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In-Cabin Radar

Solution for the child protection mandate

muRata
INNOVATOR IN ELECTRONICS

Child Protection

In just a few minutes a car can become warm enough to cause heat-stroke or death - even with the windows cracked. Unfortunately, the trend of unattended children being injured has increased over the last 30 years.

An unattended child is unable to exit the vehicle on their own, and these types of injuries and deaths are entirely preventable.

There is no question that technology improvements have increased driver safety. Advanced Driver Assistance Systems (ADAS) technologies such as adaptive cruise control, autonomous emergency braking, and forward collision warnings have saved lives. These are all examples of outward-bound, out-of-vehicle, radar solutions that are protecting drivers and passengers.

In this ebook we review a new technology that is focused on **in-cabin detection** using radar to prevent injury to children. Our primary focus will be on Child Presence Detection (CPD), which has gained attention through the European New Car Assessment Programme (NCAP) and has incentivized auto manufacturers to incorporate this technology.

Similar legislation is in process in the United States (H. R. 3164, Hot Cars Act of 2021). At this time there are not many specific details, but we anticipate that the US legislation will parallel the European NCAP standard.

<https://www.euroncap.com/en>



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The focus of these new laws is that vehicles must be able to detect the presence of a child trapped in a vehicle. This is for the protection of infants and children up to six years old.

Potentially dangerous situations include:

- Children accidentally left behind in a vehicle
- Children intentionally left behind in a vehicle
- Children three to six years of age that have entered an unlocked vehicle and become trapped inside without the knowledge of the vehicle operator.

The vehicle protection system must take all likely child positions into account, such as seating positions, all seat rows, and optional and removable seats.

A few examples are:

- Rear facing car seat
- Under a blanket
- Sleeping with no movement
- Out of position, such as floorboards. (At this time the vehicle trunk and the bed of pick-up trucks are excluded from this legislation.)

The system needs to be sophisticated enough to detect a sleeping baby under a blanket but not trigger a false positive from inanimate objects such as a soccer ball or lunch box or be distracted by activity around the vehicle such as pedestrians and other moving vehicles.



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60GHz Radar

The new 60GHz radar technology will do this. In addition to this it must be also rugged enough to operate in the automotive environment.

Once a child had been detected there are 3 levels of intervention:

- 1. Initial Warning** - after locking of vehicle, operator is notified within 10 seconds maximum of the door being locked. The alarm must be both visual and audible (e.g. car horn and flashing lights). There are two important clarifications to note:
 - If the system can positively detect the presence of an adult rather than a child – no alarm is needed.
 - If a toddler has gained access to the vehicle and closed the vehicle door, but not locked, a delay of 10 minutes maximum is permissible. If the door is closed and locked it will revert to the 10 second limit.
- 2. Escalation Warning** – if initial warning is ignored, after a maximum of 90 seconds, a more persistent and repetitive warning will repeat every minute for a minimum of 20 minutes.
- 3. Intervention** – if prior warnings have been ignored, there will be a system that mitigates the threat to the child by actively reducing the threat of hyperthermia to the child. Solutions may include:
 - Vehicle to make an automated call to a third party notifying them of the child in a dangerous situation.
 - Allowing access to the child by unlocking the doors.
 - Lowering the temperature of the vehicle by use of vehicle air conditioning.

Additional applications that can benefit from 60GHz radar:

- School bus passenger detection
- Construction equipment
- Autonomous delivery vehicle
- Lawn care robot
- Industrial robots
- Driverless forklifts
- Traffic monitoring / auto & pedestrian
- Healthcare / retail robots
- Floor cleaning
- Elevator occupancy & control
- Safety lighting
- Environment controls
- Parking facilities
- EV charging stations



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Child Presence Detection (CPD) is the first step to help protect any child that is locked in a hot car. Recent technology advances have provided us with a simple, robust solution.

