Infineon’s comprehensive solutions for Commercial Heating, Ventilation and Air Conditioning (C-HVAC)

August 2023
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   - Inverter and PFC
     - Discrete solutions
     - Gate driver solutions
     - Power modules
     - Auxiliary power
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   - Wide Bandgap
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Commercial HVAC systems, serving power ranges from 5 kW to several megawatts, can keep temperatures comfortable, the humidity consistent, and the indoor air quality high.

Infineon offers the optimal products for your C-HVAC, specially designed for larger commercial and industrial buildings such as hospitals, hotels, factories, or multi-level offices.
## Different commercial HVAC system types in a nutshell

### Rooftop units
- These self-contained HVAC systems offer heating and cooling
- Located on roofs, also known as packaged systems
- Refrigerant to provide heating and cooling to multiple zones within a building
- Consist of an outdoor unit with multiple compressors and indoor units that can be individually controlled

### Split systems
- Outdoor unit contains the condenser and compressor
- Indoor unit houses the evaporator coil and blower
- These systems use chilled water to cool
- The water is typically distributed from a central chiller plant to air handling units or fan coil units located throughout the building

### Variable Refrigerant Flow (VRF) systems
- Ease of installation and maintenance
- Versatile
- Small to mid-sized commercial spaces
- Space-saving design
- Individual temperature control
- Flexibility
- Efficiency

### Chilled water systems
- Efficiency
Key market trends and drivers

Smart HVAC / Sensor function
- Intelligent monitoring of C-HVAC systems for predictive maintenance for system operators (e.g.: monitoring of room temperature, health data, etc.) and for end customers (e.g.: changing room temperature), CO₂ and radar sensing.

Urbanization and global warming
- Urbanization is still in an early stage in developing countries with a lot of potential for new buildings with demand for air conditioning and ventilation. The HVAC industry is focusing more and more on sustainable technology to make its contribution to the environment, which includes e.g.: the use of solar panels and geothermal heating and cooling to reduce energy costs.

Stringent environmental legislation and fundings
- Strive toward green and other energy efficiency goals that reduce carbon footprints and achieve corporate sustainability goals.
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System block diagram – Outdoor unit
System block diagram – Indoor unit
Infineon’s comprehensive product range for C-HVAC applications

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<td>- AIROC™ Wi-Fi® &amp; combos</td>
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<td>- Intelligent power modules (IPM)</td>
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<td>- Gate driver ICs for IGBTs</td>
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Power stage and Power Factor Correction (PFC) – Discrete or integrated

Integration

High

Space optimized: IPM
Integrated in motor housing

Space optimized: IPM
Higher power rated motors

No heatsink

Heatsink

Low

Thermal optimized: IGBT / MOS
Larger PCB space to extend power w/o heatsink

Assembly optimized: IGBT / Module
Easy heatsink mounting + isolation

Motor power

10 W  100 W  300 W  1 kW  3 kW

Heatsink
**Power stage – Discrete IGBT/ MOS and silicon diode solutions**

**Compressor**

- **TRENCHSTOP™**
  - Good low frequency performance
  - Low \(V_{\text{CE(sat)}}\) and low switching losses
  - SC rating up to 5\(\mu\)S
  - Widest variety of packages including SMD and THT
  - Portfolio: 4 A-120 A, D²PAK, TO-220, TO-220FP

- **IGBT7 T7**
  - Best low-medium frequency IGBT
  - Benchmark low \(V_{\text{CE(sat)}}\) and low \(V_F\) IGBT
  - Enhanced controllability for better EMI
  - Portfolio: 20 A-75 A, TO-247-3 pin

- **RC-D series**
  - Cost optimized monolithically integrated diode in surface mount packages
  - SC rating up to 3\(\mu\)s (RC-D2) and up to 5\(\mu\)s (RC-D(F))
  - For low to medium frequency converters
  - Portfolio: 3 A-15 A DPAK, 1 A-6 A in SOT-223

**Indoor fan / Outdoor fan**

- **600 V TRENCHSTOP™**
- **650 V TRENCHSTOP™ IGBT T7**
- **600 V RC-D series**

- **600 V CoolMOS™ PFD7**

- **RC-D series**
  - Cost optimized monolithically integrated diode in surface mount packages
  - SC rating up to 3\(\mu\)s (RC-D2) and up to 5\(\mu\)s (RC-D(F))
  - For low to medium frequency converters
  - Portfolio: 3 A-15 A DPAK, 1 A-6 A in SOT-223

- **Integrated fast body diode with ultra low Qrr**
  - Integrated Zener diode for ESD protection (HBM Class 2)
  - Portfolio with wide range of \(RDS(\text{on})\) values ≤ 2 Ohm
  - Supporting cost effective designs with SMD solutions like SOT-223
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# EiceDRIVER™ gate drivers for commercial HVAC applications

## Inverter: 1200 V level-shift drivers
- **Key products**
  - 6ED2230/1S12T
  - 2ED132x family
- **Differentiation**
  - 1200V Level-shift based isolation
  - 30 years of product leadership from IRF portfolio (first HVIC driver in 1989)
  - State-of-the-art Infineon SOI technology for superior operational ruggedness and integrated boot strap diode

