

빠르게 성장하는 고효율 가변속 드라이브 시장에 최적화된 모터 컨트롤 솔루션

이근형 (Infineon AP Regional Marketing)
2018년 8월 17일



Agenda

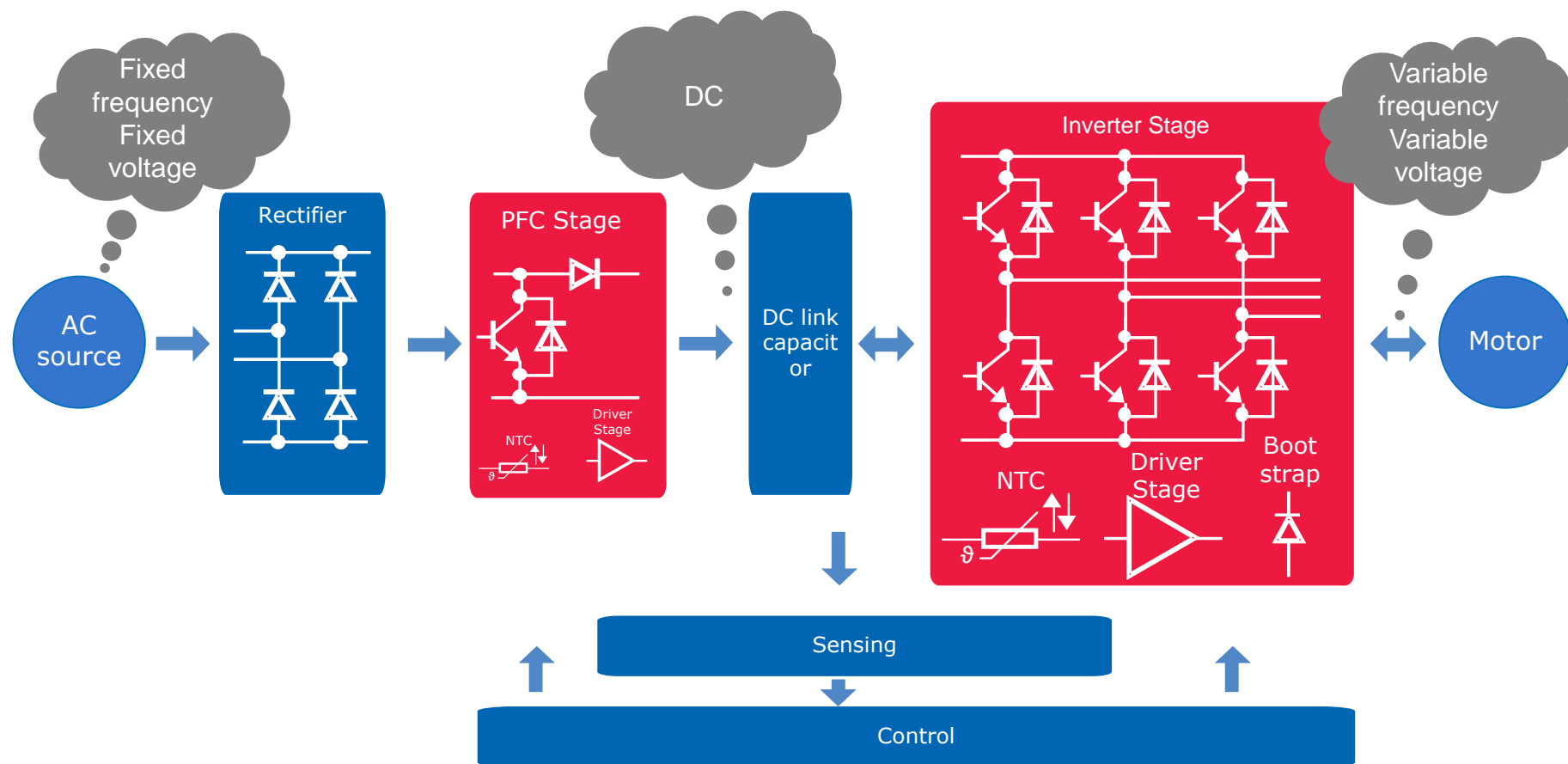
- 1 Home Appliances Market Overview
- 2 iMOTION
- 3 IPM (Intelligent Power Module)
- 4 MADK (Modular Application Design Kit)
- 5 Advanced isolation
- 6 Summary

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Why variable speed motor drives?

