



# Washing machine application and product overview

May 2022



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# Modern washing machines save energy, water and detergent



Modern washing machines feature improved **energy efficiency, low acoustic noise, saving water and detergent**, while connecting with a smart home

# Product overview for washing machines

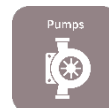
## Drum motor



- › **Motor Controller:** PSoC™, XMC™ and iMOTION™ family
- › **Inverter**
  - › **IPM:** CIPOS™ Mini and Tiny
  - › **Discrete:** IGBTs (TRENCHSTOP™ IGBT6 & RC-D2 series), MOSFETs (CoolMOS™ P7) and gate drivers (half bridge and 3-phase drivers)
- › **PFC:** TRENCHSTOP™ IGBTs, CoolSiC™ hybrid discretes, Rapid and CoolSiC™ diodes, CIPOS™ Mini IPMs and PFC gate drivers
- › **Auxiliary power:** CoolSET™ 5th generation

## Energy Efficiency

## Drain pump



- › **Inverter (IPM):** CIPOS™ Nano, Micro and iMOTION™ IPM
- › **Inverter (Discretes):** IGBTs (TRENCHSTOP™ IGBT6 & RC-D2 series), MOSFETs (CoolMOS™ PFD7), EiceDRIVER (half bridge and 3-phase drivers)

## Heat pumps



- › **Inverter (IPM):** CIPOS™ Mini
- › **Inverter (Discretes):** IGBTs (RC-D2 series), EiceDRIVER (half bridge and 3-phase drivers)

## HMI & connectivity



- › PSoC™ for **main control, touch sensing and display**
- › Bluetooth / Wi-Fi **connectivity** using our AIROC™ solutions
- › XENSIV™ MEMS microphone for **voice control**

## Condition Monitoring



- › PSoC™, XMC™ and iMOTION™ family
- › XENSIV™ sensors
- › AIROC™ for connectivity

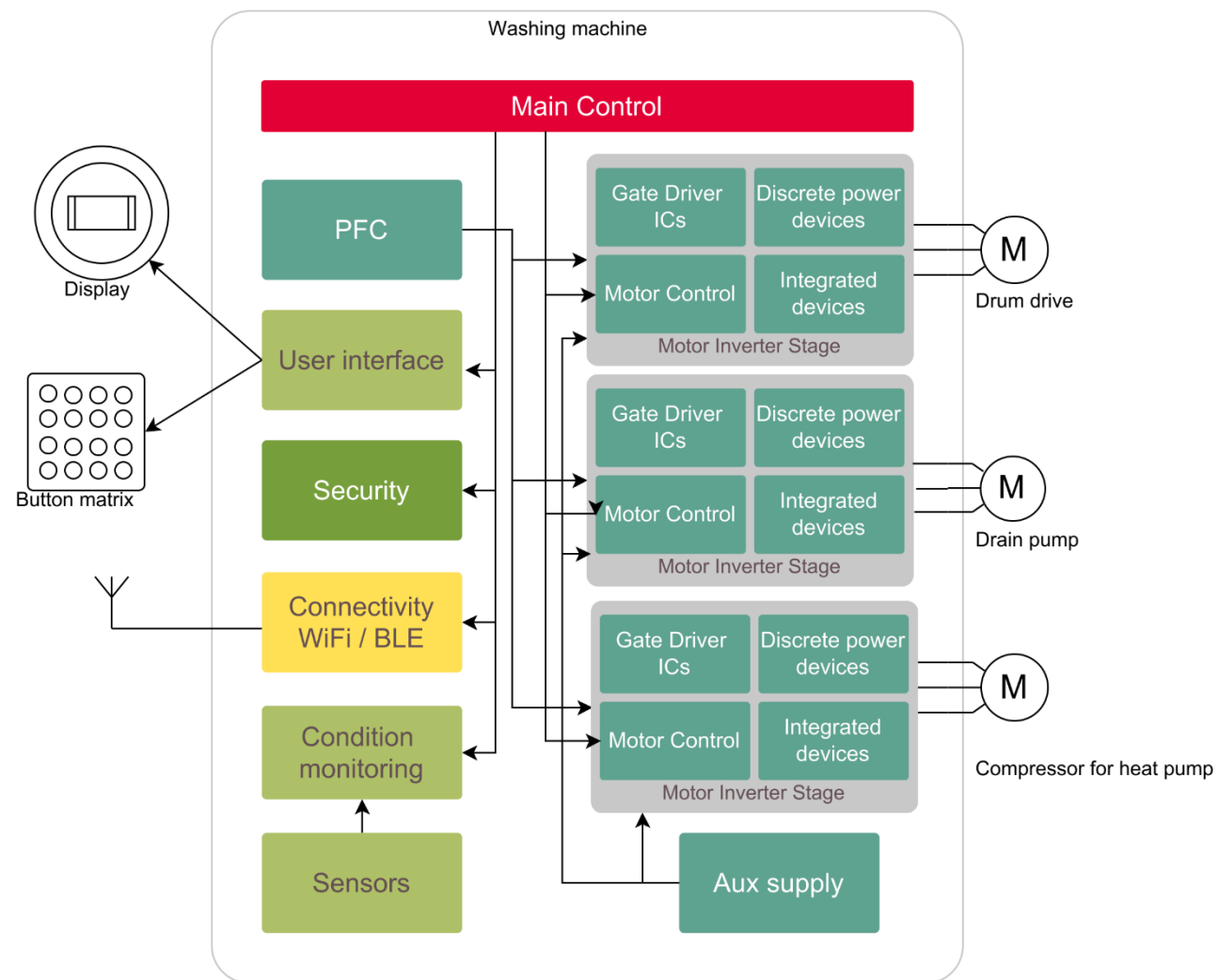
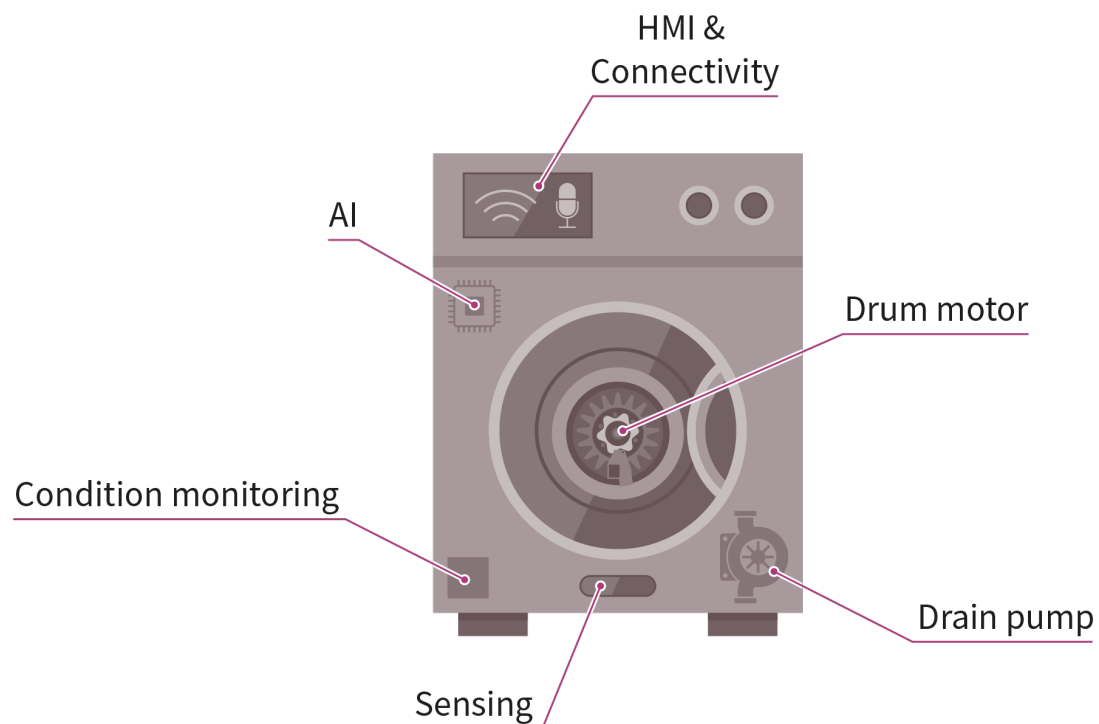
## IoT

## Sensing



- › **Pressure** sensor for water pressure and filter clogage
- › **Radar** for presence detection, gestures and material detection
- › **Touch** sensing for water level sensing
- › **Hall** sensors for open/close detection
- › **3-D Position sensor** for balance and weight sensing

# Block diagram for washing machines



# Focus products for washing machines

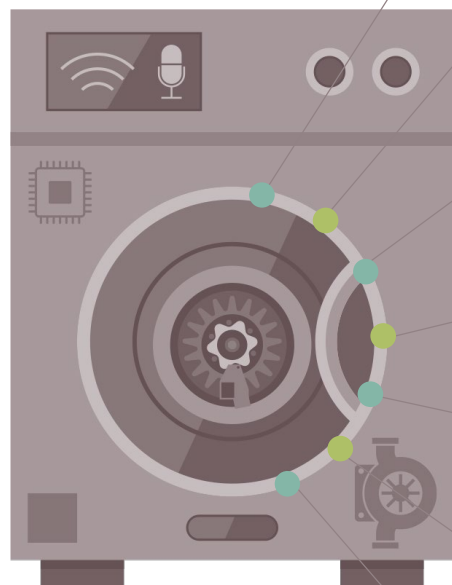
	Selected product families		Key value
Power stage	CIPOS™ Mini IM564-X6D IPM / Reverse Conducting RC-D2	➤	Highest power density and efficiency
Motor control	PSoC 4100S	➤	Full set of features and protections, fast time to market
Smart home system	PSoC™ 6 family of dual core microcontrollers M4 / M0+ with ultra low power and high performance for smart features, touch control, sensor data processing and connectivity	➤	Full feature set and IoT security
Connectivity	AIROC™ Wi-Fi® + Bluetooth® combos with IEEE 802.11a/b/g/n/ac WLAN and Bluetooth in a single-chip solution	➤	Ease of use and full compatibility
Hardware security	OPTIGA™ family to both verify that genuine parts are used and to establish secured communication to the cloud or other devices	➤	Brand protection and secured communication

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# BLDC drum motor – Features and benefits



## › More durable

- › Without brush / commutator erosion.
- › More extensive life expectancy and maintenance-free experience.

## › Quieter

- › Without mechanical friction inside the motor.
- › Noise is dramatically reduced.

## › More efficient

- › A higher energy efficiency than the conventional universal motors.
- › Reduces energy consumption by up to 40%.

## › More powerful

- › Able to work at a desired constant high speed.
- › Ensures a powerful performance from the start to the end.

## › More versatile

- › Produces wider speed range and bigger torque.

## › Longer work time

- › Lower temperature rise so it allows for continuous work.