## Inverter: Isolated gate drivers
- **Key products**
  - EiceDRIVER™ Compact
    - 1ED3141MU12F
    - 1EDI20112F
    - EiceDRIVER™ Enhanced
      - 1ED3321MC12N
      - EiceDRIVER™ Power
      - 2EPxxx
- **Differentiation**
  - CT-based isolation technology
    - Higher CMTI (300 V/ns)
    - Best-in-class part-to-part matching and prop delay
    - High current with protection
    - Robust against negative VS

## Brake chopper, buffer, or boost PFC: Low-side drivers
- **Key products**
  - 6ED223x:
    - Small footprint
    - Low BOM cost
  - 2ED132x:
    - Easier thermal management
    - Active miller clamp option
- **Differentiation**
  - Comprehensive families of single and dual channel low-side drivers
  - New feature-rich families with accurate (+/-5%), fast, over-current protection for PFC in home appliances

## Inverter: 600 V level shift drivers
- **Key products**
  - 2EDL231x06PJ
  - 2EDL218x4 family
- **Differentiation**
  - 600 V Level-shift based isolation
  - 30 years of product leadership from IRF portfolio (first HVIC driver in 1989)
  - State-of-the-art Infineon SOI technology for superior operational ruggedness, higher frequency switching and integrated boot strap diode

## Totem pole PFC: 600 V level shift drivers
- **Differentiation**
  - Infineon SOI with best-in-class integrated boot strap diode, high negative Vs robustness
  - Integrated over current and protection features
1200 V gate driver solutions

2.2 KW EASY 1B
5 KW EASY 2B
7.5 KW EASY 3B
12 KW

6ED223x Family

1200 V 6-in-1 SOI gate driver in DSO-24

- Infineon Thin-Film-SOI technology
- Negative voltage -100 V guaranteed
- Embedded 3 Bootstrap Diode
- Output current +0.35 A / -0.65 A
- 6-in-1 driver solution for motor application
- Full protection function
  - OCP (Over current protection)
  - FO (Fault Out)
  - UVLO (Under voltage Lock Out)
  - Shoot through protection (460 ns)
- 2 different UVLO version
  - 6ED2230S 10.4 V (HS), 11.4 V (LS) for IGBT
  - 6ED2231S 12.2 V (HS/LS) for SiC

2ED132x Family

1200 V Half-bridge gate driver with active miller clamp

- Infineon Thin-Film-SOI technology
- Negative voltage -100V guaranteed
- Embedded 1 Bootstrap Diode
- Output current +2.3 A / -2.3 A (4.6 A)
- Full protection function
  - Active Miller Clamp (AMC) w/ 2.3 A sink current
  - Short Circuit Clamp (SCC)
  - OCP (Over current protection)
  - FO (Fault Out)
  - UVLO (Under voltage Lock Out)
  - Shoot through protection
- 2 different UVLO version
  - 2ED1321/1322 : DSO-16(300mil) w/o AMC
  - 2ED1323/1324 : DSO-20(300mil) w/ AMC
Every switch needs a driver, the right driver makes a difference
EiceDRIVER™ isolated gate driver portfolio

Rich feature-set for advanced protection:
- X3 Digital (1ED38xx): I2C configurable enabling predictive maintenance
- X3 Analog (1ED34xx): Best-in-class DESAT accuracy, Analog Configurability
- F3 (1ED332x): Cost effective solution with DESAT

Reduced feature-set and easy to design-in:
- 2L-SRC Compact (1ED32xx): EMI & switching loss optimization
- X3 Compact (1ED31xx): easy to design & cost effective

New products with reinforced isolation (UL 1577 and VDE-11)

www.infineon.com/gdenhanced

www.infineon.com/gdcompact
EiceDRIVER™ X3 Compact (1ED31xx) family
5.7 kV isolated driver with active miller clamp or separate output

Product highlights

- Single channel isolated gate driver with 6.5 / 10 / 14 A
- Galvanic functional isolation voltages up to 2300 V
- 45 ns propagation delay with 15 ns input filter, 7 ns propagation delay matching
- Active Miller Clamp or Separate outputs
- Exceptional CMTI robustness > 300 kV/µs
- 40 V absolute maximum output supply voltage
- Isolation capabilities & certification
  - 1ED31xxMU12F: UL 1577 certified $V_{ISO}=3$ kV(rms)
  - 1ED31xxMU12H: UL 1577 certified $V_{ISO}=5.7$ kV(rms)
  - 1ED31xxMC12H: UL 1577 & VDE 0884-11 certified $V_{IORM}=1767$ V
- DSO-8 150 mil (4 mm creepage) & 300 mil package (8 mm creepage)
- Evaluation board available:
  - EVAL-1ED3121MX12H; EVAL-1ED3122MX12H; EVAL-1ED3124MX12H
  - EVAL-1ED3142MU12F-SIC; REF-22K-GPD-INV-EASY3B

www.Infineon.com/gdcompact

Sample schematic

Value proposition

- Cost effective 8-pin gate driver, easy to design-in
- 14 A output current, no booster required
- Accurate prop delay matching, enable high switching frequency
- 40 V output supply voltage, bipolar supply with high margin
- Optimized specifications for driving IGBT7 and CoolSiC™, Miller clamp against parasitic turn-on
- Fulfilling highest isolation standards: UL 1577 and VDE-11

