Gyroscope noise density level down to 0.4 m°/s/√Hz



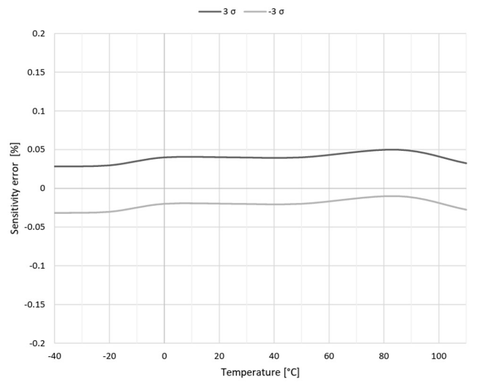
Gyroscope, Allan deviation in °/h



Accelerometer, Offset drift over lifetime in mg



Accelerometer, Sensitivity error over temperature in %



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NCU NTC Thermistors

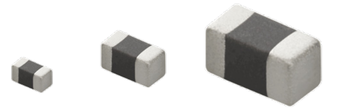
Learn More

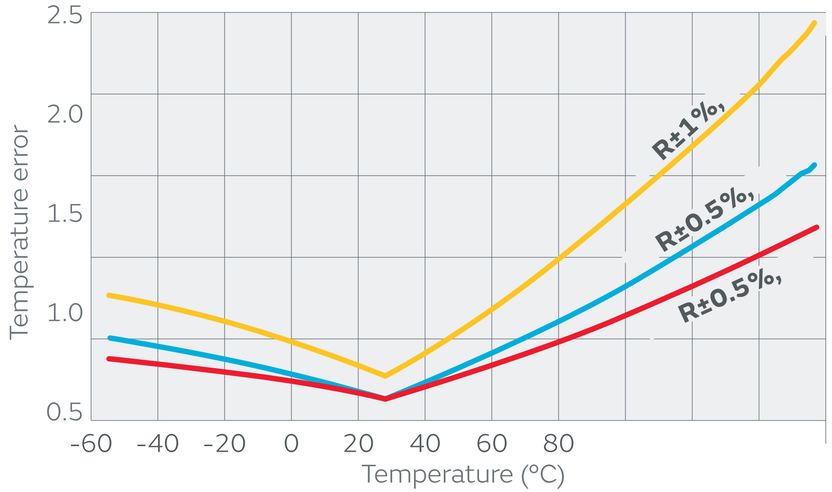
Overview

Compact sensors with excellent thermal response, suitable for temperature sensing and monitoring including temperature compensation for medical applications. Murata thermistors achieve reduced temperature errors (right) through the use of optimized ceramic materials achieving highly accurate temperature sensing for the detection of human body temperature.

Features

- Small size: 1608mm/1005mm/0603mm (Under development)
- Various resistance line up
- Tighter resistance tolerance
- High reliability





Dimensions	Operating temp. range	R25	R tolerance	B-Const(25/50°C)
0.6 x 0.3 mm 0.2 x 0.1 in	-40 to 125°C	10kΩ 100kΩ	1%	3380K 4250K
1.0 x 0.5 mm 0.4 x 0.2 in 1.6 x 0.8 mm 0.6 x 0.3 in	-40 to 150°C	10kΩ 47kΩ 100kΩ etc.	0.5 to 5%	3380K 4050K 4250K etc.

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AMR Magnetic Sensor

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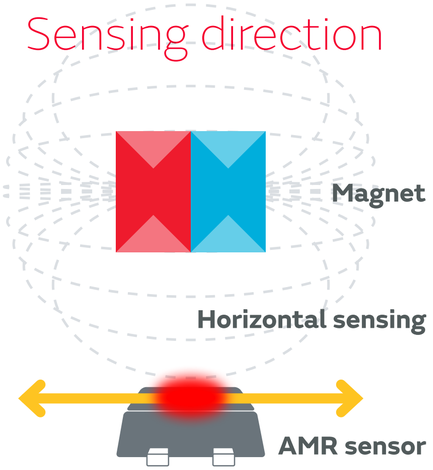
Overview

MRMS534R AMR magnetic sensor offers high-accuracy, non-contact magnetic field detection in a compact and robust design. Engineered for exceptional stability under vibration and temperature variations, it delivers precise position and movement sensing for demanding applications. Its reliable performance and small footprint make it ideal for integration into advanced equipment requiring accurate, consistent operation, including surgical robotics and other precision systems.