## › Safer

- › There is no sparking as there is no commutator and brushes.
- › Supported by the housing, so it can be cooled by conduction.
- › Entirely enclosed and protected from dirt or any foreign subjects

# High-level view on the inverter

## Motor controller

- › Regulates speed and torque of motor by manipulating voltage and current

## Gate driver

- › Amplifier that accepts low power input from a controller to produce the high current gate drive for a switch

## Power switch – IGBT or MOSFET

- › Controls current in the motor through on-off operation

## Power Factor Correction – Switch-Diode-Inductor

- › Improves power factor thus reducing load on the electrical distribution system & increasing energy efficiency

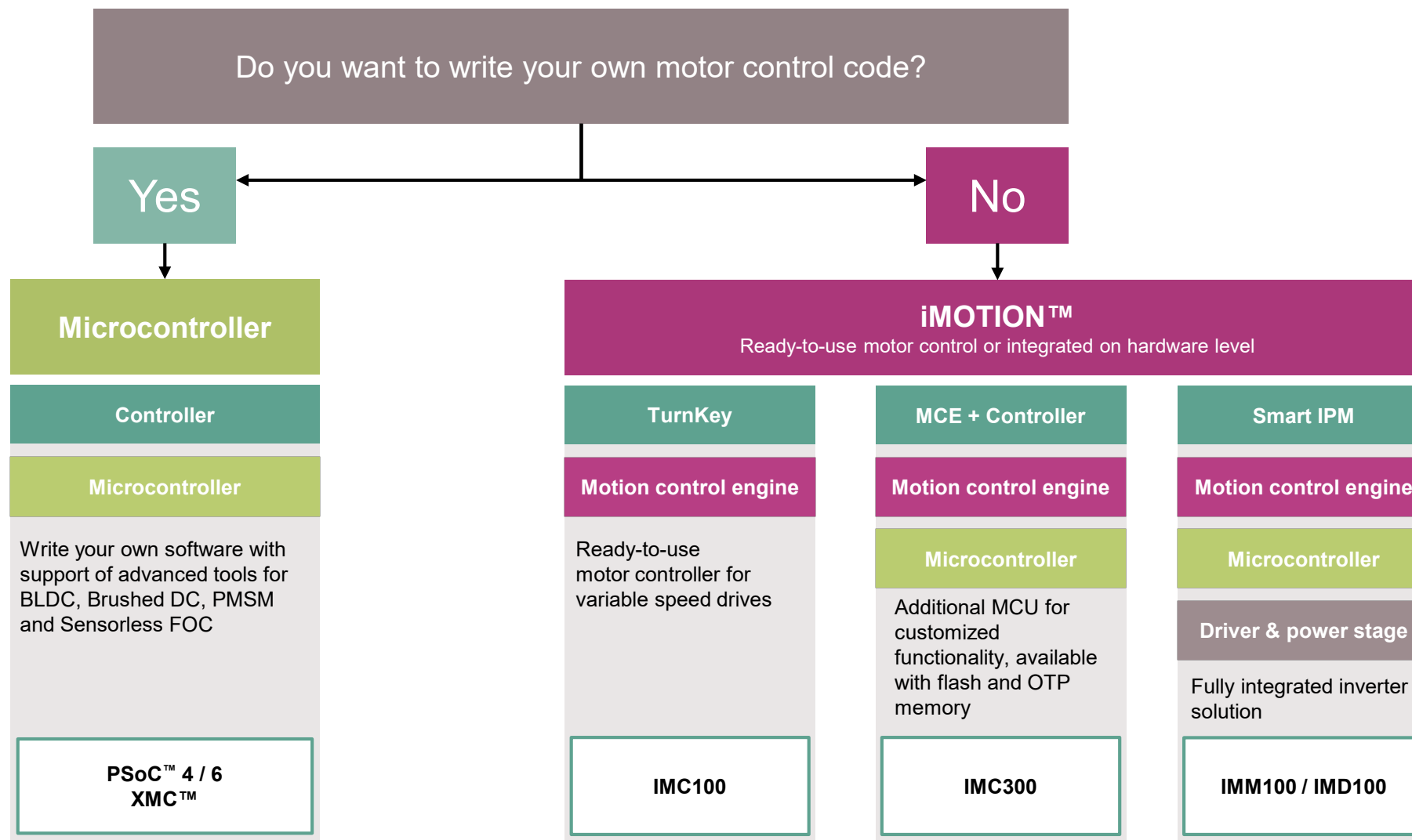
# Infineon offers various motor control solutions to choose from

S/W	MCU	Gate driver	Power switch
iMOTION™ controller			IGBT
Customer's own S/W	XMC™	EiceDRIVER™	HV FET
	PSoC™		LV/MV FET
iMOTION™ controller		CIPOS™ IPM (thermal sensor inside)	
Customer's own S/W	XMC™		
	PSoC™		
iMOTION™ driver			IGBT
			HV FET
			LV/MV FET
iMOTION™ IPM (thermal sensor inside)			

## 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. thermal management since washing machines have a lot of power cycling, high peak current
- › **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?



# Microcontroller portfolio overview

## Selected product families

### System control, HMI and connectivity

#### PSoC® 6

- › Highly integrated HMI solution with capacitive touch sensing and TFT display
- › PSoC™ 6 + Wi-Fi® & BT Combo: Providing the total solution of IoT connectivity & security (Cloud service, Mesh Gateway)

#### PSoC® 4

- › HMI + system control (2-in-1 solution): Reliable & stable capacitive touch sensing, large pin pitch package, wide voltage range

#### PSoC® series

- › Integrated with OPA/CMP, TCPWM, reduce BOM cost
- › Supported by mature, validated and reliable motor control algorithm and total solution for home appliances, short time to market

### Motor control

#### XMC series

- › Versatile real-time motor and power stage control peripherals
- › Scalable to various control schemes from single motor up to dual motor and PFC control
- › 5V supported by XMC1000 series

### Ready-to-use, highly integrated motor control

#### iMOTION™

- › Integrates all the control and analog interface functions required for sensor-less FOC
- › Eliminates software coding from the motor control algorithm development process

# PSoC™ selection guide for washing machines

	Main control	Connectivity		HMI			Display drive		Motor Control			Additional features	Software
		BT	WiFi	Button	Display LCD	Display TFT	Display LCD	Display TFT	Top load	Front load	Dryer fan control		
PSOC™ 4000S/4100S	Only PSoC4100S			<7"			✓		4100S				PSoC™ creator
PSOC™ 4100 Plus/ Max	✓			<7"/9"			✓					2 Capsense blocks	PSoC™ creator/Modus toolbox
CY8C62x4/5	✓		Host for Wi-Fi		✓		✓	✓				Security (PSoC™ 64)	Modus toolbox
CY8C62x6/7/A/8	✓				✓		<7"					Security (PSoC™ 64)	PSoC™ creator/Modus toolbox
CY8C63x7/8	✓		BLE		✓		<7"					Security (PSoC™ 64)	PSoC™ creator/Modus toolbox
PSoC4500H									Rolling and drying (2 motor control with single chip)				Modus toolbox

# iMOTION™ selection guide for washing machines

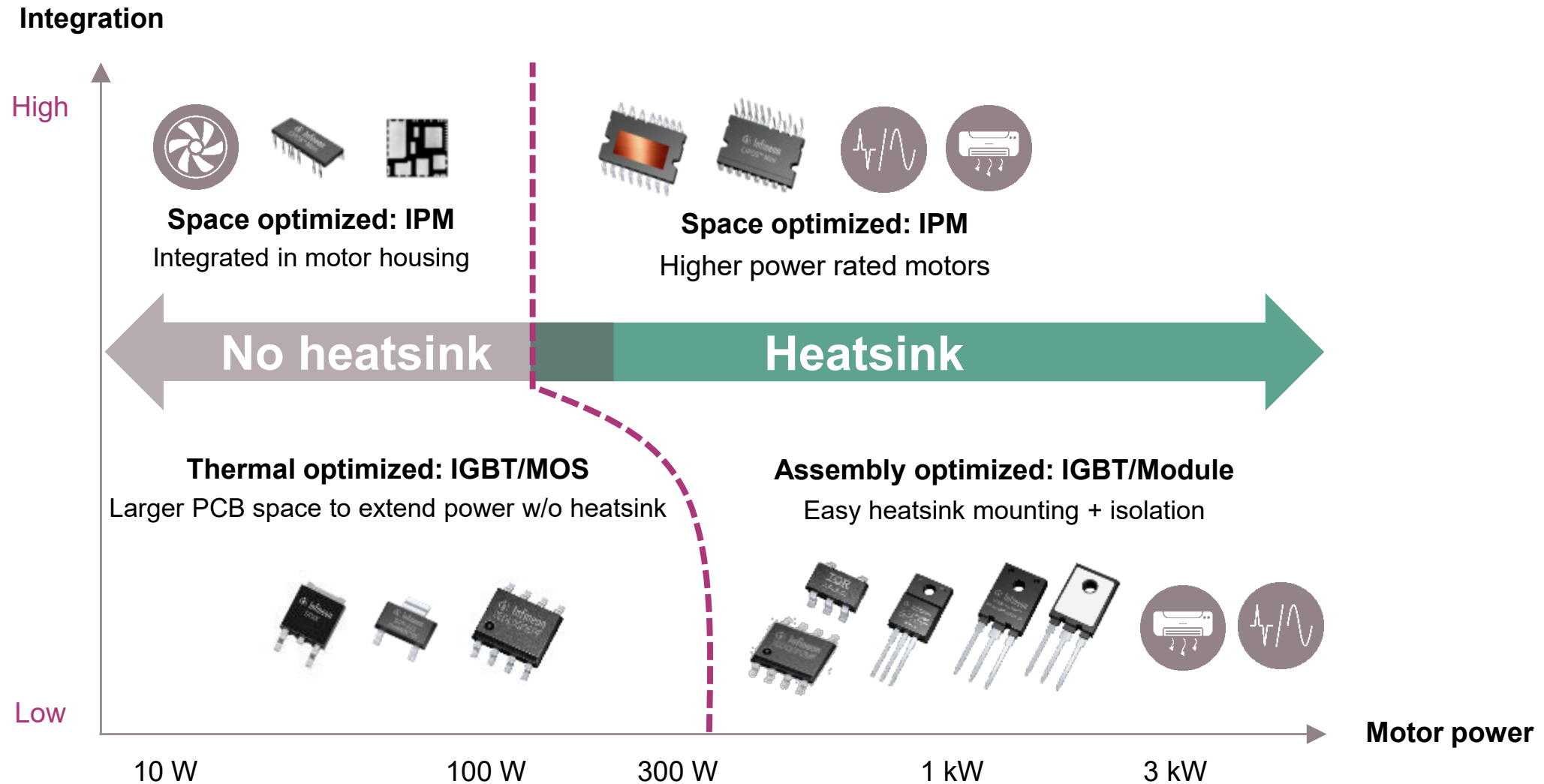
	Main control	Connectivity		HMI			Display drive		Motor Control		Additional features	Software
		BT	Wi-Fi®	Button	Display LCD	Display TFT	Display LCD	Display TFT	Single + PFC	Dual + PFC		
IMC100									✓	✓		Ready to use + Script engine
IMC 300									✓		Additional M0 core	Ready to use + Script engine
IMD110									✓		Integrated GD	Ready to use + Script engine
IMI110*									✓		Integrated GD + Power Stage	Ready to use + Script engine
IMM100*									✓		Integrated GD + Power stage	Ready to use + Script engine