Typical Applications

- Lighting
- SMPS
- UPS
- EV charging
- Solar
- Drives
- Aircon

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Infineon Proprietary
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# EasyPACK™ IGBT power modules

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<th>Key features</th>
<th>Benefits</th>
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<tbody>
<tr>
<td><strong>Performance</strong></td>
<td>EasyPACK™ IGBT modules enable the evolutionary IGBT chip performance with the most advanced packaging technology</td>
</tr>
<tr>
<td><strong>Reliability</strong></td>
<td>Quality and reliability is one of the core values of IGBT modules, with the experience and commitment for decades</td>
</tr>
<tr>
<td><strong>Customization</strong></td>
<td>EasyPACK™ modules support flexible pin grid configurations</td>
</tr>
<tr>
<td><strong>Easy to use</strong></td>
<td>Fully integration of power devices that simplifies the system design</td>
</tr>
<tr>
<td><strong>Scalability</strong></td>
<td>EasyPACK™ family offers packages of Easy1B, Easy2B and Easy3B with the same mechanical height</td>
</tr>
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</table>
# EconoPIM™ IGBT power modules

<table>
<thead>
<tr>
<th>Key features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Equipped with in house state of the art IGBT technology</td>
</tr>
<tr>
<td></td>
<td>First to be equipped with Industrial leading IGBT technology</td>
</tr>
<tr>
<td>Reliability</td>
<td>Well established package with high volume production</td>
</tr>
<tr>
<td></td>
<td>High volume production with &gt;20 years proven package technology</td>
</tr>
<tr>
<td>Performance</td>
<td>Humidity robustness suited for outdoor compressor</td>
</tr>
<tr>
<td></td>
<td>Robustness against harsh environment</td>
</tr>
<tr>
<td>Easy to use</td>
<td>Ready for Thermal Interface Material (TIM)</td>
</tr>
<tr>
<td></td>
<td>Pre applied Thermal Interface Material ensure long term stability</td>
</tr>
<tr>
<td>Scalability</td>
<td>Current range of 25 A to 100 A in EconoPIM™ 2 and 75 A to 200 A in EconoPIM™ 3</td>
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<td>Scalability enables platform design with minimal board re-design</td>
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Auxiliary power – 5th generation CoolSET™

**Robustness**
- Integrated 700 V, 800 V or 950 V superjunction MOSFET
- Comprehensive protection features
- Auto-restart scheme to minimize interruption

**Ease of design**
- Numerous design examples covering both indoor and outdoor aircon
- Design tools, guide and application note
- Reference designs

**Broad portfolio**
- Choice of fixed-frequency or quasi-resonant switching scheme
- Isolated flyback or non-isolated buck topology
- Highest power delivery up to 43 W
- Available in DIP-7 or SMD DSO-12 package

Auxiliary SMPS in Flyback or buck topology to perform AC/DC power conversion to power the various system blocks in home appliances.
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Infineon offers various motor control solutions to choose from

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<th>Gate driver</th>
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<td>iMOTION™ controller</td>
<td></td>
<td></td>
<td>IGBT</td>
</tr>
<tr>
<td>Customer's own S/W</td>
<td>XMC™</td>
<td></td>
<td>HV FET</td>
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<tr>
<td></td>
<td>PSoC™</td>
<td>EiceDRIVER™</td>
<td>LV/MV FET</td>
</tr>
<tr>
<td>iMOTION™ controller</td>
<td></td>
<td>CIPOS™ IPM (thermal sensor inside)</td>
<td>IGBT</td>
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<td>XMC™</td>
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<td>HV FET</td>
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<td>LV/MV FET</td>
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<tr>
<td>iMOTION™ driver</td>
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<td></td>
<td>IGBT</td>
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<td>iMOTION™ IPM (thermal sensor inside)</td>
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Considerations to select a solution

- The value proposition of each offering
  e.g., SMD package up to 300 W without heatsink, better EMI performance of IGBT, better light road efficiency of MOSFET

- Technical requirements of each application
  e.g., 30 A IPM is required for a BLDC blender because peak current is higher than in normal motor applications

- IFX recommended offerings based on customer’s preference and system specifications
  e.g., switching frequency, power rating, PCB space constraint, assembly process, heatsink-less, multi-source, efficiency, EMI performance, price, high or low voltage motors, internal thermal sensor, control algorithm

- Evaluation or simulation results per each application
  e.g., loss simulation
Motor Control: iMOTION™ or microcontroller?

Do you want to write your own motor control code?

Yes

Microcontroller

Controller

Write your own software with support of advanced tools for BLDC, Brushed DC, PMSM and Sensorless FOC

PSOC™ 4/6
XMC™

No

iMOTION™

Ready-to-use motor control or integrated on hardware level

iMOTION™ Controller

Motion Control Engine

Microcontroller

IMC100
IMC300

iMOTION™ Driver

Motion Control Engine

Gate driver

Integrated gate driver for MOSFET or IGBT power stage

IMD110

iMOTION™ IPM

Motion Control Engine

Gate driver

Power stage

Fully integrated inverter solution

IMM100
IMI110

Do you want to write your own motor control code?