The new standards allow for the detection of a human presence by either indirect or direct sensing. This is an important distinction as Indirect Sensing methods will not be considered as a solution starting in 2025.

Indirect Sensing: Uses a logic algorithm based upon car activity (e.g. door opening or closing), pressure sensors to determine whether there may be a life presence inside the vehicle.

Direct Sensing: Tracks the physical breathing, heartbeat, motion, or other signs of life. Examples would be in-cabin radar or cameras.

Internally mounted cameras are a potential solution, but they have some significant drawbacks:

- Privacy is difficult to control
- Limited field of view (unless multiple cameras are used)
- Limited effectivity in certain lighting conditions
- Potential for false positives due to:
 - Pedestrian traffic
 - Vehicular traffic



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In-Cabin Mounting

A more robust solution is the use of Murata's 60GHz, automotive grade, radar module.

Murata has developed a very small, in-cabin radar module based upon the Texas Instruments AWR6843 chip which uses 60 GHz radar to detect a life presence in a vehicle.

As the baby may be out of position, sleeping, or covered by a blanket, the subtle motion of the infant's breathing must be detected.

Module mounting positions

Locations such as the overhead console near the rear-view mirror, in the headliner, in the B/C pillars and the seats. This provides flexibility to Tier 1s' and car makers in planning their specific application.

Murata in-cabin radar

Part number: LBVA0ZZ1VM Under Development

Size: 27.0 x 25.0 x 2.6mm

Frequency: 60 to 64 GHz FMCW
(Frequency Modulation, Continuous Wave)

Broad operating Temperature: -40 to +85°C

Low Current consumption: 350 mA, 1A max.

Antenna: Built in patch antenna

Interface: UART / CAN

<https://www.ti.com/AWR6843>



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The Murata module uses a high frequency radar in the Gigahertz range, also known as mm wave. The wavelength of a 60 GHz signal is approximately 5mm (very short) in length. This short wavelength has several advantages:

1. Allows for a smaller module as Murata can use smaller electronic components and antennas. However, this does increase the design complexity – but this is one of Murata's strengths.
2. Reduces interference with other systems in the vehicle as the signal does not travel very far.
3. Improves the accuracy of the detection system.

The radar module emits a continuous frequency modulated signal. The module detects the reflected signal back and determines whether there is any motion in the vehicle. This is how the radar will detect the presence of a baby, through the subtle motion of the baby's breathing, and would not be confused by a soccer ball under a blanket.

A CPU in the TI chip does the calculations using data from the 3 transmitters and 4 receivers. This provides the information Life Presence Detection, Passenger Location, and Passenger Classification (Adult vs. Child).

One of the best aspects of mm wave technology is its robustness. The radar module will work in challenging environmental conditions such as extreme temperatures, rain, snow, poor lighting, and dust.

High-frequency 60GHz radar ensures passenger privacy and operates in inclement operating conditions