- > Energy Efficiency Regulations force the use of variable speed drives
- > Variable speed motor drives can save up to 40%~60% of energy
- > These are implemented with AC → DC → AC power conversion



Drives Appliances - Application Cluster

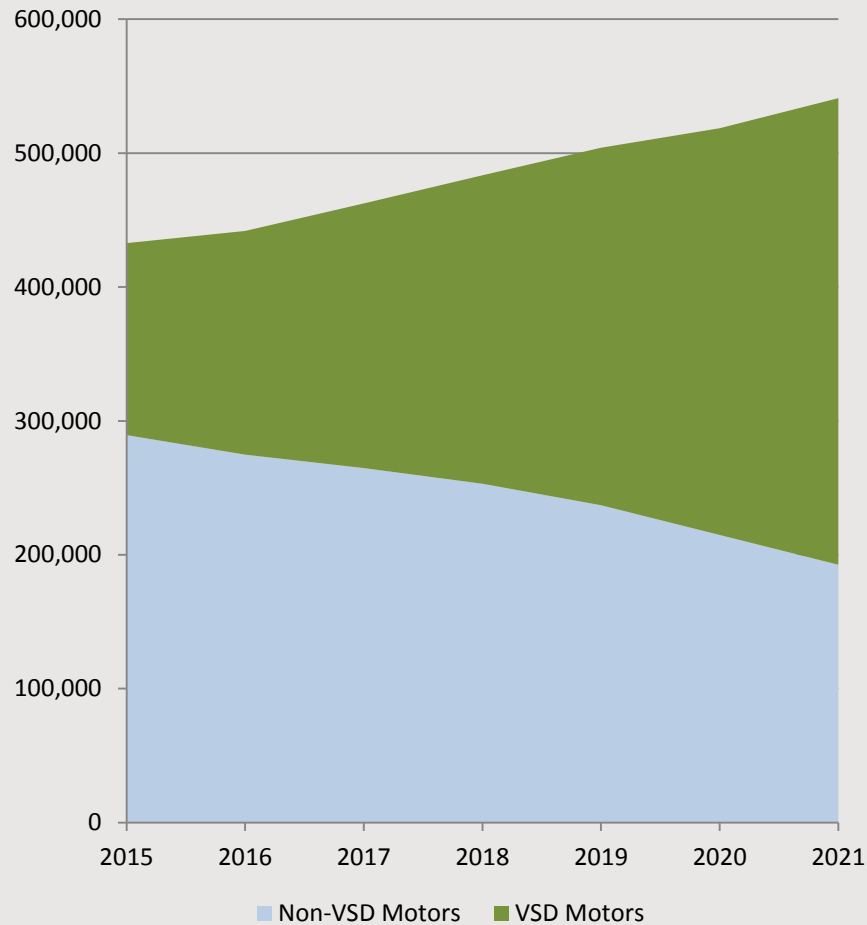
	uIPM	IPM or Discretes
Washing machines (WM)		600W - 1.5kW
Dishwasher (DW) main pump	80-150W	
WM & DW drain pump	30 - 90W	
Fridge Compressor and Fan	30 - 300W	
Commercial Freezer	10 - 40W	
Vacuum Cleaners		300W - 1.6kW
Kitchen tools		300W - 1kW
Ceiling & pedestal fan	30W - 200W	
Aircon fan	30W - 300W	
Aircon compressors		800W - 3kW
Circulation pumps	30W - 100W	
Air purifier	30W - 100W	