# XMC™ selection guide for home appliances






















	Main control	Connectivity		HMI			Display drive		Motor Control		Additional features	Software
		BT	Wi-Fi®	Button	Display LCD	Display TFT	Display LCD	Display TFT	Single + digital PFC	Dual + digital PFC		
XMC1300									✓		MATH co-processor, 64MHz motor control timers, 5 V	LLD, DAVE Apps for configuration and code generation, Class B safety Lib, XMC Lib
XMC1400									✓		MATH co-processor, 96 MHz motor ctrl timers, 5 V, 4 ACOMP	
XMC4100/200										✓	High resolution motor control timers, 4 ADC, 125°C	

\*targeting IDU fan

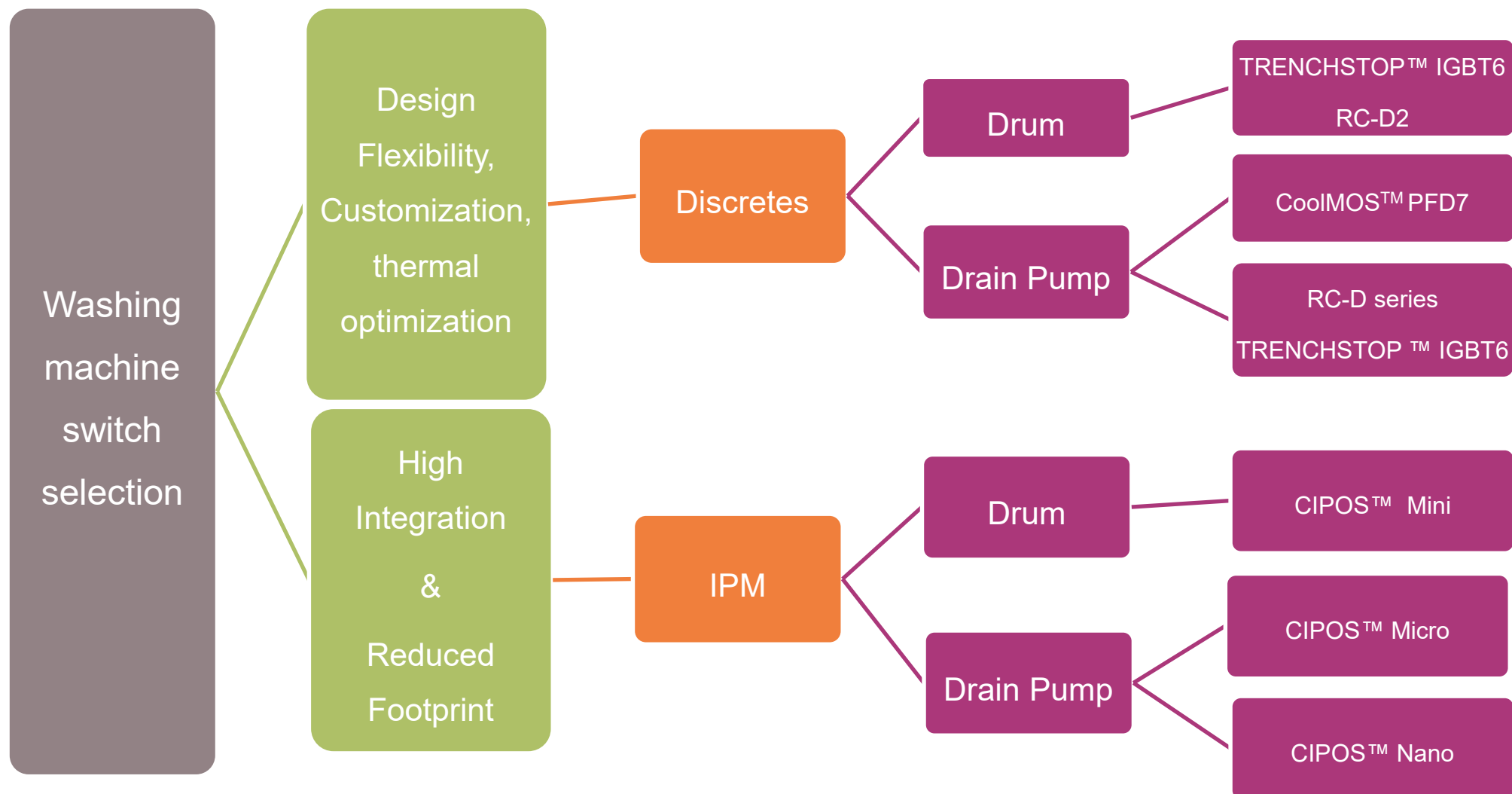
# Power stage and Power Factor Correction (PFC) – discrete or integrated



# Power Factor Correction – Topologies

Criteria \ Topology	Partial PFC		CCM Boost PFC		Totem-pole PFC	
Suitable power range	› Limited power 1-1.5 kW		› Suitable for >1.5 kW		› Suitable for >2.5 kW	
Cost	› Low cost		› Moderate cost		› Affordable for high power	
Switching frequency	› Low switching frequency › High harmonics		› High switching frequency › Low harmonics		› High switching frequency › Low harmonics	
Efficiency	› Bridge rectifier needed		› Bridge rectifier needed		› No bridge rectifier needed	
	› Hardly meets energy regulations		› Meets energy regulations		› Meets energy regulations › Best efficiency near 99%	
Power factor	› PF <0.9 › Acceptable harmonics		› PF ~0.99 › Minimized harmonics		› PF ~0.99 › Minimized harmonics	
Control	› Easy control, but no dedicated controller available		› Easy implementation › Dedicated controller available		› Slightly complex than ordinary boost PFC, and no dedicated controller available	
Form factor	› Bulky inductor needed		› Smaller form factor		› Smallest form factor	

# Switch selection for washing machines



# Product overview: Integrated Power Modules

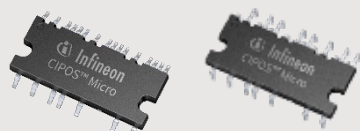
## CIPOS™ Nano



Dimension [mm]	8x9 / 12x10 / 12x12
Configuration	Half-bridge / 3-phase
Voltage Rating	250 V, 500 V
Rdson [max].	0.15 – 6.0 Ω

- › **Heatsink-less operation**
- › **Various topology solutions; Half-bridge, H-bridge, 3-phase**
- › **Power capability to 200 W**
- › Multiple protection available

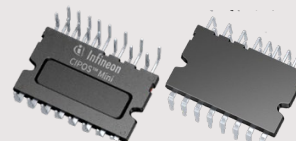
## CIPOS™ Micro IM241 series



Dimension [mm]	29x12x2.9
Configuration	3-phase
Voltage Rating	600V
Current [A]	2 – 6 A

- › **Wide range of product coverage in the same foot print**
- › Optimized dv/dt for loss and EMI trade-off
- › **HV H3TRB qualified**

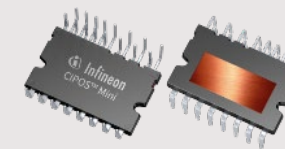
## CIPOS™ Mini IM523 series



Dimension [mm]	34x15x3.1
Configuration	3-phase
Voltage Rating	600V
Current Rating	6-17A

- › **Best optimized performance for consumer and low power drive applications**
- › **Various current ratings available from 6 A to 17 A**

## CIPOS™ Mini



Dimension [mm]	36x21x3.1
Inverter	600V 10-30A
PFC + Inverter	600V 10A, 15A
Interleaved PFC	650V 20A, 30A

- › **Best optimized performance up to 3 kW**
- › **Flexibility and scalability (4 ~ 30 A)**
- › **Market proven and reliable solution with high volume shipment record**

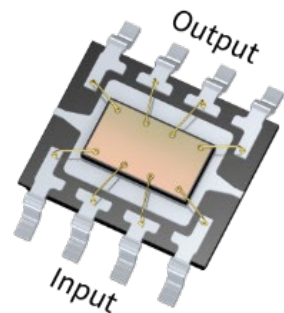
## Customer benefits

- › Fast time to market
- › System cost savings from smaller footprint and reduced PCB space
- › Optimized performance and package options available
- › UL certified package

For more information: [www.infineon.com/ipm](http://www.infineon.com/ipm)

# EiceDRIVER™ Gate Drivers for Washing Machines

## PFC



Low-side drivers

- › **Low-side:**
  - 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
  - Industry-standard DSO-8 and small form-factor SOT23, WSON, and TSNP packages

### Key products

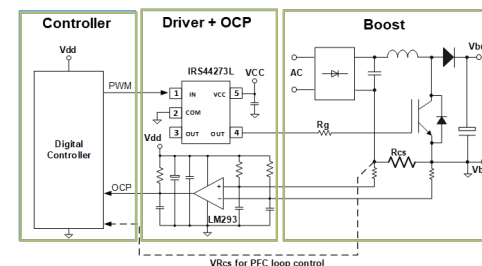
- › 1ED44173/5/6N01 (OCP)
- › 1ED44171N01B
- › IR4427, IRS4427, IRS44273

### Differentiation

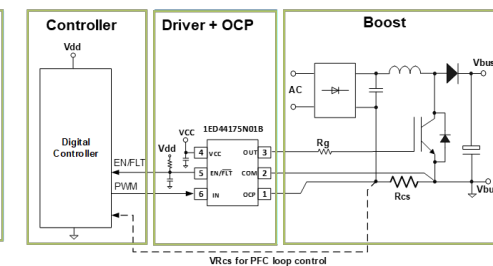
- › Integrated over-current protection (OCP) and fault reporting
- › Cost-effective
- › Market-proven

## 1ED4417x integrated OCP

### Current solution



### 1ED4417x solution

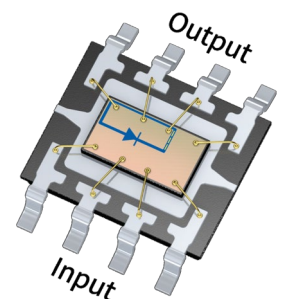


- › **> 20% Cost Saving**
- › **> 50% Space Saving**

### 1ED4417x integrates

- › Low side gate driver
- › Overcurrent protection
- › Fault output
- › Programmable fault clear time
- › Enable input

## Drum Drive & Drain Pump



600 - 700 V  
Level-shift drivers

- › **Level-shift:**
  - **30 years** of product leadership from International Rectifier portfolio
  - State-of-the-art **Infineon SOI** technology for higher operational ruggedness and higher frequency switching
  - **Infineon SOI** technology with inherent integrated bootstrap diode

### Key products

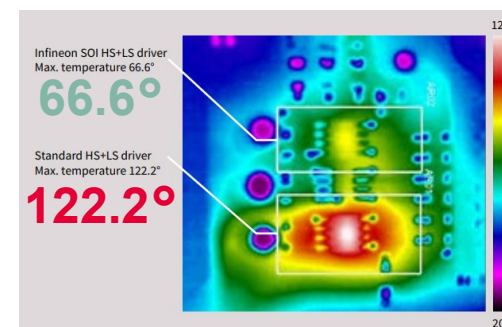
- › 2ED2304S06F
- › 6EDL04x06xT

### Differentiation

- › Proven technology
- › Largest standard portfolio
- › Infineon SOI (BSD, – VS, lower losses)