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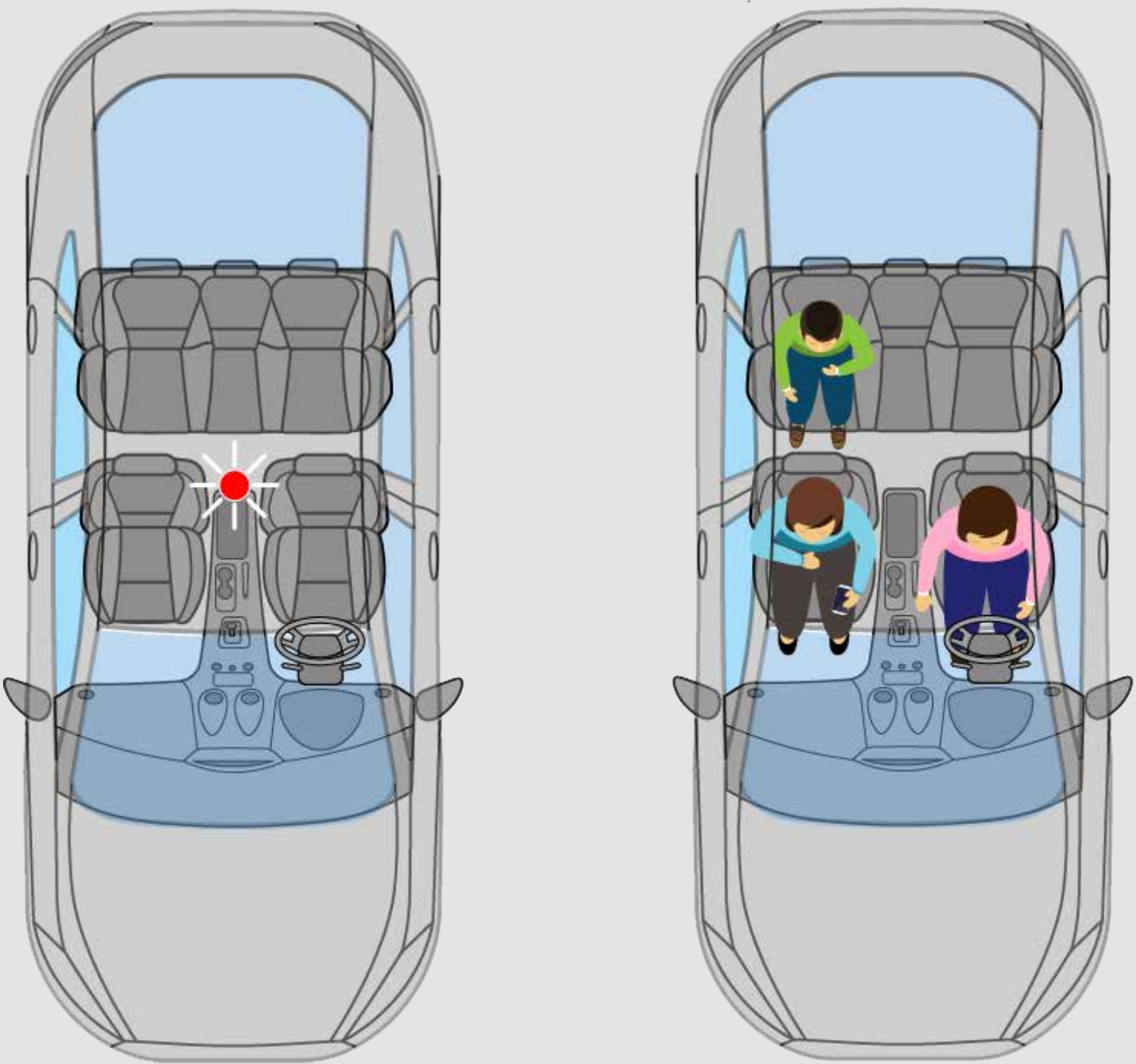
- In addition to Child Presence Detection (CPD), this module also provides:
- 1. Passenger localization to indicate which seats are being occupied.
 - 2. Passenger classification to distinguish between a child and an adult.
 - 3. Intruder detection. Anyone reaching into a vehicle through a window or door will be detected.

The location and classification features are helpful for seat belt reminders as well as control of air bag deployment.

Detection Category	Camera	In-Cabin Radar
Privacy	Poor	Good
Breathing Detection	Fair	Good
Motion Detection	Good	Good
Out of position	Poor (requires multiple cameras)	Good
Under blanket	Poor	Good
Passenger Localization	Good	Good
Passenger Classification	Good	Good
Intruder Detection	Good	Good
Gesture	Good	Good
2 row (5 seat)	Poor	Good
3 row (7 seat)	Poor	Good
Flexibility of sensor position	Poor	Fair

Murata’s modules are based upon TI’s AWR6843 chip.

LPD: Life Presence Detection. This is the primary tool used for Child Presence Detection.