Yes

No
## Microcontroller portfolio overview

### Selected product families

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<th>System control, HMI and connectivity</th>
<th>PSoc™ 6</th>
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<tbody>
<tr>
<td></td>
<td>• Highly integrated HMI solution with capacitive touch sensing and TFT display</td>
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<tr>
<td></td>
<td>• PSoc™ 6 + Wi-Fi® &amp; BT Combo: Providing the total solution of IoT connectivity &amp; security (Cloud service, Mesh Gateway)</td>
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<tr>
<td>• HMI + system control (2-in-1 solution): Reliable &amp; stable capacitive touch sensing, large pin pitch package, wide voltage range</td>
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<th>PSoc™ series</th>
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<td></td>
<td>• Integrated with OPA/CMP, TCPWM, reduce BOM cost</td>
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<td>• Supported by mature, validated and reliable motor control algorithm and total solution for home appliances, short time to market</td>
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<td>• Versatile real-time motor and power stage control peripherals</td>
</tr>
<tr>
<td>• Scalable to various control schemes from single motor up to dual motor and PFC control</td>
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<td>• 5 V supported by XMC1000 series</td>
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<th>Ready-to-use, highly integrated motor control</th>
<th>iMOTION™</th>
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<td>• Integrates all the control and analog interface functions required for sensor-less or hall-based FOC</td>
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<td>• Eliminates software coding from the motor control algorithm development process</td>
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Infineon microcontrollers for commercial HVAC

<table>
<thead>
<tr>
<th>Applications</th>
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<tr>
<td></td>
<td>Solution Ready MCU</td>
<td>SW/HW Integrated ASSP</td>
</tr>
</tbody>
</table>

**Roadmap / Portfolio**

**Performance approach**

- **PSoc™ 6**
  - Cortex® M4/ M0+M4
- **XMC™ 4000**
  - Cortex® M4
- **XMC™ 1000**
  - Cortex® M0
- **PSoc™ 4**
  - Cortex® M0/ M0+

**Integration approach**

- **iMOTION™ IPM**
  - MCE + 600 V GD + Power Stage
- **iMOTION™ Driver**
  - MCE + 600 V Gate Driver
- **iMOTION™ Controller**
  - MCE
What is iMOTION™?

Software integration
- MCE
  Motion Control Engine
- Scripting engine

Hardware integration
- Controller
- iMOTION™ Driver
- iMOTION™ IPM

MADK and reference designs

Development tools and documentation

With the objective of making it...
- Easier to use than ever!
- Faster and cheaper to market!
**iMOTION™ Solution Platform Dedicated to Motor and PFC Control**

<table>
<thead>
<tr>
<th>Right-fit Products and Highest Functional Integration</th>
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<tbody>
<tr>
<td><strong>Hardware Integration</strong></td>
</tr>
<tr>
<td>From controller to full inverter in one package</td>
</tr>
<tr>
<td><strong>Motion Control Engine</strong></td>
</tr>
<tr>
<td>MCE – Ready-2-use motor and PFC control algorithm</td>
</tr>
</tbody>
</table>

- iMOTION™ controller
- iMOTION™ driver
- iMOTION™ IPM

**Markets**
- Major and small home appliances
- Industrial pumps and fans
- Motion for building automation

- + Less components
- + Reduced PCB space

- + Minimized SW coding/test
- + Less certification effort

- System cost reduction
- Fast time to market
- Less R&D spending
# Table of contents

1. Application scope and market trends  
   - Infineon's solution offering  
     - Inverter and PFC  
       - Discrete solutions  
       - Gate driver solutions  
       - Power modules  
       - Auxiliary power  
     - Motor control  
     - Wide Bandgap  
2. Smart HVAC  
3. Key take-aways
Discretes or IPMs for inverter solutions? Wide Bandgap (WBG) can increase output power for the same thermal system.

Integration

High

Space optimized: IPM
- Integrated in motor housing
- Gate driver integrated in IPM

CoolGaN™

CoolSiC™

Enabled by WBG

No Heatsink

Heatsink

Space optimized: IPM
- Higher power rated motors
- Gate driver integrated in IPM

Thermal optimized: IGBT/MOS
Larger PCB space to extend power w/o heatsink

Assembly optimized: IGBT/Module
Easy HS mounting + isolation

Motor power

10 W 100 W 300 W 1 kW 3 kW
Wide Bandgap has significant > 50% less power dissipation advantage over Si solutions (IGBT)

Wide Bandgap solution has significantly better power dissipation that can be leveraged to:

- Get significantly more output power out of the same thermal system
- Shrink the power stage → miniaturization
- Removing the heatsink
- Meet new efficiency regulations
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Holistic sense-compute-connect approach for HVAC indoor unit

Overview

Detect defects before they happen

Intuitive display to control the entire smart home

Voice control
Gesture control

Connect to the Internet for wireless control

Turn on AC on your way home
Integrate AC in your smart home, e.g., control via Alexa or Smart Phone
Buy-and-UnLock features from sensor data

Sense environment for intuitive and autonomous use

Is someone in the room?
How are people in the room doing?
How many people are in the room?
How is the air quality?
Where are people in the room?