Features

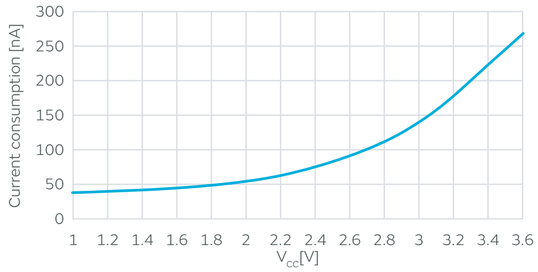
- Ultralow current consumption
  - 50nA typ.@1.5V contributes long product operation with coin-cell battery
- Low voltage operation
  - Applicable for both 1.5V & 3.0V coin-cell batteries
- Smaller package size
  - PCB space saving, and good for smaller product concept
  - 1.45mm x 1.45mm x 0.55mm

Sensing direction

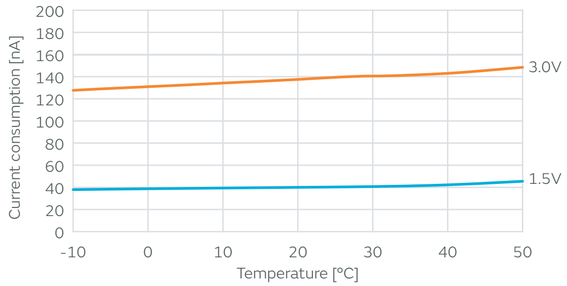


Current consumption

V_{cc} vs Current consumption (typ.)



Temp. vs Current consumption (typ.)



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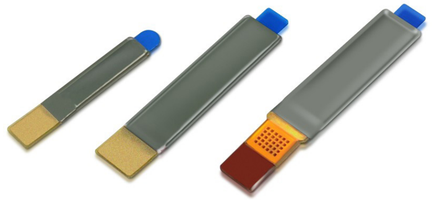
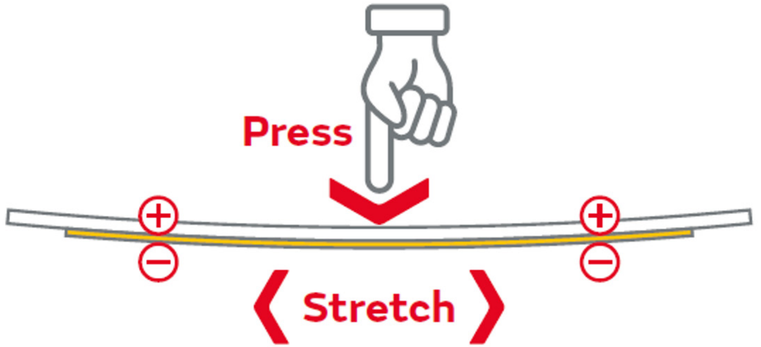
Picoleaf