## Infineon's SOI Technology for level-shift drivers

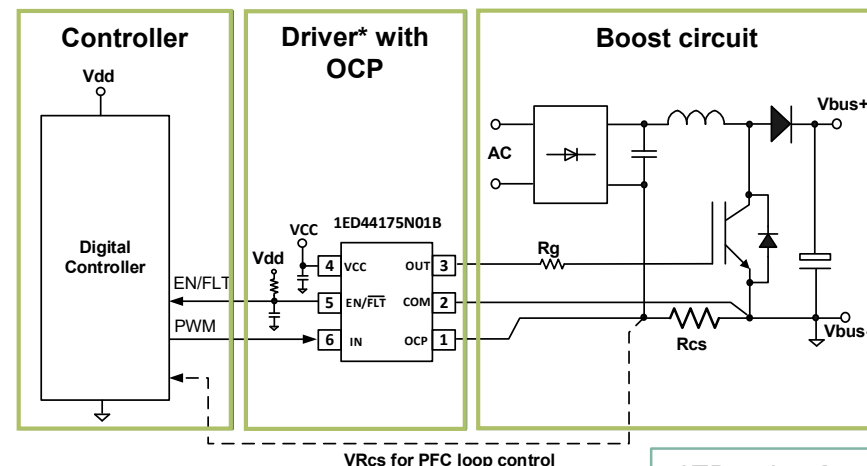
- › Integrated bootstrap diode (BSD)
- › Tolerant to negative transient voltage up to 100 V
- › Low level-shift loss in high frequency application (below)



Power loss comparison between **SOI** gate driver and **standard** level-shift gate driver

[www.infineon.com/gatedriver](http://www.infineon.com/gatedriver)

## New solution advantages – smaller size, lower BOM, OCP



SOT236 0805 1206



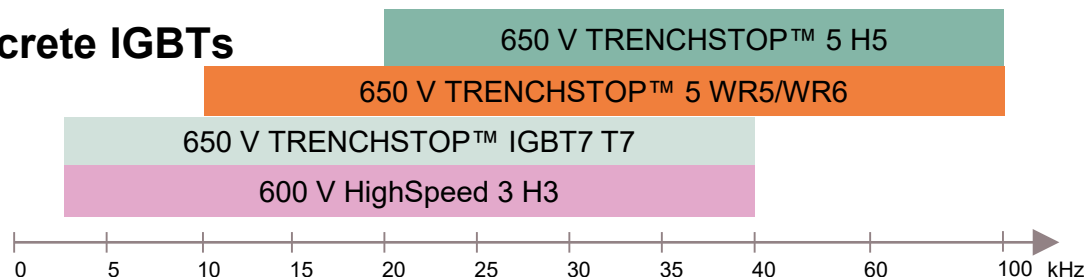
**1ED44175 / 1ED44173**  
***Simplify system design***

- 1ED44173 integrates**
- › Low side gate driver
  - › Overcurrent protection
  - › MOSFET UVLO levels
  - › Enable Input / Fault output
  - › Programmable fault clear time

\* - example circuit with 1ED44175N01

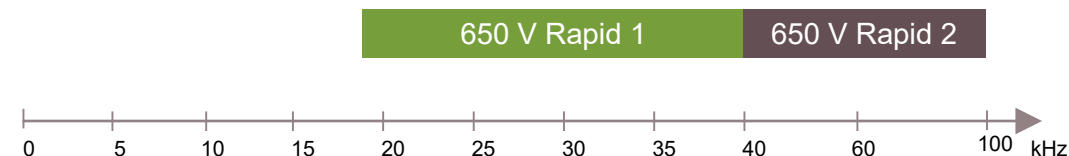
# Discrete IGBT & silicon diode solutions in the PFC stage

## Discrete IGBTs



No SC rating	TRENCSHTOP™ 5 H5	<b>Best-in-class high frequency IGBT</b> Highest efficiency, especially under light load conditions Portfolio: 20 A – 75 A TO-220, TO-247 3/4 pin, Advanced Isolation package
	TRENCSHTOP™ 5 WR5/WR6	<b>PFC application optimized IGBT</b> Optimized full rated hard switching turn-off Excellent RG controllability with soft recovery plus low Qrr for diode Portfolio <b>WR5</b> : 30A – 50A, TO-247-3 pin & TO-247-3-HCC (30A); <b>WR6</b> : 20 A – 70 A, TO-247-3-HCC
SC rating	IGBT7 T7	<b>Benchmark low-medium frequency IGBT</b> Benchmark low $V_{ce(sat)}$ and low $V_F$ IGBT Enhanced controllability for better EMI Portfolio: 30 A – 50 A, TO-247 3 pin
	HighSpeed3 H3	<b>High speed IGBT</b> Low $E_{off}$ Lowest switching losses Portfolio: 30 A – 75 A, TO-247 3 pin, Advanced Isolation package

## Silicon diodes



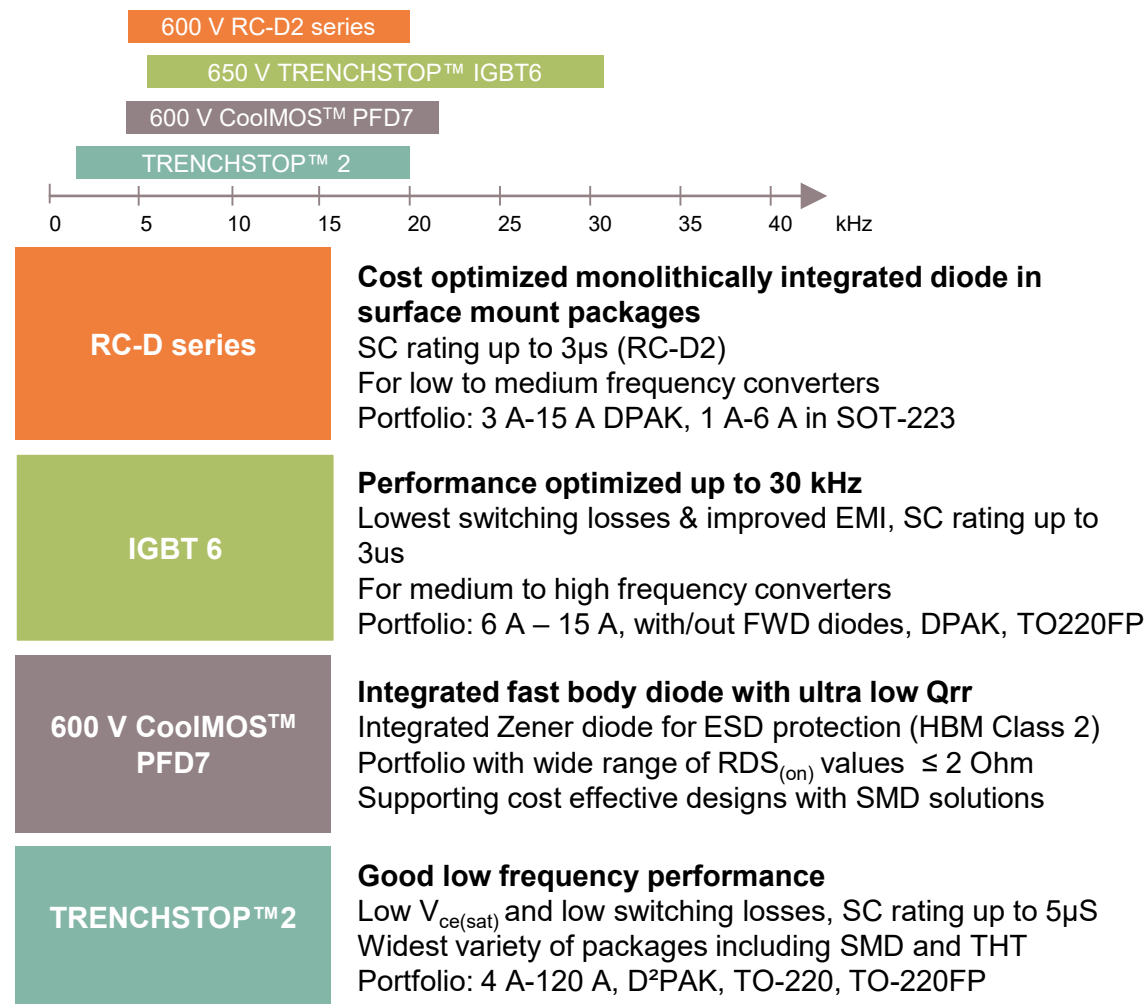
Rapid 1	<b><math>V_F</math> optimized diode for low frequency applications</b> 1.35 V temperature-stable forward voltage ( $V_F$ ) Lowest peak reverse recovery current ( $I_{rrm}$ ) Reverse recovery time ( $t_{rr}$ ) < 100 ns Portfolio: 8 A – 80 A, packages include TO-220FP, TO-247, and Advanced Isolation package
Rapid 2	<b>Qrr/trr optimized hyperfast diode for high frequency applications</b> Lowest Qrr : $V_F$ ratio for best-in-class performance Lowest peak reverse recovery current ( $I_{rrm}$ ) Reverse recovery $t_{rr}$ < 50 ns Portfolio: 8 A – 40 A, packages include TO-220FP, TO-247

# Discrete IGBT & silicon diode solutions in drum and pump

## Drum drive

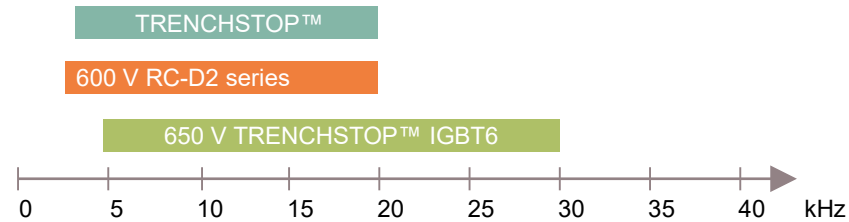


## Drain Pump



# Power Stage – Discrete IGBT/MOS and silicon diode solutions in Washing Machines

## Compressor



### TRENCHSTOP™

#### Good low frequency performance

Low  $V_{ce(sat)}$  and low switching losses  
SC rating up to 5μS  
Widest variety of packages including SMD and THT  
Portfolio: 4 A-120 A, D<sup>2</sup>PAK, TO-220, TO-220FP