Condition Monitoring

Detect defects before they happen

User interface

Intuitive display to control the entire smart home
**Holistic sense-compute-connect approach for HVAC indoor unit Enablement**

**Increasing energy cost and climate change**

- **Required cost savings**
  - Enables demand-controlled ventilation in public buildings
  - Requires: Sense, Compute, Connect

- **Decarbonization**
  - Drives increasing legislations and certifications
  - Requires: Sense, Compute, Connect

**Data-driven business models**

- **Smart sensing**
  - Room occupancy data can be deduced from CO2 data leading to optimized space management
  - Requires: Sense, Compute, Connect

- **Monetization**
  - Buy-and-unlock peripherals over air based on local data (e.g., air quality-based fan control)
  - Requires: Sense, Compute, Connect

**Health & well-being**

- **Health**
  - COVID and flu prevention in public places (school, administrations, offices, etc)
  - Requires: Sense

- **Well-Being**
  - Avoid discomfort and dizziness, improve attention by optimized CO2 levels
  - Requires: Sense
XENSIV™ IoT portfolio that matches indoor HVAC sensing trends

Smart sense

- "Monitor Air for demand-controlled ventilation"
- "Monitor & Control air flow for comfort"
- "Adjust fan based on user positioning"
- "Voice control to turn on the AC"

Best cost-performance CO2 gas sensor
Precise air pressure sensor
3D Radar / ToF technology
Highest SNR Microphones

Compute

XMC™ / PSoC™ Edge processing

Connect

AIROC™ Bluetooth LE and 802.15.4 for cloud connectivity + OPTIGA™ for network security
Infineon Power solutions

- Buy-and-unlock peripherals over air (e.g. air quality based fan control)
- Smart home / IoT interoperability (e.g. Handheld control, outdoor air flow control, etc.)
- Remote monitoring and event management (e.g. Building management)
- Over-The-Air updates (new algos or comfort scenes)
- Dashboard, historical data and trend analysis
- Sensor-fusion and Machine Learning for Predictive Maintenance and optimized OEE*

Increase well-being
Reduce energy cost
Data-driven business models

OEE = Operational Efficiency of Equipment
Infineon at the core of IoT

- **Sense**: Broad XENSIV™ sensor portfolio
- **Compute & Connect**: PSoC™ and XMC™ microcontrollers and WiFi/BT/USB solutions for embedded applications
- **Actuate**: Power semiconductors enable actuation in end products
- **Security Solutions**: OPTIGA™ and CIRRENT™ Cloud ID: device-to-cloud authentication and robust protection for IoT devices
- **Software & Ecosystem**: ModusToolbox™ Software supports a wide range of Infineon microcontrollers and connectivity solutions
XENSIV™ radar selected target applications

Smart thermostats and displays
- Activation by proximity sensing
- Enhance booting time & user experience
- Support gesture control

Security systems incl. cameras
- Start camera & recording only by movements inside the covered area
- Reduce number of false alarms

Smart lighting systems
- Activate only where people are located
- Indoor & Outdoor
- Higher sensitivity than PIR sensors

Laptops and monitors
- Turn off/ Reduce brightness by absence detection
- Increased battery lifetime
- Lock the screen to protect data

Room air conditioners
- Turn on & off devices based on presence & vacancy detection
- Steer airflow away from people's position

Laptops and monitors
- Turn off screen by absence detection
- Pause & resume streaming content based on presence & absence

TVs
- Turn off screen by absence detection
- Pause & resume streaming content based on presence & absence
# XENSIV™ 60 GHz and 24 GHz radar sensor portfolio

## 60GHz

<table>
<thead>
<tr>
<th>1Tx / 1Rx</th>
<th>1Tx / 3Rx</th>
<th>2Tx / 2Rx</th>
<th>2Tx / 4Rx</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /> <strong>BGT60LTR11AIP</strong>&lt;br&gt; Doppler Radar Antenna-in-Package&lt;br&gt;6.7 x 3.3 mm²</td>
<td><img src="image2.png" alt="Image" /> <strong>BGT60UTR11AIP</strong>&lt;br&gt; FMCW Radar Antenna-in-Package&lt;br&gt;4.05 x 4.05 mm²</td>
<td><img src="image3.png" alt="Image" /> <strong>BGT60TR13C</strong>&lt;br&gt; FMCW Radar Antenna-in-Package&lt;br&gt;5 x 6.5 mm²</td>
<td><img src="image4.png" alt="Image" /> <strong>BGT60ATR24C</strong>&lt;br&gt; FMCW Radar Without Antenna&lt;br&gt;6 x 6 mm²</td>
</tr>
</tbody>
</table>

## 24GHz

<table>
<thead>
<tr>
<th>1Tx / 2Rx</th>
<th>3.6 x 3.6 mm</th>
<th><img src="image5.png" alt="Image" /> <strong>BGT24LTR22</strong>&lt;br&gt;Cascading</th>
<th><img src="image6.png" alt="Image" /> <strong>BGT24MTR11</strong>&lt;br&gt;+ <strong>BGT24MR2</strong>&lt;br&gt;4.5 x 5.5 mm</th>
<th><img src="image7.png" alt="Image" /> <strong>BGT24MTR12</strong>&lt;br&gt;4.5 x 5.5 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image8.png" alt="Image" /> <strong>BGT 24LTR11</strong>&lt;br&gt;2.4 x 2.4 mm</td>
<td><img src="image9.png" alt="Image" /> <strong>BGT24LTR22</strong>&lt;br&gt;Cascading</td>
<td><img src="image10.png" alt="Image" /> <strong>BGT24MTR11</strong>&lt;br&gt;+ <strong>BGT24MR2</strong>&lt;br&gt;4.5 x 5.5 mm</td>
<td><img src="image11.png" alt="Image" /> <strong>BGT24MTR12</strong>&lt;br&gt;4.5 x 5.5 mm</td>
<td></td>
</tr>
</tbody>
</table>
## XENSIV™ radar frequency offerings