Learn More 〉



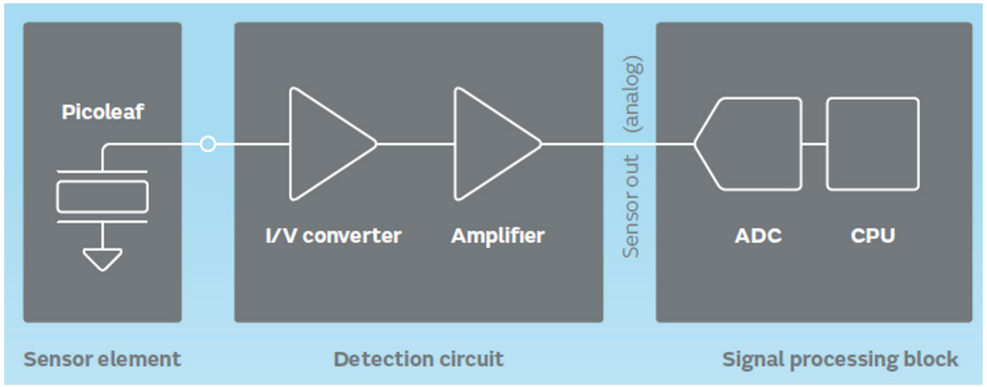


Overview

'Picoleaf' is a thin, flexible sensor which is capable of highly sensitive pressing force detection. It has been developed using Murata's proprietary piezoelectric technology to be smaller and thinner than conventional sensors with the aim of improving the functionality, ease of assembly, and durability of products that require HMI sensing.
To function as a sensor, electrodes are printed or laminated onto a thin and highly flexible organic piezoelectric film. The film can be mounted to a device with double-sided adhesive tape, eliminating the need for an adhesive pasting process.

Features

- Thickness of 0.2mm or less and ultra-compact 2x10mm size
- Flexible structure
- High sensitivity
- Non-pyroelectric
- Low power consumption



Download Datasheet 〉

Picoleaf at Murata.com 〉

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Picoleaf

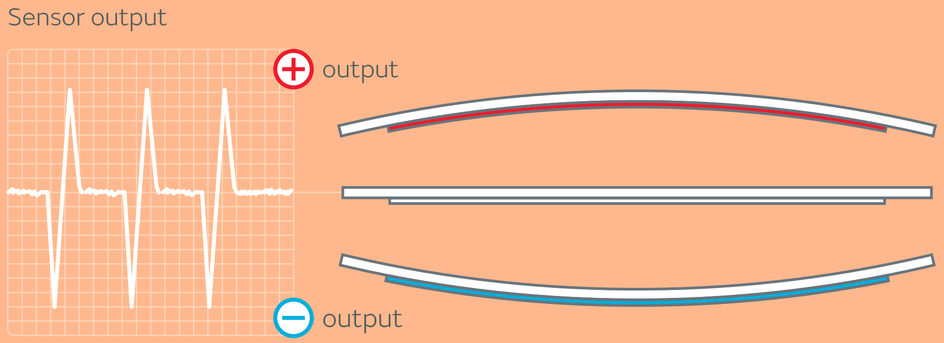
What does Picoleaf detect?
The piezoelectric properties of Picoleaf sensors enable the detection of both 'displacement direction' and 'displacement velocity'.

Displacement direction
The displacement direction is output to the positive side of the Picoleaf reference voltage for 'mountain-fold' deformation and to the negative side for 'valley-fold' deformation.

Displacement velocity
In addition to the displacement direction, displacement velocity can be calculated from the peak voltage, which increases in proportion to theto the displacement velocity.

Switch configuration
The push-and-release actions can be applied as a seamless switch in the UI by using the characteristic that the output of the Picoleaf sensor is reversed.

State detection
If attaching the Picoleaf to something that vibrates periodically, Picoleaf can detect periodic vibration, so it can be applied as a state detection sensor.



Sensing functions achievable with

- **Force detection**
  - Seamless SW
- **State detection**
  - Twisting
  - Liquid flow
  - Deformation
- **Biosignal detection**
  - Pulse
  - Respiration
  - Wear-on
  - Grasping

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Stretchable Printed Circuit (SPC)