OLC: Occupant Location & Classification. Indicates which seats are occupied and whether by an adult or child. This is important with new legislation that will require intelligence with Seat Belts and Air-Bag deployment.

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Safety Regulations

Module certification support is provided by Murata. North America is formulating legislation for vehicles and refers to the FCC Part 15 Subpart (15.255), which has the same frequency band.

At this time, China has no regulations, but 60GHz may be approved for use in the near future.

<https://docs.fcc.gov/public/attachments/DOC-373482A1.pdf>



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[OBC \(On Board Charger\)](#)

[DC-DC Converter](#)

[Engine ECU](#)

[TCU \(Telematics Control Unit\)](#)

[IVI \(In Vehicle Infotainment\)](#)

[ADAS \(Advanced Driver Assist System\)](#)

[IPA \(Intelligent parking assist\)](#)

[Lidar](#)

[Radar](#)

[Front Camera](#)

[V2X Solutions](#)

[LF Antennas](#)

High Reliability Products

[AEC-Q 200 Compliant Chip Multilayer Ceramic Capacitors](#)

[Chip Multilayer Ceramic Capacitors for Automotive](#)

[High Q Chip Multilayer Ceramic Capacitors for Automotive](#)

[Soft Termination Chip Multilayer Ceramic Capacitors for Automotive](#)

[Polymer Aluminum Electrolytic Capacitors](#)

Chip Ferrite Beads: [BLM](#) , [NFZ](#)

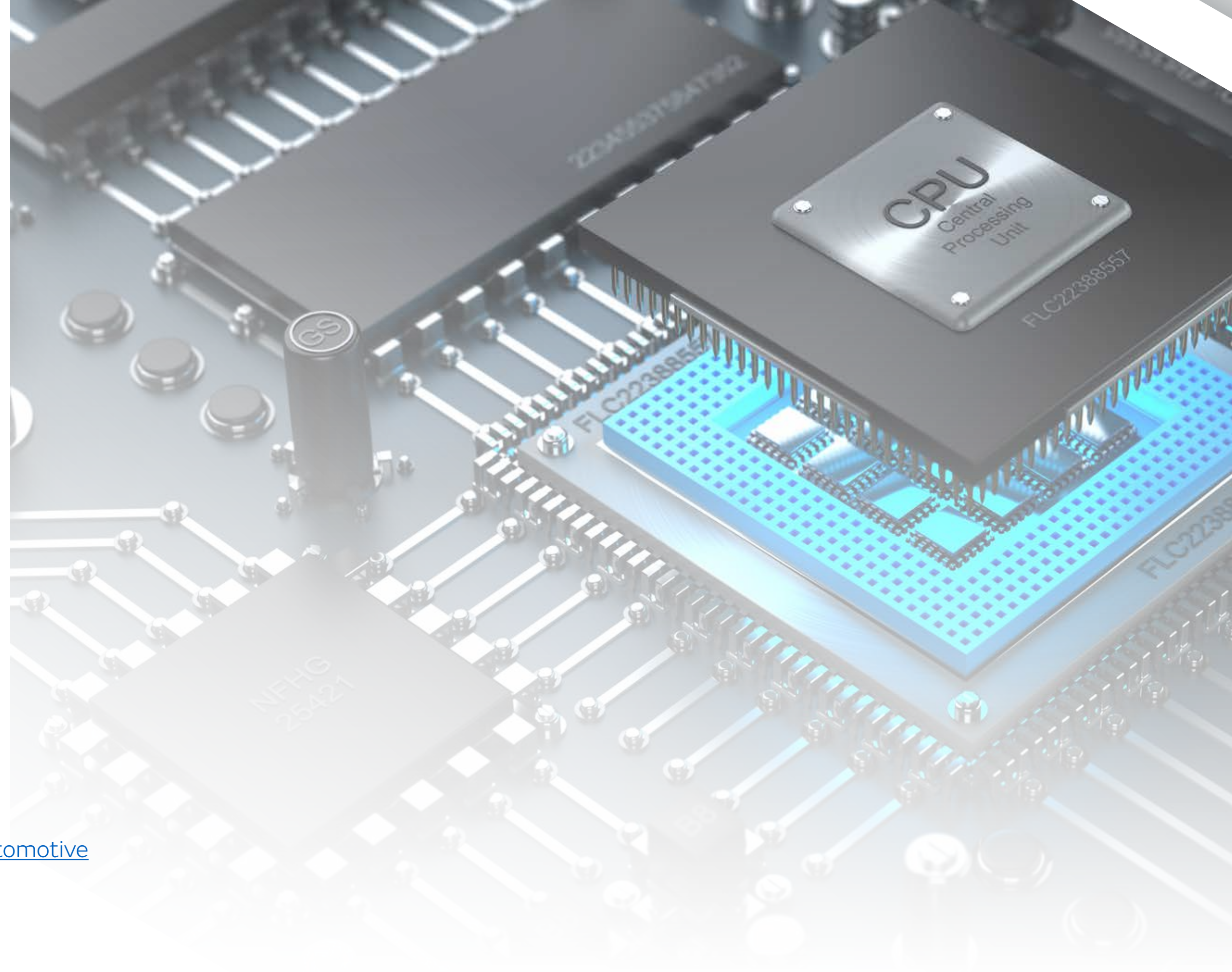
Chip Inductors (Chip Coils) [LQM/LQH/DFE](#) [LQW](#)