### RC-D2 series

#### Cost optimized monolithically integrated diode in surface mount packages

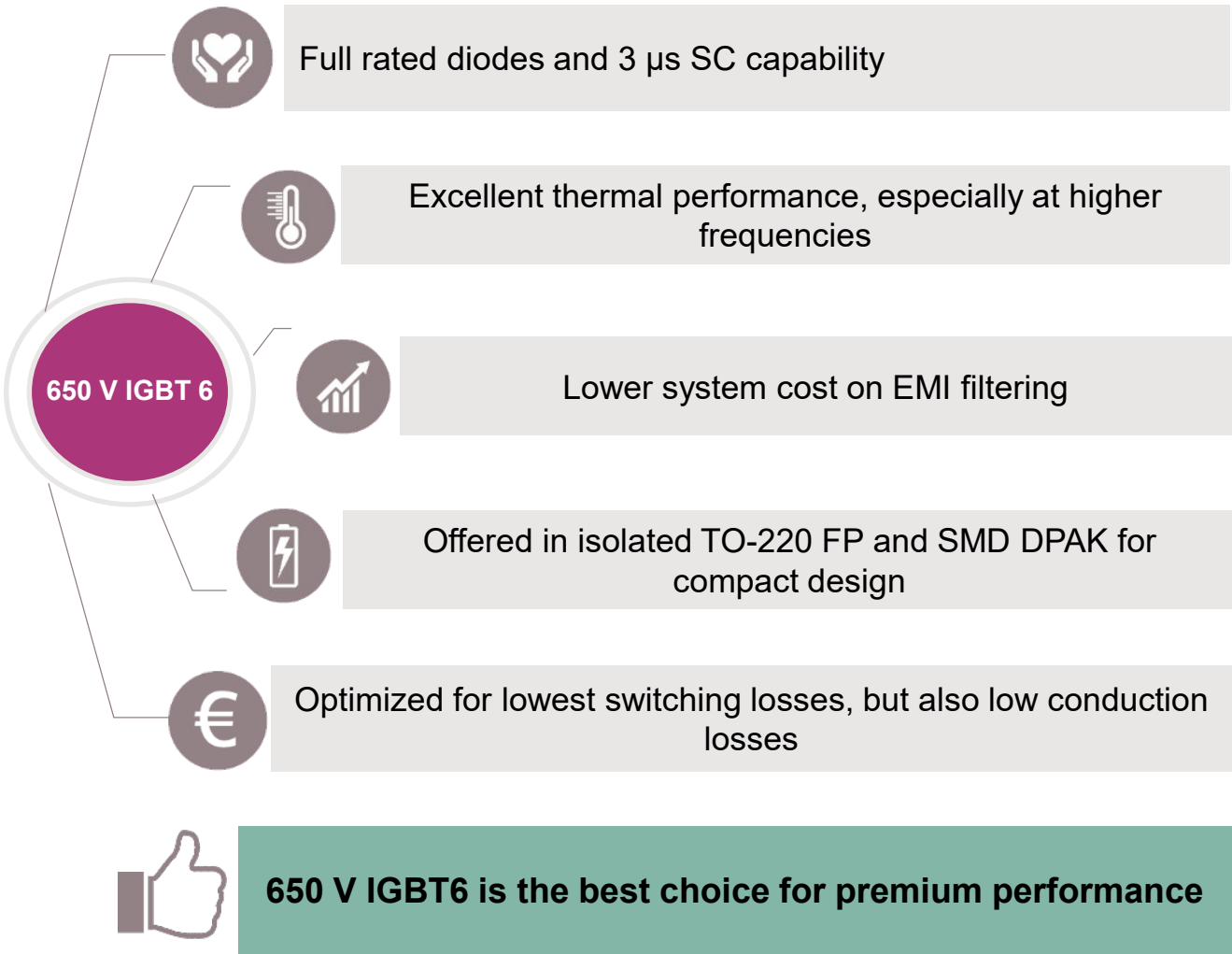
SC rating up to 3μs(RC-D2)  
For low to medium frequency converters  
Portfolio: 3 A-15 A in DPAK, RC-D2 also in 1 A-6 A in SOT-223

### IGBT 6

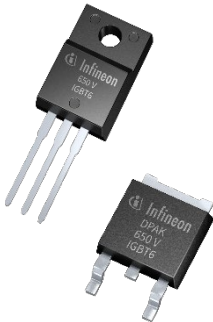
#### Performance optimized up to 30 kHz

Lowest switching losses and improved EMI  
SC rating up to 3us  
For medium to high frequency converters  
Portfolio: 6 A – 15 A, with/out FWD diodes, DPAK, TO220FP

# 650 V TRENCHSTOP™ IGBT6



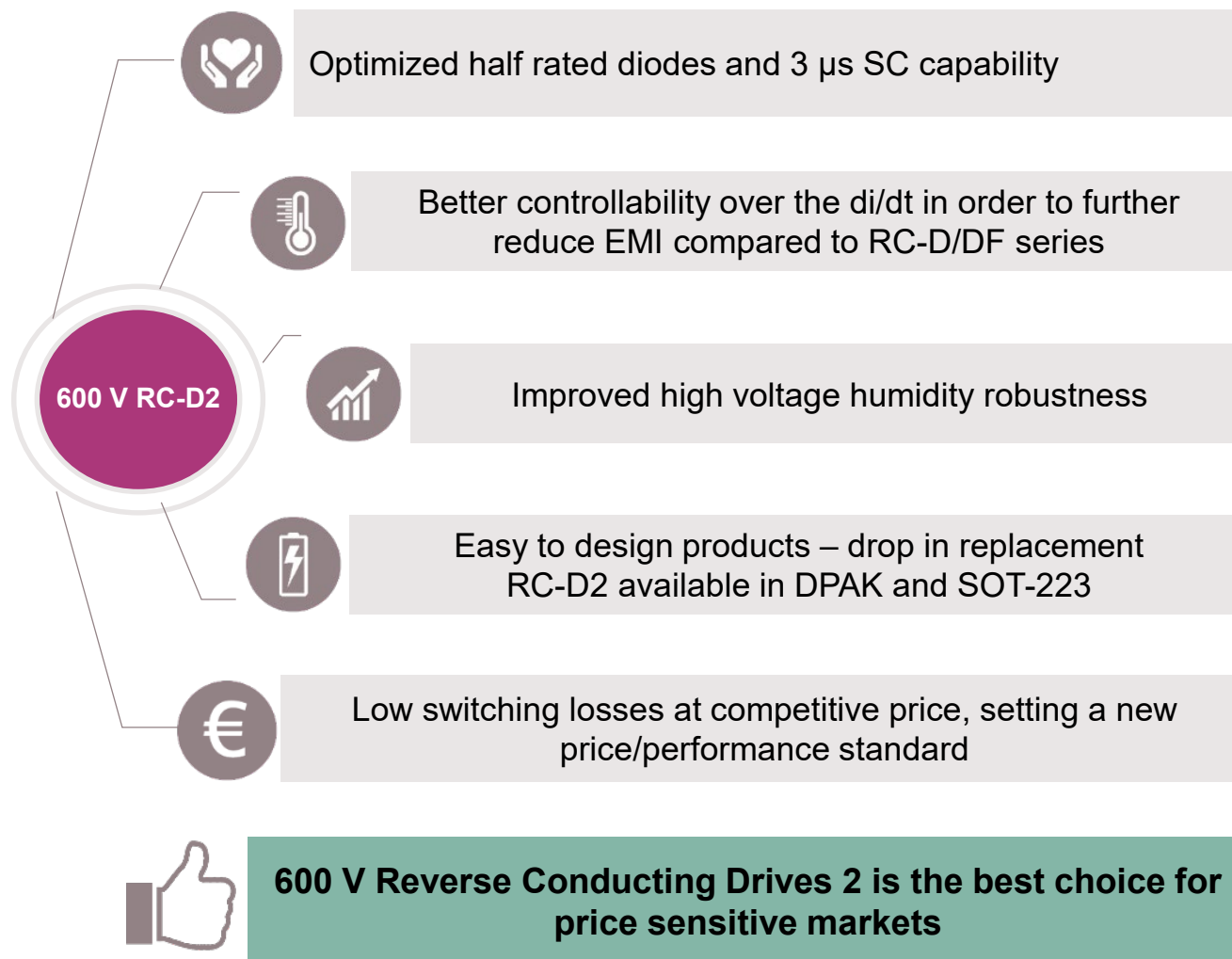
650 V IGBT6 portfolio		
Ic 100°C	DPAK	TO-220FP
	TRENCHSTOP™ IGBT 6	TRENCHSTOP™ IGBT 6
6	IKD06N65ET6	
8	IKD08N65ET6	IKA08N65ET6
10		IKA10N65ET6
15		IKA15N65ET6
Single IGBT		
6	IGD06N65T6	
10	IGD10N65T6	
15	IGD15N65T6	



**Recommended for washing machine drums**

**Recommended for washing machine pumps**

# 600 V Reverse Conducting Drives 2



600 V RC-D2 portfolio		
Ic 100°C	SOT-223	DPAK
	RC-D2	RC-D2
1	IKN01N60RC2	
3	IKN03N60RC2	
4	IKN04N60RC2	IKD04N60RC2
6	IKN06N60RC2	IKD06N60RC2
10		IKD10N60RC2
15		IKD15N60RC2



**Recommended for washing machines**

**Recommended for washing machine pumps**



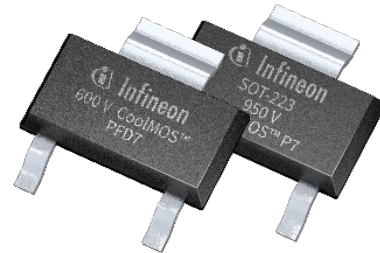
# Recommended CoolMOS™ 7 SJ MOSFETs portfolio for washing machines

## Drain pump inverters

Series: **600 V CoolMOS™ PFD7**  
Packages: DPAK, SOT-223  
 $R_{DS(on)}$  max: 1.0 - 2.0  $\Omega$   
Examples: IPD60R1K0PFD7S, IPN60R1K5PFD7S

## AUX Power

Series: **700 - 950 V CoolMOS™ P7**  
Packages: DPAK, SOT-223  
 $R_{DS(on)}$  max: 0.6 - 4.5  $\Omega$   
Examples: IPN80R4K5P7, IPD70R2K0P7S



## Recommended package

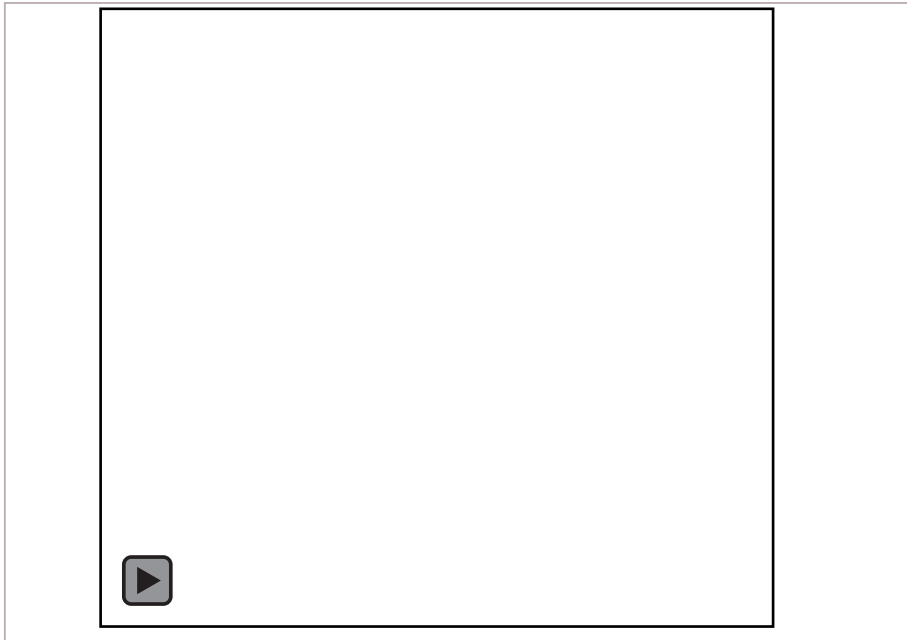
**SOT-223**, the cost-effective drop-in replacement for DPAK