SPC Features

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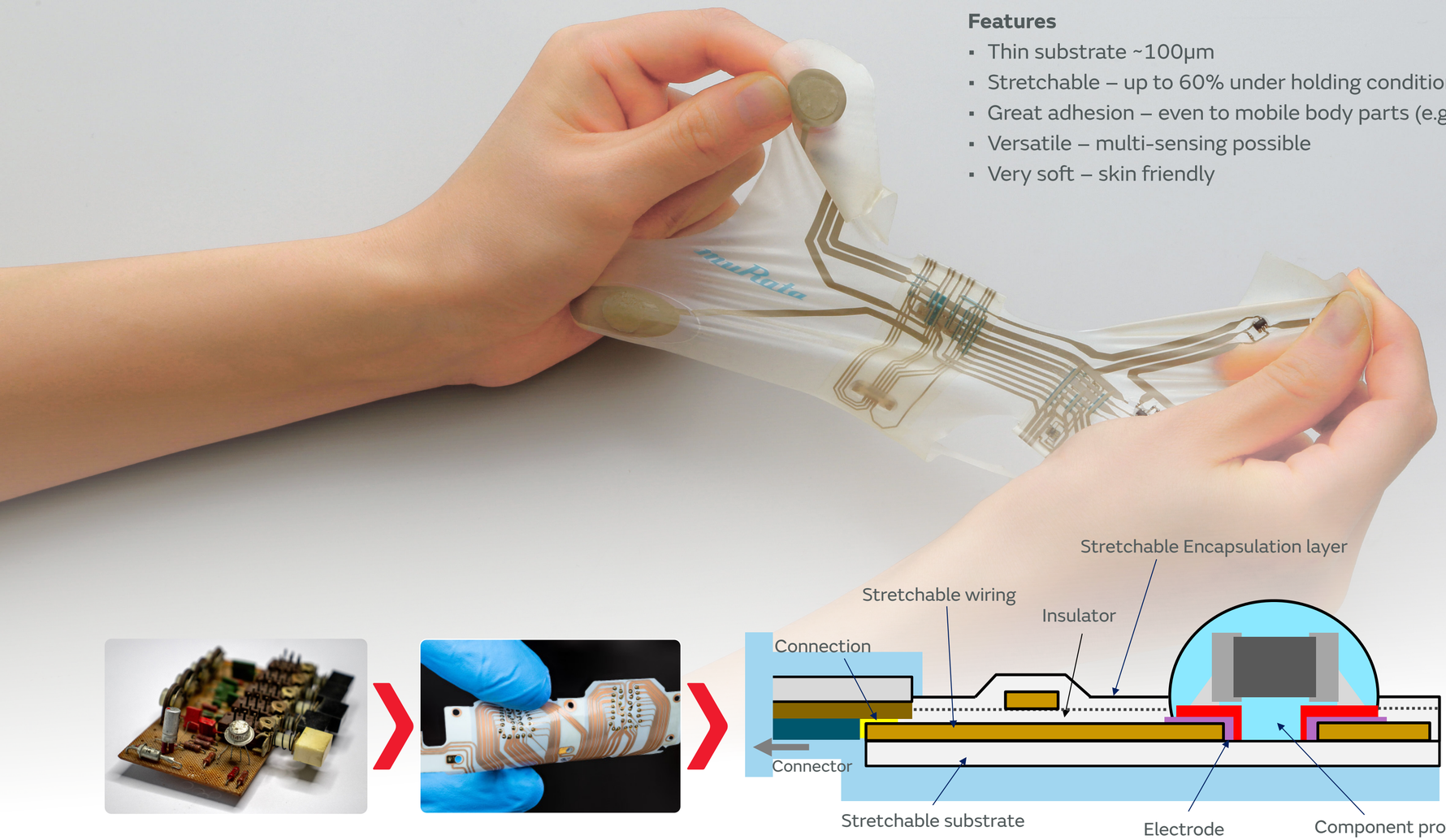
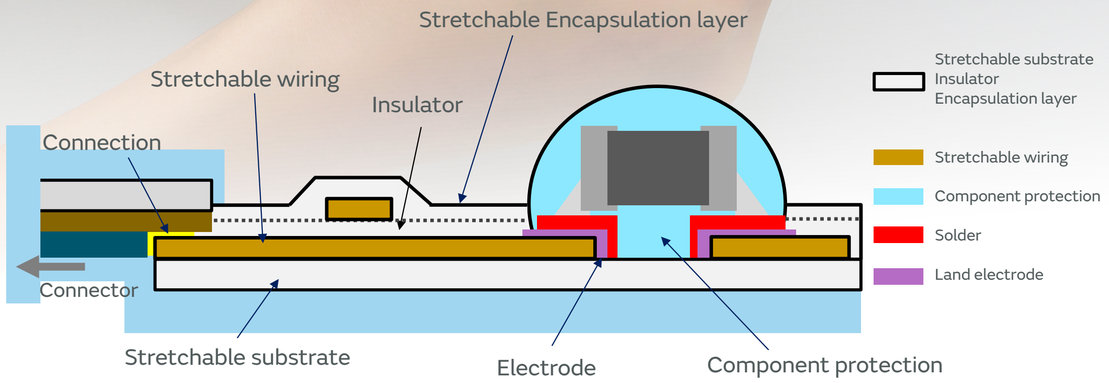