[Accelerometers](#) [Inclinometers](#) [Gyro Sensors](#)

[SCHA63T 6-DOF](#) IMU for harsh environment with centimeter-level accuracy

[Solutions for EV Chargers](#)

- AC/DC converters
- Non isolated DC/DC
- Isolated DC for RS485
- Isolated DC for gate driver
- Wireless connectivity
- Micro battery
- Isolated DC for RS485
- Current sensors
- High power high frequency transformer for DC/DC converter
- UWB modules



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With Murata's unique position of supporting all levels of the electronics industry, we can assist you with your designs for both in-vehicle and out of vehicle applications. Our product portfolio includes industrial and automotive grade, multi-layered chip capacitors (MLCCs), inductors, thermistors, Wi-Fi/BT® modules, MEMS, IMU, 5G cellular modules, and power conversion (AC-DC and DC-DC) solutions.

Power Supplies	
AC-DC Open Frame and Enclosed	
Board Mount AC-ADC	
Isolated DC-DC	Non-Isolated DC-DC
POE	Digital Meters

Batteries
Coin Cell
Medical Coin Cell
Cylindrical Type Lithium **
Laminated Type Lithium **

Point of Loads
600mA Boost Converters, MYRBPxx0080 Series
150mA - MYRLP-F
Buck, 2.0A
Buck, 2.5A to 6A
Buck, 4A, 6A, 8A, 12A, 20A, 30A, 40A
24A with PMBus

Capacitors
MLCC
Polymer Aluminum Electrolytic Capacitor
Silicon Capacitor

Inductors
RF Inductors
Inductors for Power Lines
General Circuit Inductors
Inductors for NFC
Variables Inductors
Power Inductors