Inverterization is driving growth in Home appliances globally

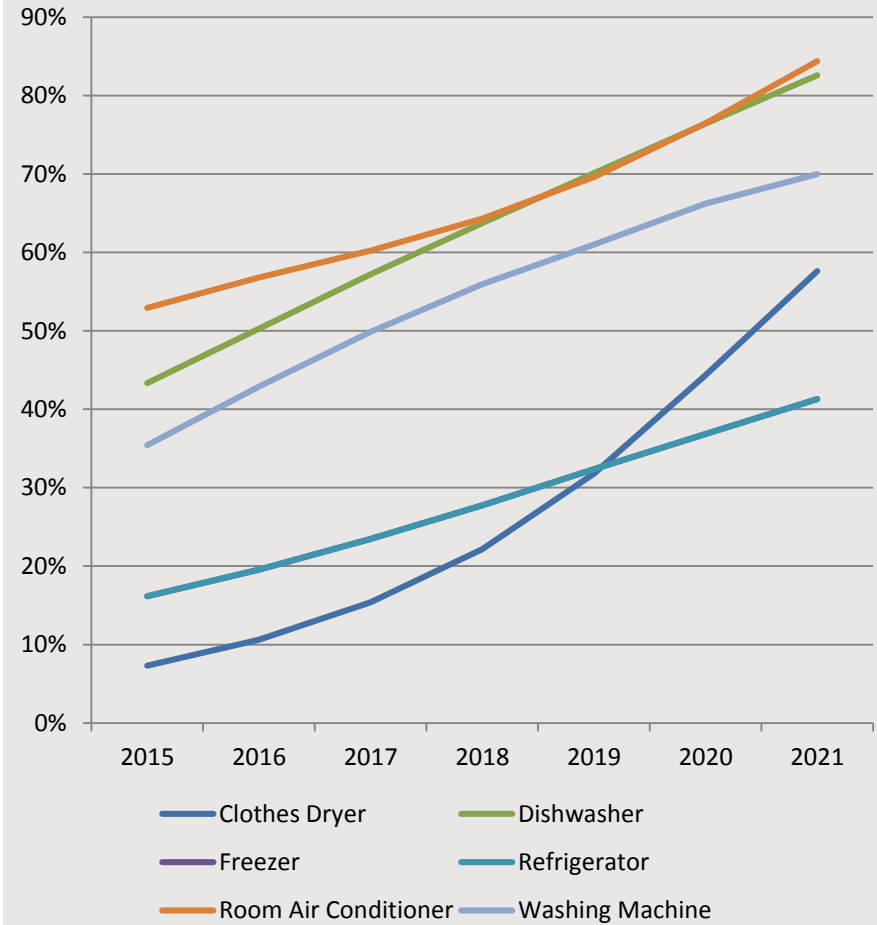


Total worldwide shipments (kU)

(Clothes Dryer, Freezer, Dishwasher, Refrigerator, AriCon, Wahsin Machine)