<table>
<thead>
<tr>
<th>Feature</th>
<th>24 GHz</th>
<th>vs.</th>
<th>60 GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection range</td>
<td>up to 100m</td>
<td>vs.</td>
<td>up to 10m</td>
</tr>
<tr>
<td>Range resolution</td>
<td>up to x28 related to 24 GHz</td>
<td>vs.</td>
<td>up to x28 related to 24 GHz</td>
</tr>
<tr>
<td>Integrated antennas</td>
<td>No</td>
<td>vs.</td>
<td>Yes</td>
</tr>
<tr>
<td>System size</td>
<td>~625 mm²</td>
<td>vs.</td>
<td>~125 mm²</td>
</tr>
<tr>
<td>Power consumption</td>
<td>&lt;1mW possible</td>
<td>vs.</td>
<td>&lt;1mW possible</td>
</tr>
<tr>
<td>Detection through obstacles</td>
<td>Good penetration</td>
<td>vs.</td>
<td>Limited penetration</td>
</tr>
<tr>
<td>Enviromental robustness</td>
<td>unsusceptible</td>
<td>vs.</td>
<td>vulnerable</td>
</tr>
</tbody>
</table>

Infineon offers Doppler and FMCW radar sensors with 24 and 60 GHz.
XENSIV™ PAS CO2 selected target applications

**HVAC**

- Adjust temperature and flow based on air quality in the room

**Air quality devices**

- Turn on & off based on measured air quality in the room
- Adjust settings based on presence

**Consumer Devices**

- Indicate air quality via display, voice, or LEDs

**Smart home and building appliances**

- Turn off screen by absence detection
- Adjust temperature in the room based on presence
- Regulate ventilation based on air quality
# Infineon XENSIV™ PAS CO2

**Key specifications**

<table>
<thead>
<tr>
<th>XENSIV™ PAS CO2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Mode</strong></td>
<td>Real CO₂ sensor based on Photoacoustic Spectroscopy</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>High accuracy: +/-30 ppm +/-3 % of reading (up to 5,000 ppm at ambient conditions)</td>
</tr>
<tr>
<td><strong>Product lifetime and drift</strong></td>
<td>10 years with &lt; 1 % drift per year with compensation algorithms enabled</td>
</tr>
</tbody>
</table>

## Additional Information

| OPN | PASCO2V01BUMA1 |

## Value Proposition and focus applications

- Meeting the accuracy & stability of high-end NDIR CO2 sensors in a four times smaller size
- Compliance with major standards and regulations for indoor air quality (e.g.: WELL, LEED and ASHRAE 62.1)
- Suitable for high volume standard assembly process
## XENSIV™ PAS CO2 evaluation options

### Sensor evaluation only

**Mini Evaluation Board**
- XENSIV™ PAS CO2 Sensor

**Sensor2Go Evaluation Kit**
- Only USB-UART Bridge

**Modularity level**
- NA

**SW & tools**
- NA

**Evaluation scope**
- Sensor integration in custom prototyping
- Visualization of sensor data on local PC

### Sensor evaluation with Arduino platform

**Shield2Go Board**
- XENSIV™ PAS CO2 Sensor
  - Compatible with Infineon My IoT Adapter Boards for Arduino & Raspberry Pi

**Fusion GUI**
- Arduino library ready

### Infineon Prototyping Sensor System

**XENSIV™ Connected Sensor Kit (Rapid IoT Connect Dev. Kit with XENSIV™ PAS CO2 Wing)**
- XENSIV™ PAS CO2 + DPS368 Sensors

**Sensor evaluation only**
- Sensor evaluation with Arduino platform

**Sensor evaluation with Arduino platform**
- Infineon Prototyping Sensor System

**Controller**: PSoC™ 62

**Connectivity**: WiFi, BLE

**Security**: OPTIGA™ Trust M

**Code examples and Libraries in Modus Toolbox®**

**Infineon sensor cloud GUI with one year sensor evaluation experience**

**Rapid IoT System Prototyping incl. sense, compute, connect, secure.**

**Visualization of sensor data in cloud UX dashboard**

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**2023-08-03**

**public**

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**Infineon Proprietary**
## Value proposition AIROC™ connectivity solutions

<table>
<thead>
<tr>
<th>Wi-Fi® 4</th>
<th>Wi-Fi® 5/6</th>
<th>Wi-Fi® 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest cost</td>
<td>High data throughput</td>
<td>Congestion/future proof</td>
</tr>
</tbody>
</table>

### Interoperability
Home Appliances must work on all continents: Broadcom is leader in routers and Cypress bought their IoT group. Thus the connectivity components have highest interoperability.

### Co-existence
Many applications use BT and Wi-Fi, which can interfere with each other. Our AIROC™ devices have best in class, configurable Co-Existence engines to optimise for multi protocol operation.

### Operating system
We support a variety of RTOS solutions including FreeRTOS, MBED OS, etc. We also support Linux and Android natively using our FMAC driver.

### Tech support
We have dedicated Applications and Field Applications support locally that can help debug any issues, as well as a large community support site where you can find answers to common questions.