**7**  
CoolMOS™

# Infiniteon provides state-of-the-art evaluation boards to ensure a fast time-to-market for customers

## EVAL\_DRIVE\_3PH\_PFD7



OPN: EVALDRIVE3PH\_PFD7TOBO1

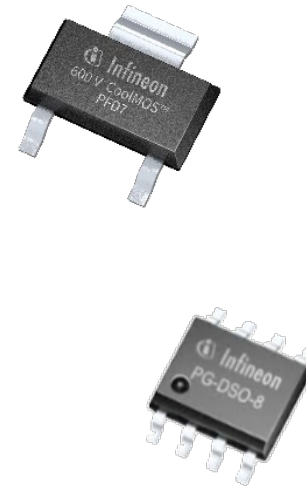
Learn more: [IFX product website](#)

### Summary of benefits

- › High efficiency
- › Cost effective solution
- › Simplified design
- › Smooth startup
- › Download software free of charge

### List of components

- › 600 V CoolMOS™ PFD7 ([IPN60R1K5PFD7S](#))
- › 2ED EiceDRIVER™ (2ED28073J)
- › iMOTION™ microcontroller (IMC101)



**Three-phase inverter power stage** with half-bridge gate-driver IC based on 600 V CoolMOS™ PFD7, the latest Infineon's SJ technology with fast body diode:

**Compact 3-phase motor drive system** up to 100 W

Designed for **sensorless FOC** motor control

**Spin your motor** with easy-to-use GUI

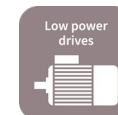
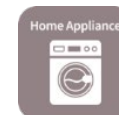
The hardware board and motor control software provides:

→ Synchronous rectification algorithm to reduce reverse-current hard-commutation stress

→ Sensor-less speed controlled direct FOC startup

→ 3PH / 2PH SVM

→ Over-current protection by CTRAP



# 5th generation CoolSET™ for auxiliary SMPS

## Robustness

- › Integrated 700 V or 800 V superjunction MOSFET
- › Comprehensive protection features
- › Auto-restart scheme to minimize interruption

## Ease of design

- › Numerous design
- › Design tools, guide and application note
- › Reference designs

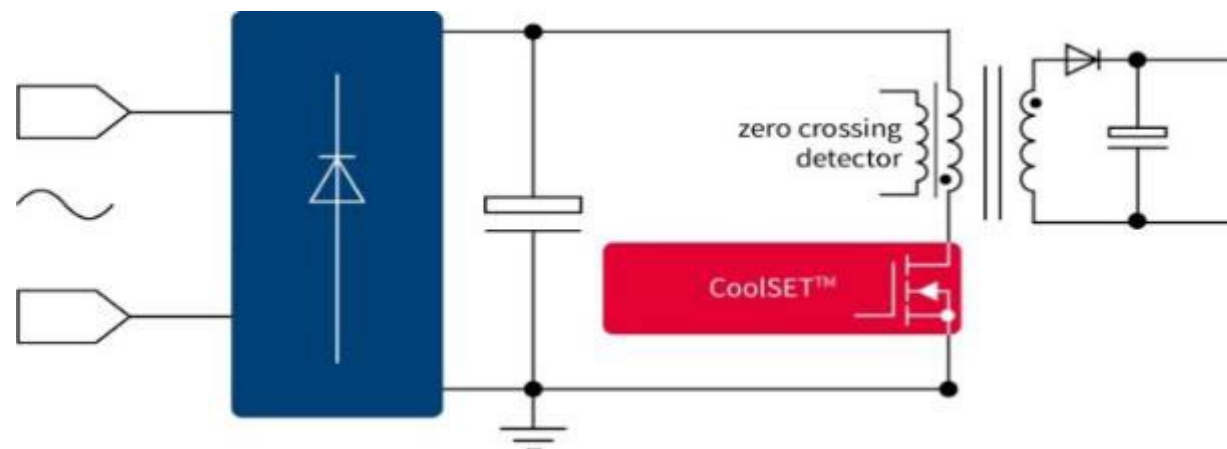
## Broad portfolio

- › Choice of fixed- frequency or quasi-resonant switching scheme
- › Highest power delivery up to 43 W
- › Available in DIP-7 or SMD DSO-12 package

More information → <http://www.infineon.com/CoolSET>



Auxiliary SMPS in Flyback topology to perform AC/DC power conversion to power the various system blocks in home appliances.



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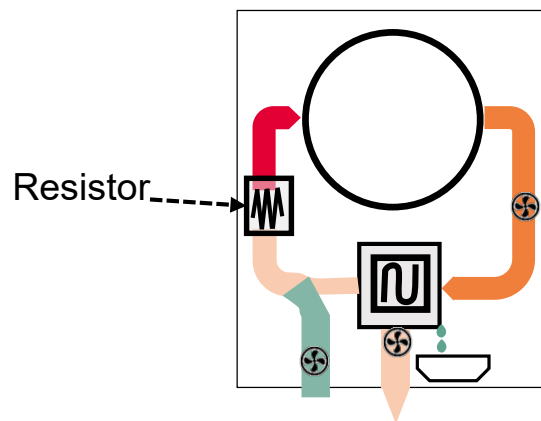
# Heat pump as a solution

- › Traditional heating technologies: best case 100% of electrical energy converted to heat (e.g. Resistive heating elements) **100%**

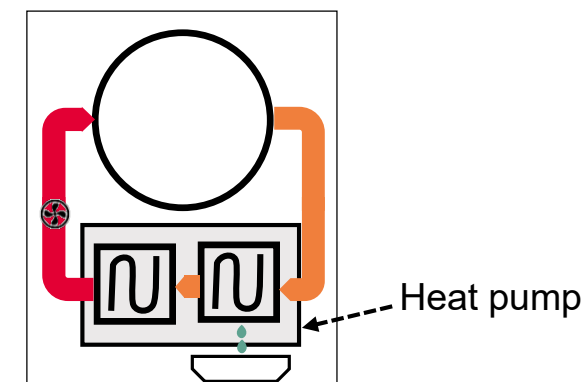
**Heat pumps:** can transfer same heat as conventional heating with just a fraction of the electrical energy requirement → up to 500% less electricity usage compared to resistive heating, depending on Coefficient of Performance (CoP)

**up to 500%**

**In traditional tumble dryers:** hot air used to dry the clothes gets first condensed to remove the moisture and then partially expelled in the ambient. 'New' air is therefore continuously heated-up by means of resistive heater.

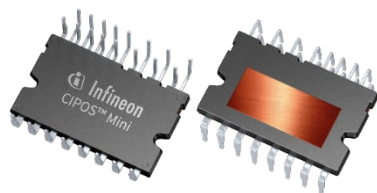


**In heat-pump tumble dryers:** hot air gets first condensed, as for conventional tumble dryers and it is then completely re-heated by means of the heat pump.



# Inverter for heat pumps: Integrated and discrete solutions

## Integrated solution



CIPOS™ Mini  
IKCM20L60GD

- › Excellent thermal performance
- › Higher power capability



Motor controller:  
IMC301

- › dual core device
- › Incorporates MCE 2.0



Gate Driver:  
6EDL04N06PT

- › Integrated bootstrap diode
- › Over current protection
- › Enable and fault reporting



Motor controller:  
XMC1402

- › Focus on low-cost embedded control applications

## Discrete solution



IGBT: RC-D2  
IKD10N60RC2

- › Monolithically integrated diode
- › Cost-optimized solution



Gate driver:  
1ED44175N01B

- › Cost and space savings by integrating the comparator
- › best-in-class fault reporting accuracy



SiC Diode:  
IDW30G65C5

- › Improved thermal characteristics
- › Lower figure of merit ( $Q_c \times V_f$ )



CoolMOS™:  
IPP60R120P7

- › Best-in-class  $R_{ds(on)}$
- › Inherently low gate charge



IGBT:  
IKWH20N65WR6

- › Lowest  $V_{CE(sat)}$
- › Lowest switching losses

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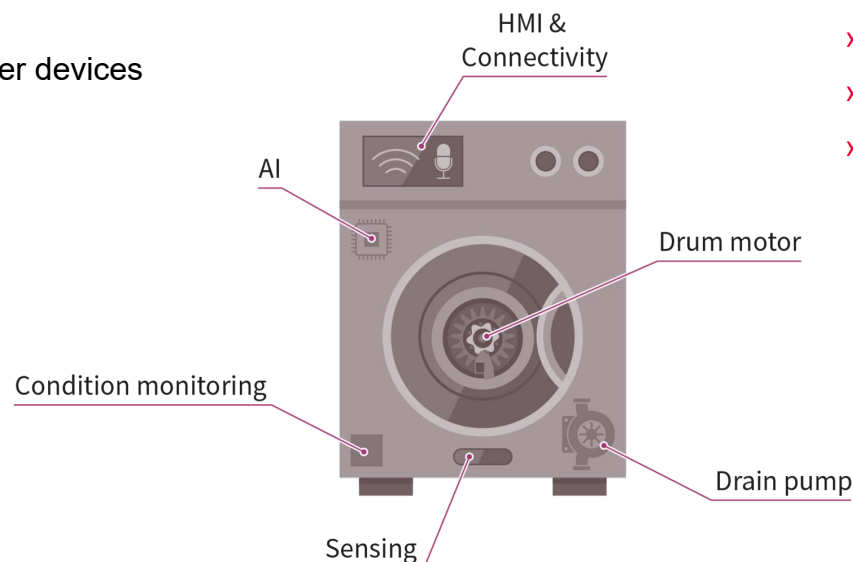
# Smart laundry systems: Trends, use cases and Infineon's offering

## Connect to the internet for wireless control

- › Be informed when program is finished
- › Update firmware and download new washing programs
- › Remotely turn on washing machine
- › Have washing machine communicate with other devices such as dryer

## Sense environment, machine and content

- › Presence detection: Is someone in the room to interact with?
- › Fabric detection
- › Weight measurement
- › Filter clogging
- › Water flow and pressure measurement
- › Water level measurement
- › Foam detection



## Condition monitoring

- › Detect defects before they happen to inform maintenance service

## User interface

- › Intuitive display to control washing machine
- › Voice control
- › Gesture control

# Value proposition AIROC™ connectivity solutions

	Wi-Fi® 4	Wi-Fi® 5/6		Wi-Fi® 6
	Lowest cost	High data throughput	Congestion/future proof	Low power consumption
<b>Interoperability</b>	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.			
<b>Co-existence</b>	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.			
<b>Operating system</b>	We support a variety of RTOS solutions including FreeRTOS, MBED OS, etc. We also support Linux and Android natively using our FMAC driver.			
<b>Tech support</b>	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.			
<b>Long distance</b>	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.			
<b>High integration</b>	Our MCU solutions can drive the touch button/screen, whilst also serving as the main control and as a host to the Wi-Fi solution.			
<b>End-customer analytics</b>	Product analytics that improve the performance, the reliability and connectivity of the appliance by providing real-time visibility into the performance of the appliance			