Features

- Thin substrate ~100µm
- Stretchable – up to 60% under holding condition
- Great adhesion – even to mobile body parts (e.g. elbows/knees)
- Versatile – multi-sensing possible
- Very soft – skin friendly



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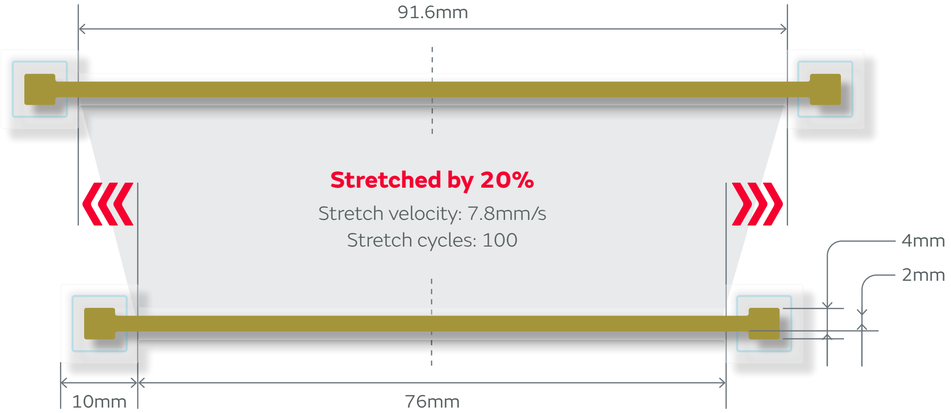
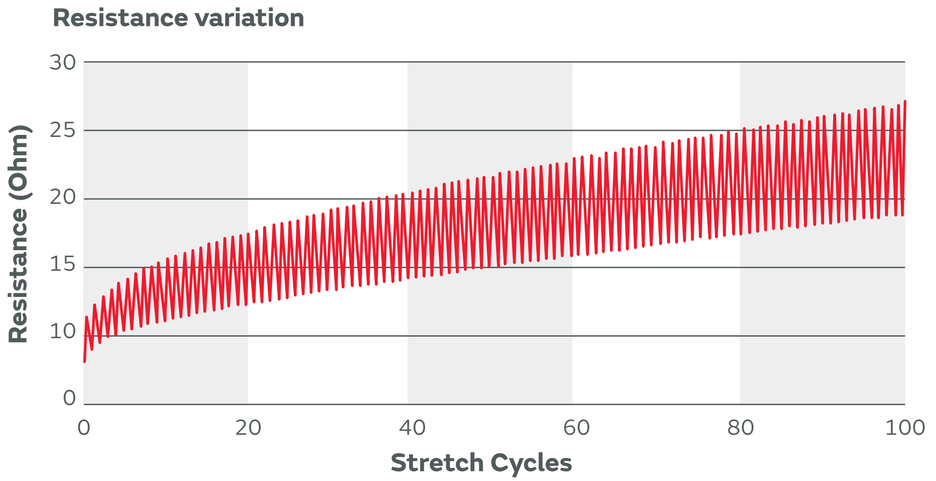
Stretchable Printed Circuit (SPC)

Resistance Variation During Stretching

Resistance variation during stretching

- Printed conductive tracks can be stretched repeatedly without disconnection.
- The figure shows a track's resistance variation during cycling of 20% stretching, in which the resistance increases slightly, depending on stretching times, but it is not disconnected.
- Our simulation technology can predict how track resistance varies and increases, therefore, we can propose the track design and layout based on your requirements.