### Long distance
Our high RX sensitivity coupled with our tuning for maximum output power per region, offers greater distance and improved coverage over the deployed location, increasing the reliability and performance of the connection.

### High integration
Our MCU solutions can drive the aircon's touch button/screen, whilst also serving as the main control and as a host to the Wi-Fi solution.

### End-customer analytics
Product analytics that improve the performance, the reliability and connectivity of the appliance by providing real-time visibility into the performance of the aircon.

- **Wi-Fi® 4**: Lowest cost
- **Wi-Fi® 5/6**: High data throughput, Congestion/future proof
- **Wi-Fi® 6**: Low power consumption
# Value proposition of individual AIROC™ products

<table>
<thead>
<tr>
<th>Wi-Fi® 4</th>
<th>Wi-Fi® 5/6</th>
<th>Wi-Fi® 6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lowest cost</strong></td>
<td><strong>High data throughput</strong></td>
<td><strong>Low power consumption</strong></td>
</tr>
</tbody>
</table>

**Wi-Fi® 4: CYW43439**

- Unique home appliances solution offering Wi-Fi® 4, Bluetooth® 5 and WPA 3 allowing smart home certification (WFA certificate)

**Wi-Fi® 5 (11AC): CYW4373/E**

- Wi-Fi® 5 dual band (2.4 GHz and 5 GHz)
- Capable of beam-forming for increased range
- External PA (E-version) on module also increasing range

**Wi-Fi® 6/5G: CYW55571/2/3**

- Tri-band, (2.4 GHz, 5 GHz, 6 GHz)
- Target wake time (TWT): Today router is master, but it allows end device to negotiate with the router when to wake up
- Higher modulation schemes: Even higher data through-put
# AIROC™ selection guide

<table>
<thead>
<tr>
<th>Type</th>
<th>Products and functions</th>
<th>Wi-Fi®</th>
<th>Wi-Fi® + Bluetooth®</th>
<th>BT only</th>
<th>BT (BLE) in µC</th>
</tr>
</thead>
<tbody>
<tr>
<td>µC</td>
<td>Integrated processor</td>
<td>CYW43907</td>
<td>CYW43364</td>
<td></td>
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</tr>
<tr>
<td>SW</td>
<td>Library/Modus Toolbox</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drivers for all major µC available</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wi-Fi® 4: CYW43907</td>
<td></td>
<td></td>
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<tr>
<td>Wi-Fi® 5: CYW54907</td>
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<tr>
<td></td>
<td>CYW43364</td>
<td></td>
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<tr>
<td>Wi-Fi® 4: CYW4338/9</td>
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<tr>
<td>Wi-Fi® 4: CYW43012</td>
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<tr>
<td>BT 5.0: CYW20735</td>
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<td>BT5.2: CYW20829</td>
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<tr>
<td></td>
<td>PSoC™ 63xx</td>
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<td></td>
<td>– M0+ and M4</td>
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<td></td>
<td>– Capsense</td>
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<td></td>
<td>– Motor Control</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>– Main Control</td>
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<tr>
<td></td>
<td>– Audio/Video Transfer</td>
<td></td>
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<td></td>
<td>– Audio/Video Transfer</td>
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</tbody>
</table>

- WPA3 security
- Voice command
- Low Power Wi-Fi® + Bluetooth®
- Audio/Video Transfer
- Audio/Video Transfer
Touch control: Implement touch with the leading provider of touch solutions

1. Replace mechanical buttons with the world's easiest touch solution
   - MBR3 – configurable touch controllers

2. Complex touch HMI interfaces in single MCU platform
   - PSoC™ 4 touch controllers

3. Dual-core high performance touch solution with IoT edge compute capabilities
   - PSoC™ 6 touch controllers
Why use Infineon touch solutions in your aircon system?

**Proven**
- #1 provider of touch solutions for many years

**Most robust solution**
- Water tolerance – Even works with wet fingers
- Works in the noisiest environments

**Most sensitive solution**
- Appliances usually have thick plastic overlays. The sensitivity of our solution allows you to sense more accurately than any other solution out there.

**Ease of integration**
- The SmartSense tool helps you to layout your PCB. It will sense the size and the capacitance of buttons to make implementation easy. No more need for tuning

**Touch on metal**
- The inductive sensing (MagSense™) technology enables sensing of metal objects (e.g. proximity). A single chip to support hybrid sensing advanced HMI.

**High integration**
- We offer a wide variety of integrated features such as wired and wireless connectivity, audio and additional compute capabilities for IoT edge
Main security concerns for our customers

- Identity protection against **fake devices**
- Protection against **eaves dropping**
- Protection against **the manipulation of the data**
- Protection against **illegal update of firmware**

Improved smart HVAC system security
Value proposition OPTIGA™ Trust family in aircon systems

**Shorter time to market**
- By using Infineon's PKI* infrastructure including root CA and HSM infrastructure certificate authorities you can drastically reduce your cost and effort for your smart air con system.

**Cost reduction**
- With Infineon's OPTIGA™ Trust solution you are able to make use of a one-stop-shop turnkey solution which perfectly matches future requirements of smart air con systems.

**Zero touch provisioning**
- With Infineon's optimized processes you get the ability for easy certificate-based device registration to all major cloud service providers. It is an automated cloud provisioning of your smart air con without your involvement.