# Value proposition of individual AIROC™ products

Wi-Fi® 4	Wi-Fi® 5/6		Wi-Fi® 6
Lowest cost	High data throughput	Congestion/future proof	Low power consumption
Wi-Fi® 4: 43439	Wi-Fi® 5 (11AC): 4373/E	Wi-Fi® 6/5G: CYW55571/2/3	
<ul style="list-style-type: none"> <li>› Unique home appliances solution offering Wi-Fi® 4, Bluetooth® 5 and WPA 3 allowing smart home certification (WFA certificate)</li> </ul>	<ul style="list-style-type: none"> <li>› Wi-Fi® 5 dual band (2.4 GHz and 5 GHz)</li> <li>› Capable of beam-forming for increased range</li> <li>› External PA (E-version) on module also increasing range</li> </ul>	<ul style="list-style-type: none"> <li>› Tri-band, (2.4 GHz, 5 GHz, 6 GHz)</li> <li>› Target wake time (TWT): Today router is master, but it allows end device to negotiate with the router when to wake up</li> <li>› Higher modulation schemes: Even higher data through-put</li> </ul>	

# AIROC™ selection guide

Type	Wi-Fi®		Wi-Fi® + Bluetooth®	BT only	BT (BLE) in µC
µC	Integrated processor	External host	External host	Integrated processor	Integrated processor
SW	Library/Modus Toolbox	Drivers for all major µC available	Drivers for all major µC available	SDK	SDK
Products and functions	Wi-Fi® 4: CYW43907	CYW43364	Wi-Fi® 4: CYW43438/9	BT 5.0: CYW20735	
			<ul style="list-style-type: none"> <li>› WPA3 security</li> <li>› Voice command</li> </ul>		
	Wi-Fi® 5: CYW54907		Wi-Fi® 4: CYW43012	BT5.2: CYW20829	
			<ul style="list-style-type: none"> <li>› Low Power Wi-Fi® + Bluetooth®</li> </ul>		
			Wi-Fi® 5: CYW4373/E		PSoC™ 63xx <ul style="list-style-type: none"> <li>› M0+ and M4</li> <li>› Capsense</li> <li>› Motorcontrol</li> <li>› Main Control</li> </ul>
			Wi-Fi® 6/5G: CYW55572		
			<ul style="list-style-type: none"> <li>› Audio/Video Transfer</li> </ul>		

# Make your washing machine become a part of the smart home eco system with Matter



The biggest global companies came together



## Google, Amazon, Apple back Matter standard so smart home devices cooperate

Smart lightbulbs, door locks, thermostats and other items should be easier to install and interconnect, and Google will upgrade many current products with Matter software updates.

<https://www.cnet.com/home/smart-home/google-amazon-apple-back-matter-standard-so-smart-home-devices-cooperate/>

With a new open-source approach to interoperability

- › Today's Smart Home is often too complex, insecure, and incompatible
- › Smoother and easier experience for consumers (onboarding, control...) and manufacturers
- › User interoperability – products from all matter members should work together
- › Strong security

Infineon is the leading provider for key technologies

- › AIROC™ Wi-Fi® combos
- › AIROC™ Bluetooth and Multi-protocol SoCs
- › PSoC™ 62 and 64 MCUs
- › OPTIGA™ Trust anchor

Infineon's support for Matter

- › Integration of Matter Open Source and Open Thread into Modus Toolbox
- › Customers can integrate using these tools for CYW43439
- › Security will be integrated into SoC to offer options of internal or external security processor for maximum flexibility
- › Long term assurance across Wi-Fi® and 15.4 products

# Develop highly capable graphics and deploy to PSoC 6 with Embedded Wizard

## Accelerate Graphics Development on PSoC 6



## Embedded Wizard Studio Powering PSoC 6 Graphics

- › No royalties, just tool license
- › Reduces lines of code to write
- › Wide range of code examples

## What Features are available

- › Embedded Wizard Studio allows the deployment of graphics onto the device without writing any code
- › Has callbacks which can be used to link touch and voice
- › Very low resources used meaning a very low footprint
- › With hardware modification, supports DMA mode for better refresh rate

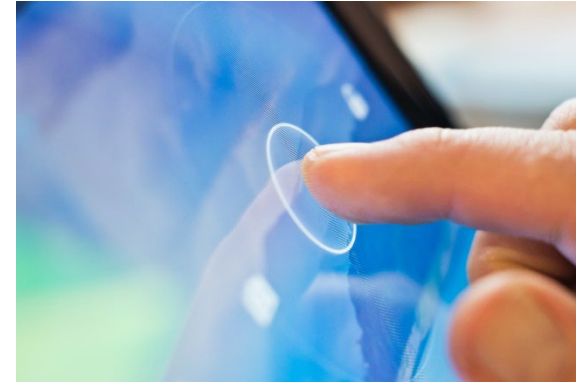
## Getting Started Links and Collateral

- › For information on the product, please visit:
  - <https://www.embedded-wizard.de/platforms/infineon-psoc6>
- › For getting started visit, please visit
  - <https://doc.embedded-wizard.de/getting-started-psoc-62s2>
- › Also supports the Smart Home Reference Design

# Touch control: Implement touch with the leading provider of touch solutions



Replace mechanical buttons



Implement touch screens

- 1 Replace mechanical buttons with the world's easiest touch solution
- 2 Complex touch HMI interfaces in single MCU platform with connectivity
- 3 Dual-core high performance touch solution with IoT edge compute capabilities

MBR3 – configurable touch controllers

PSoC™ 4 touch controllers

PSoC™ 6 touch controllers

# Why use Infineon touch solutions in your appliance?

## 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.

## 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**



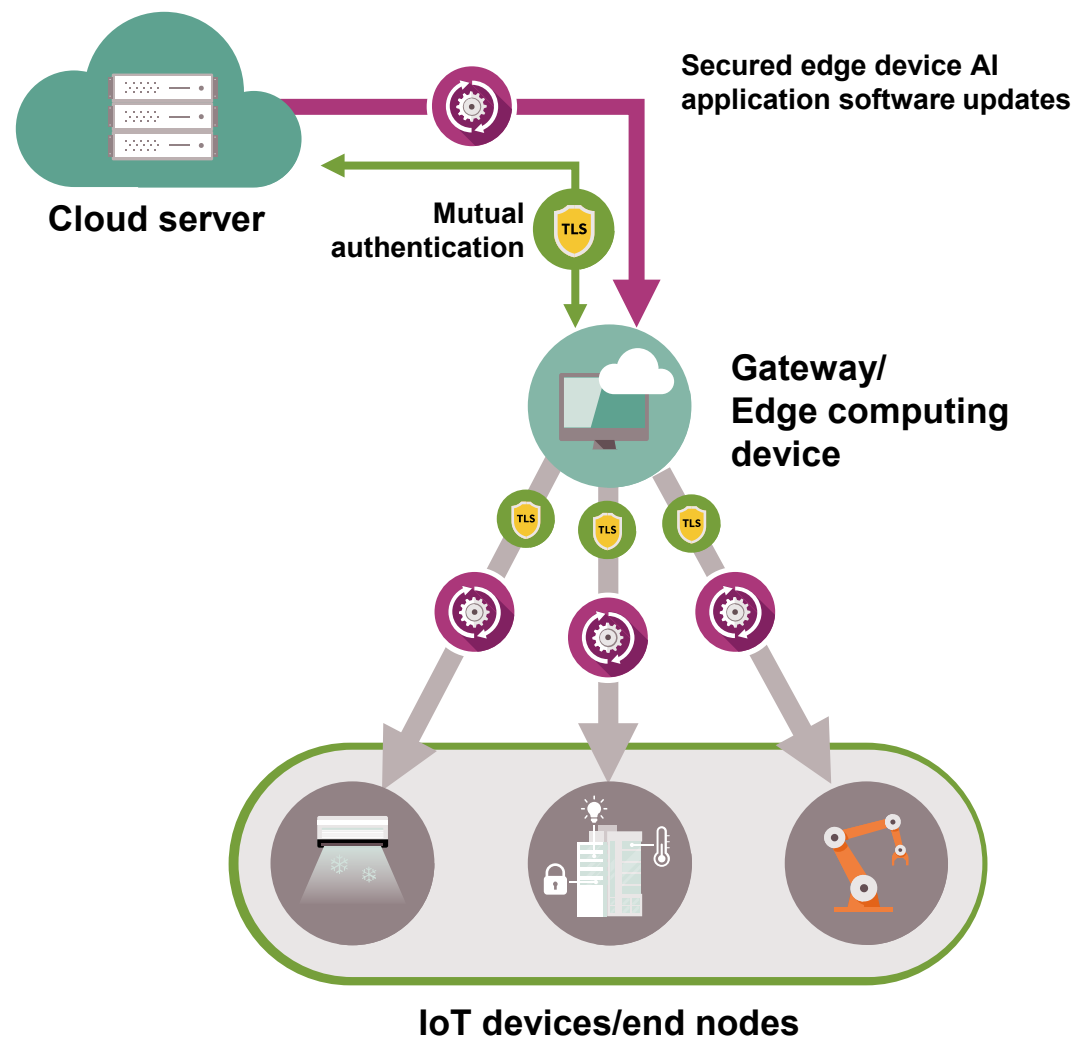
Protection against **the manipulation of the data**



Protection against **illegal update of firmware**

**Don't let your smart residential air con be the weakest point in the system.**

# OPTIGA™ Trust M – Protecting the IoT from cloud to end nodes



**Secured connectivity**



**Secured cloud authentication**



**Secured software update over-the-air**

# Value proposition OPTIGA™ Trust family in washing machines

## Shorter time to market

- › By using Infineon's PKI\* infrastructure including root CA and HSM infrastructure certificate authorities you are able to 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