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Stretchable Printed Circuit (SPC)

Insulation Integrity

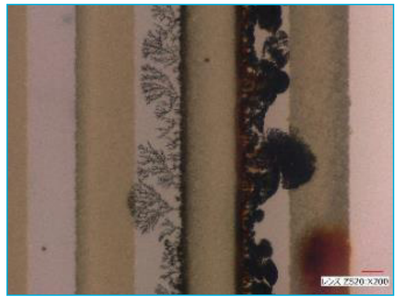
Insulation Integrity

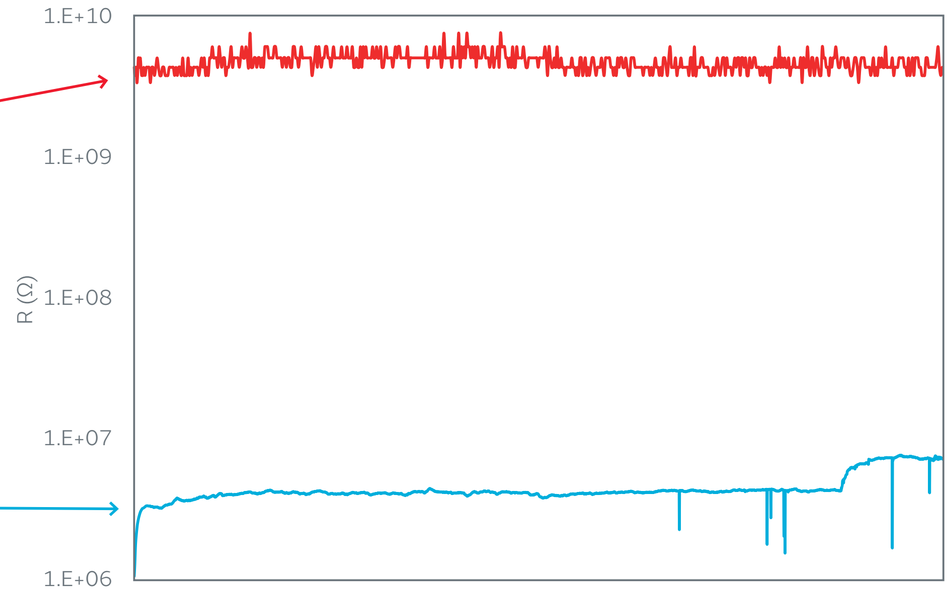
- Murata SPC offers >1GΩ insulation resistance even under high (95%) relative humidity at 40°C.

Ion migration is suppressed

Murata SPC

TPU





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XRCGB Series Crystals

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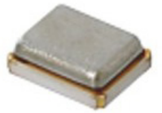
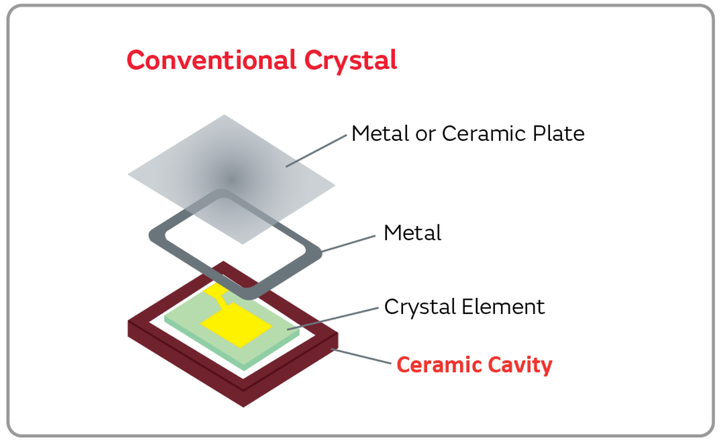