Microblower Air Pump

RFID

Sound Component

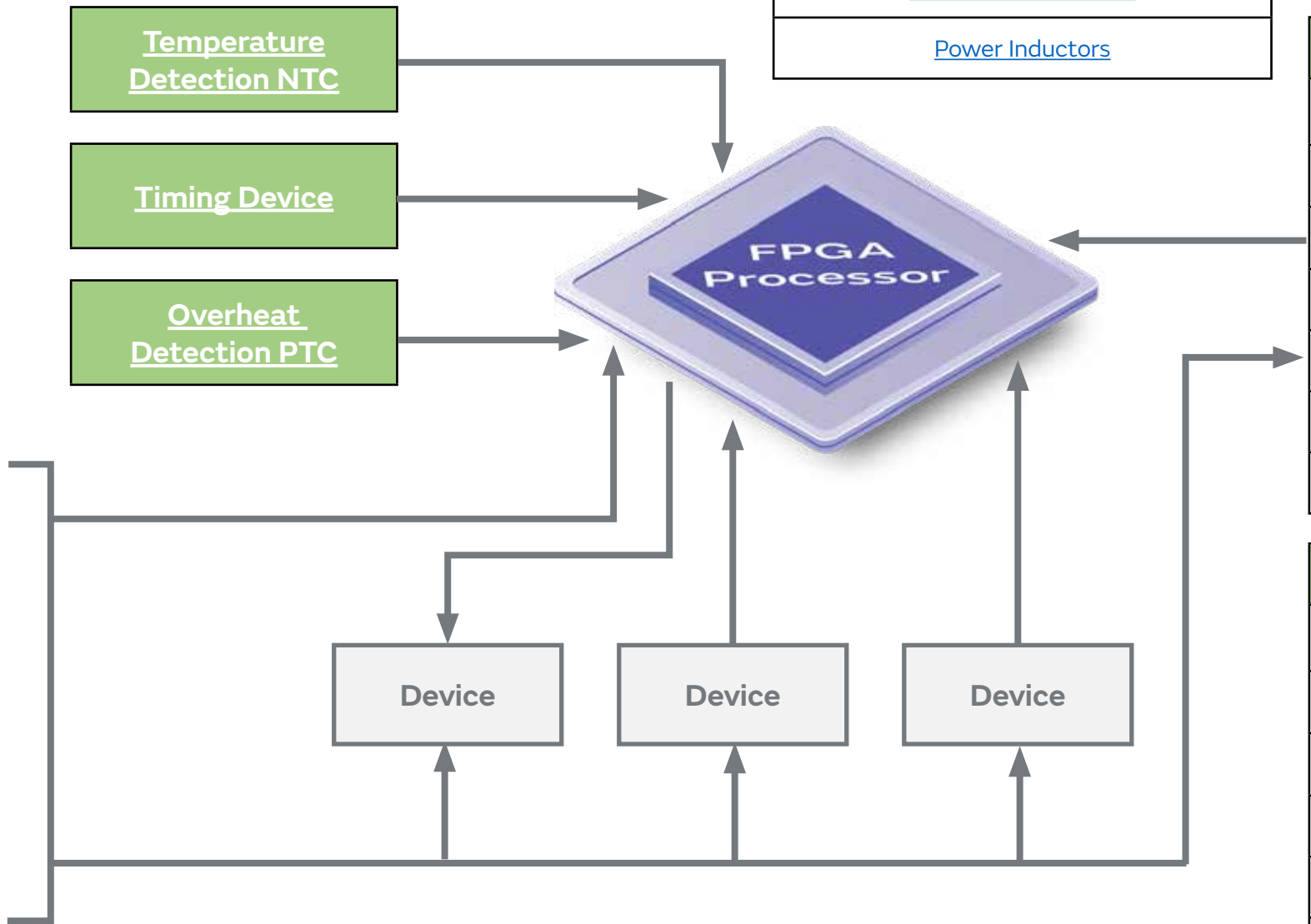
RF Components

Connectivity Modules
BLE
Wi-Fi + BLE Modules
Wi-Fi Modules
Cellular IoT
V2X
LoRa
UWB

Sensors
PIR
Accelerometers
Gyroscope
Magnetic-AMR
Magnetic-TMR
Thermistors
CO2
Pressure

Common Mode Chokes for Signal Lines
USB, MIPI D-PHY, MIPI-C PHY, HDMI, Display Port

Common Mode Chokes for Power Lines



KEY:
■ = Automotive
■ = Industrial

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