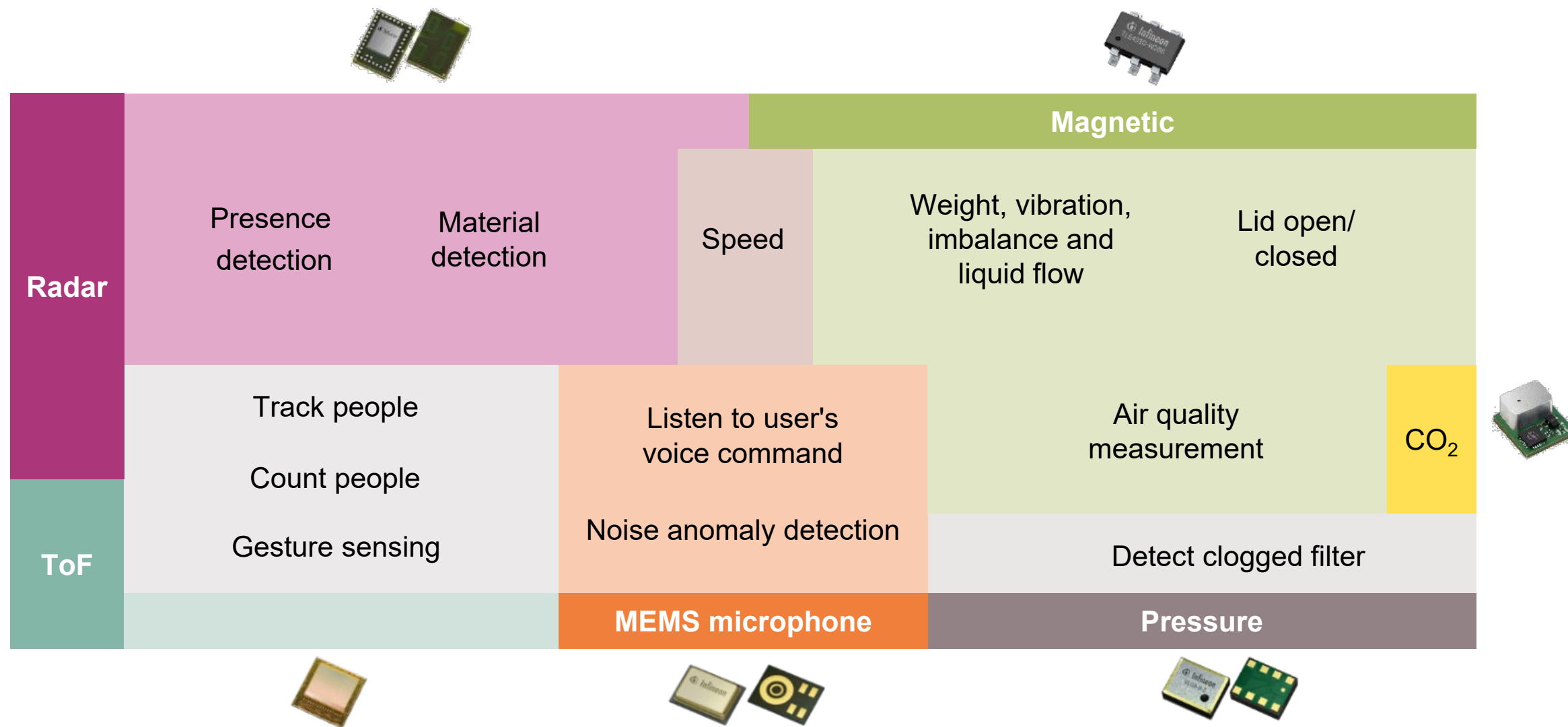
- › Infineon's OPTIGA™ Trust family provides an anchor of trust for connecting your smart air con device to the cloud, protects your critical data transferred over your network and thus your application running on your smart air con.

## 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

# Devices become smart by imitating human senses



# Our wide sensor portfolio enables smart home appliance use cases

	Sensors				
	Radar	Microphone	Pressure	CO <sub>2</sub>	Magnetics
Unique selling propositions	Plug and Play for motion detection	Highest SNR to detect voice in noisy devices and from long distances	Very rugged (IPX8 certified) even for A/C outdoor use	Plug & Play: Direct data output	Smallest 3D Hall sensor in the market in WLB package
	Proven reliability: First radar in a consumer product	Global market leader	Small size	Highest performance/ data quality	Broadest portfolio in the market: Hall switches and latches 3D, Linear Hall and angle sensors
	Ongoing A/C and fridge projects		World's best resolution	Smallest form factor	High end to cost efficiency – all products provide benchmark quality at their level

# Interact with user with XENSIV™ radar solutions for presence detection

Determine if a person is present in the room, even if the person is not moving

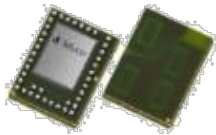
Infineon offer

**Example:** Interact with user approaching washing machine

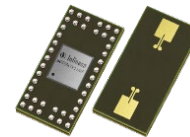


Sense presence up to 10 m (very high sensitivity, even recognizes breathing and tiny motions)

Sense motion up to 10 m without using a microcontroller



BGT60TR13C for highest sensitivity



BGT60LTR11AIP for lowest cost, motion detection

- › Software solution and turnkey solution available for high-end presence detection
- › 60 GHz with integrated antennas to reduce design-effort

# Door contact, weight and imbalance measurements using XENSIV™ hall sensors

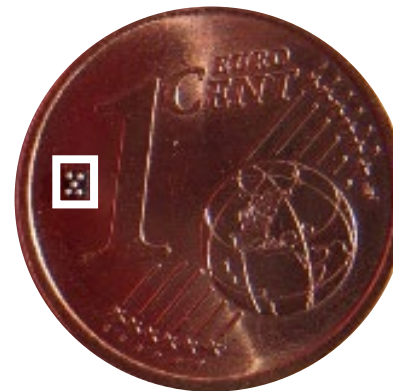
Determine open/close of door, drum load and imbalances

**Example 1:** Door Contact – disable door opening while in operation (Hall Switch)

**Example 2:** Detect drum load and imbalance (Hall Switch, 3D)



Smallest 3D Hall sensor



Infineon offer

Hall

- › Contactless measurement principle minimizing wear and tear
- › Better design flexibility as with mechanical/resistive solution

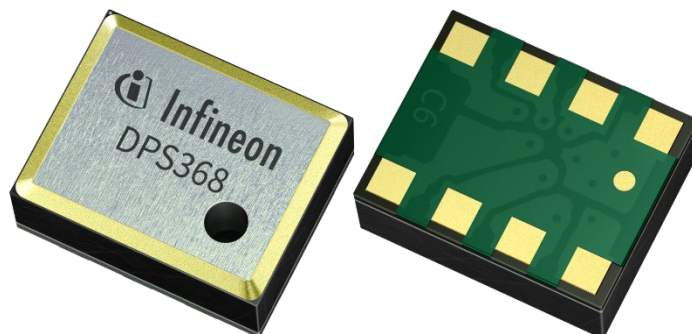
3D

- › Improved mechanical design flexibility with 3D hall technology
- › Push and rotation functionality with a single sensor (e.g. HMI interfaces)
- › 3D sensor in WLB package: Extremely small size, slim PCB design, high design flexibility (lateral, vertical)
- › Software modules supporting XMC™ and PSoC™

# Detect filter clogging with XENSIV™ pressure sensors

Detect if filters are clogged to alert user or inform maintenance service

**Example:** Pressure sensor detects if filter is clogged



## Infineon offer

- › Software solution and turnkey solution available for high-end presence detection
- › IPX8 certified for additional robustness (water, dust, humidity)
- › High precision and accuracy:  
Precision:  $\pm 0.002$  hPa  
Rel. accuracy:  $\pm 0.06$  hPa
- › Small size

# Tank and water level measurements using XENSIV™ sensors and CapSense® technology

Determine fill rate of water tank or drain pan

Keep water from overflowing, stop water inflow or inform the user accordingly.  
Water tanks for the water dispenser at the right level  
Avoid water leakage from the drain pan

Infineon offer

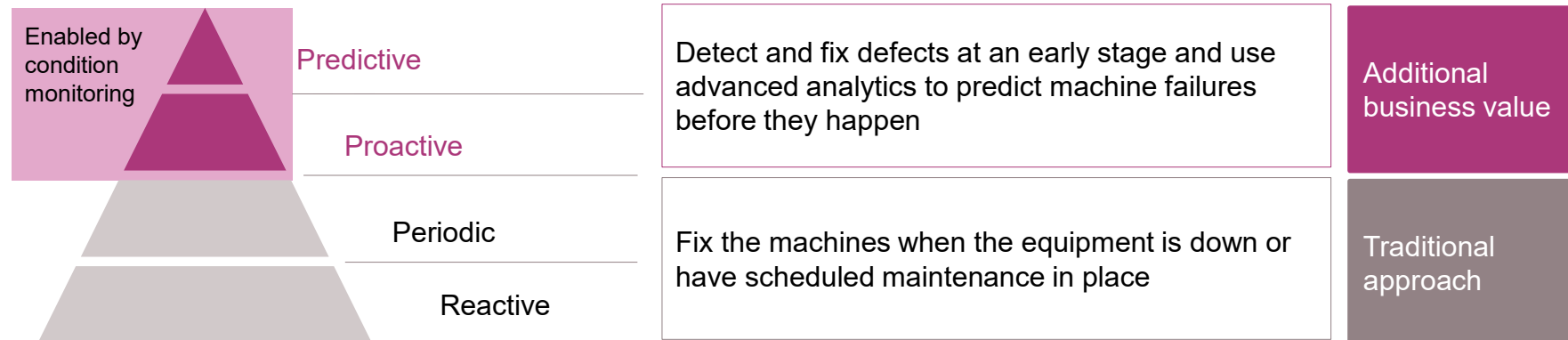
- › CapSense® Liquid Level Sensing Shield ([Link](#))
- › XENSIV™ radar sensor
- › MEMS microphone for ultrasonic measurements

Infineon offers several options to detect water depending on your needs



# Condition monitoring and predictive maintenance

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



## Infineon offering

XENSIV™ DPS368 Barometric Pressure Sensor	› <b>Air flow measurement</b> in the system	XENSIV™ PAS CO2 Sensor	› <b>CO<sub>2</sub> level monitoring</b> for indoor quality monitoring
XENSIV™ TLI4971 Current Sensor	› <b>Current measurement</b> at fan and compressor	XENSIV™ IM69D130 MEMS Microphone	› <b>Noise monitoring</b> at motor and compressor
XENSIV™ TLI493D-W2BW 3D Magnetic Sensor	› <b>Position monitoring</b> of components	PSoC™ 6, PSoC™ 4, XMC4000	› <b>Data processing and system management</b>
XENSIV™ TLx496x Hall Sensors	› <b>Open/close lid detection</b>	OPTIGA™ Trust M	› <b>Secured connection &amp; communication</b>
XENSIV™ TLI4966G Double Hall Sensor	› <b>Speed &amp; direction monitoring</b> of components	Wi-Fi® and Bluetooth Combo controller	› <b>Connectivity for remote management</b>
XENSIV™ TLE4997E2 Linear Hall Sensor	› <b>Linear movement and vibration</b>		

# Infiniteon, AWS and Klika Tech developed a joint evaluation kit for enabling predictive maintenance in HVAC systems



- › Kit includes different **set of sensors** including microcontroller and embedded security **for holistic condition monitoring** of HVAC systems
- › Infineon's **hardware content**:
  - Pressure sensors
  - MEMS microphones
  - 3D magnetic sensors
  - Hall sensors
  - Current sensors
  - Microcontroller
  - Embedded security solution
- › **All required software** for a basic setup of collecting data at the edge, preprocessing it and sending it to the AWS Cloud is part of the kit
  - <https://github.com/Infineon/pred-main-xmc4700-kit>
- › AWS CloudFormation template and Quick Start guides **simplify setup** for testing
- › Kit **ideal starting point** for customization and next steps towards a final solution for production

# UV-C LEDs can eliminate bacteria and viruses to equip washing machines with water 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





Part of your life. Part of tomorrow.