**Protection**
- Infineon's OPTIGA™ Trust family provides an anchor of trust for connecting your smart air con device to the cloud, protects your critical data transferred over your network and thus your application running on your smart air con.

**Future proven**
- As the #1 supplier in embedded secure elements, we are able to professionally solve our customers' biggest problems and concerns even in difficult security relevant areas like industry or automotive.

*) PKI = Public Key Infrastructure
OPTIGA™ Trust M – Protecting the IoT from cloud to end nodes

- Secured connectivity
- Secured cloud authentication
- Secured software update over-the-air

Cloud server → Mutual authentication → Gateway/Edge computing device

- Secured edge device AI application software updates

IoT devices / end nodes
Condition monitoring and predictive maintenance

Predictive maintenance can help prevent failures before they happen by monitoring a device’s condition.

- **Predictive**: Detect and fix defects at an early stage and use advanced analytics to predict machine failures before they happen.
- **Proactive**: Fix the machines when the equipment is down or have scheduled maintenance in place.
- **Periodic**: Additional business value
- **Reactive**: Traditional approach

Infineon offering

<table>
<thead>
<tr>
<th>Sensor Type</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>XENSIV™ DPS368 Barometric Pressure Sensor</td>
<td>Air flow measurement in the system</td>
</tr>
<tr>
<td>XENSIV™ TL4971 Current Sensor</td>
<td>Current measurement at fan and compressor</td>
</tr>
<tr>
<td>XENSIV™ TLI493D-W2BW 3D Magnetic Sensor</td>
<td>Position monitoring of components</td>
</tr>
<tr>
<td>XENSIV™ TLx496x Hall Sensors</td>
<td>Open/close lid detection</td>
</tr>
<tr>
<td>XENSIV™ TLI4966G Double Hall Sensor</td>
<td>Speed &amp; direction monitoring of components</td>
</tr>
<tr>
<td>XENSIV™ TLE4997E2 Linear Hall Sensor</td>
<td>Linear movement and vibration</td>
</tr>
<tr>
<td>XENSIV™ PAS CO2 Sensor</td>
<td>CO₂ level monitoring for indoor quality monitoring</td>
</tr>
<tr>
<td>XENSIV™ IM69D130 MEMS Microphone</td>
<td>Noise monitoring at motor and compressor</td>
</tr>
<tr>
<td>PSoC™ 6, PSoC™ 4, XMC4000</td>
<td>Data processing and system management</td>
</tr>
<tr>
<td>OPTIGA™ Trust M</td>
<td>Secured connection &amp; communication</td>
</tr>
<tr>
<td>Wi-Fi® and Bluetooth Combo controller</td>
<td>Connectivity for remote management</td>
</tr>
</tbody>
</table>
UV-C LEDs can eliminate bacteria and viruses to equip air conditioners with air purification functions

- UV-C LEDs sterilize airborne contaminants such as bacteria and viruses by disinfecting the surface of the evaporator
- Infineon offers the optimal LED driver ICs for UV-C LEDs

**Value proposition**

- Constant current enables **homogenous light** output
- Controlling the UV-C LED current ensures **long lifetime** of the UV-C LEDs and the entire product
- Current reduction at increasing ambient or UV-C LED temperature enhances the **reliability** of the UV-C LED product
- Compared to discrete constant current circuits BCR ensures a pretested **easy to use** and cost-effective device
- Best solution for space-constrained UV-C LED applications
- Best solution to drive multiple UV-C LEDs
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     - Auxiliary power ...................................................................... 26
   - Motor control ............................................................................. 28
   - Wide Bandgap ........................................................................... 35
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Infineon’s value proposition for commercial HVAC

Infineon’s very complete system solutions for Commercial HVAC systems support designs that are **energy efficient, reliable, and fully connected**, for improved end-customer experience. Smart HVAC systems are integrated with new features and **secured connectivity**, and new sense-enabled use cases, accessible through **complete documentation** and a **global support** structure for hardware and firmware design.

### Secured and connected
- **Wide range of secure products**
  OPTIGA™ Trust family of security solutions is designed for easy integration into embedded systems to protect the confidentiality, integrity and authenticity of information and devices.

- **High Integration MCUs:**
  PSoCTM 6 integrates HMI, system control and Connectivity HOST on a single chip

- **Connectivity with AIROC™ Wi-Fi® & combos and AIROC™ Bluetooth®:**
  Widely-deployed Wi-Fi® and Bluetooth® combo ICs that offer the industry’s best interoperability and RF performance.

### Innovative and reliable
- **Sense-enabled use cases:**
  Wide set of sensors with high accuracy for enablement of innovative use cases (e.g., zoning, condition monitoring & predictive maintenance, voice control) and constant development of new technologies (CO2 sensor, radar)

- **Reliability:**
  Decades of field proven reliability for power semiconductors

- **Design support:**
  Ecosystem of proven partners for design-in support to shorten development times

### Easy to use
- **Complete solutions with off-the-shelf evaluation and prototyping tools**
  A complete eco-system of simulations, documentation, and demonstration boards enable a faster time to market

- **Reduced cost:**
  Much lower R&D efforts at the customer, combined with easy-to-use examples of new, innovative functionality

- **Application experience and deep technical knowledge**
  Highly experienced global application engineering team for all steps from design through manufacturing
More info on

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