Overview

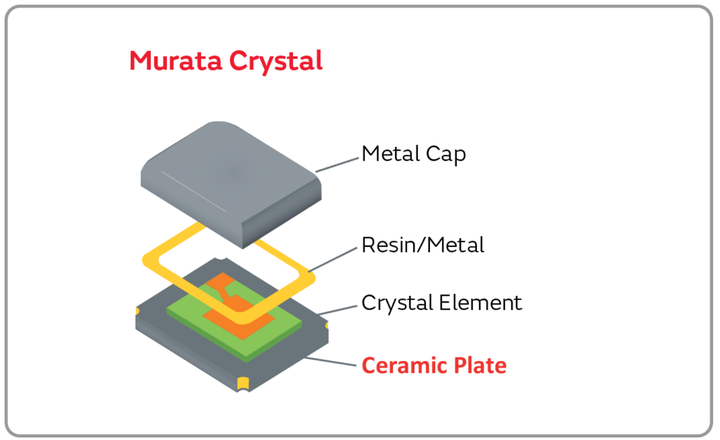
Murata Crystal is made of high-stability piezoelectric quartz crystal, functioning as a mechanical resonator.
Our particle screening process ensures that Murata crystals can achieve the high-quality requirements of medical equipment, making them the best fit for connectivity functions in medical applications.
Crystal can generate clock signals which are essential for Ics and LSIs to operate, achieving high stability, adjustment-free performance and miniaturization.

Features

- Frequency range: 16.000 to 50.000MHz
- Size: 2.0 x 1.6 x 0.7mm
- Resin sealed package
- RoHS compliant



Ceramic cavity plate designs used in conventional Crystal are both complex and expensive



The unique metal cap and planar ceramic plate construction has a proven track record, increases our production output and reduces costs

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⚠ **Note**

1 **Export Control**

For customers outside Japan:

No Murata products should be used or sold, through any channels, for use in the design, development, production, utilization, maintenance or operation of, or otherwise contribution to (1) any weapons (Weapons of Mass Destruction [nuclear, chemical or biological weapons or missiles] or conventional weapons) or (2) goods or systems specially designed or intended for military end-use or utilization by military end-users.

For customers in Japan:

For products which are controlled items subject to the “Foreign Exchange and Foreign Trade Law” of Japan, the export license specified by the law is required for export.

2 Please contact our sales representatives or product engineers before using the products in this catalog for the applications listed below, which require especially high reliability for the prevention of defects which might directly damage a third party’s life, body or property, or when one of our products is intended for use in applications other than those specified in this catalog.

① *Aircraft equipment*
② *Aerospace equipment*
③ *Undersea equipment*
④ *Power plant equipment*
⑤ *Medical equipment*
⑥ *Transportation equipment (vehicles, trains, ships, etc.)*
⑦ *Traffic signal equipment*
⑧ *Disaster prevention / crime prevention equipment*
⑨ *Data-processing equipment*
⑩ *Application of similar complexity and/or reliability requirements to the applications listed above*

3 Product specifications in this catalog are as of March 2020. They are subject to change or our products in it may be discontinued without advance notice. Please check with our sales representatives or product engineers before ordering. If there are any questions, please contact our sales representatives or product engineers.

4 Please read rating and ⚠CAUTION (for storage, operating, rating, soldering, mounting and handling) in this catalog to prevent smoking and/or burning, etc.

5 This catalog has only typical specifications. Therefore, please approve our product specifications or transact the approval sheet for product specifications before ordering.

6 Please note that unless otherwise specified, we shall assume no responsibility whatsoever for any conflict or dispute that may occur in connection with the effect of our and/or a third party’s intellectual property rights and other related rights in consideration of your use of our products and/or information described or contained in our catalogs. In this connection, no representation shall be made to the effect that any third parties are authorized to use the rights mentioned above under licenses without our consent.

7 No ozone depleting substances (ODS) under the Montreal Protocol are used in our manufacturing process.

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