Inverter-Share by Application

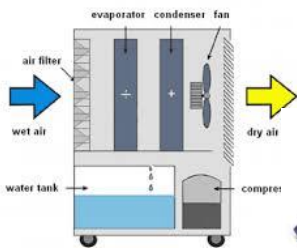


Source: IHS Major home appliance market report - 2017

Small Home Applications



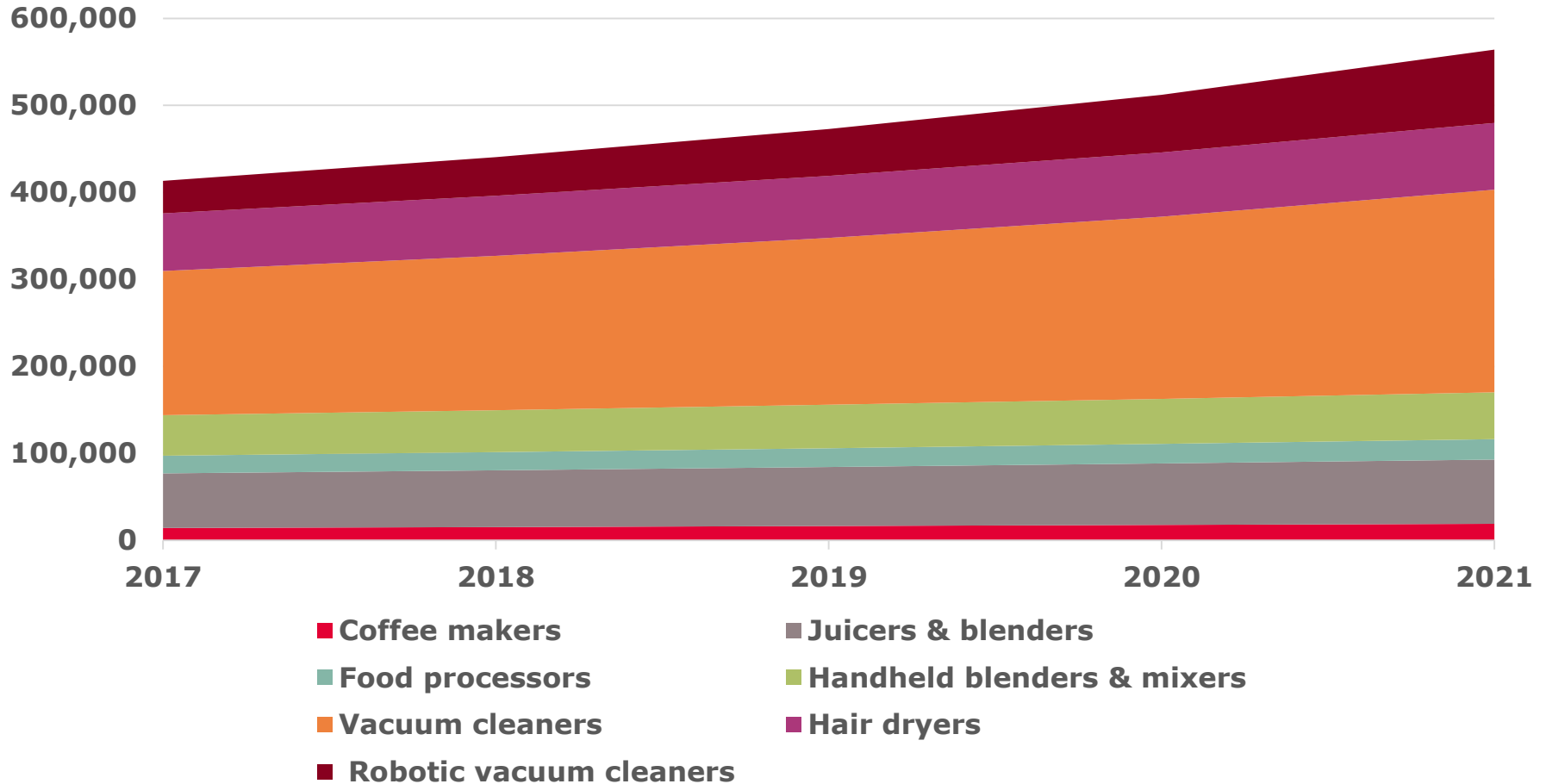
**Part of Life
\$ Volumes \$
Heating
Motion-Control
Power Supply
Sensing
Authentication**



Small Home Appliances World Motor Market Size – Unit Shipment



Motor Market for Small Appliances Unit Shipment (k)



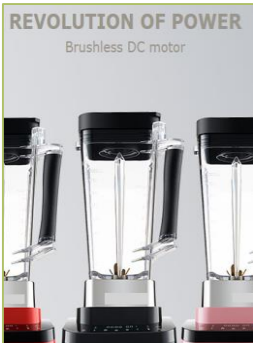
Source: IHS Markit 2017

Blenders have evolved in terms of design, functionality and power



Touchscreen interface

- › **Preset recipe programs**
- › **i.e. Juice, Smoothie, Hot Drinks, Sauce, Grind, Ice Cubes, Dough program modes**



BLDC motor

- › **10 times Longer Life**
- › **20% Quieter**
- › **40% Lower Energy Consumption**
- › **Heavy Duty Blending Specialist**



Bluetooth Connectivity & Smartphone APPs



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

- › Works produces wider speed range and bigger torque.
- › Any blending, crushing, or grinding tasks are all a breeze.

Longer Continuous Work Time

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

More Safe

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

Infineon System Solution Residential Air conditioning



Outdoor Unit



Compressor



Fans



Compressor

- › Main MCU: XMC series
- › Inverter: IPM/CIPOS MINI
- › PFC: IGBT/H5 series, Diode/Rapid diodes, Gate IC/1ED44176N01F
- › Precise and Quick Cooling: Pressure & Temperature Sensor Combo/DPS422
- › SMPS: CoolSET/5QR series

Outdoor Fan

- › Inverter: IPM/CIPOS Micro

Indoor Fan

- › Inverter: IPM/Smart IPM

Indoor Unit



Fans



Voice



Radar



Air Purifier



AI

- › Voice Assistant: Microphone/High SNR MEMS Microphone

HEPA filter

- › Authentication of Filter: Secure Elements match/OPTIGA Trust B

Human Detection

- › People presence detection, counting, tracking: Radar sensor/BTG24xTRxx

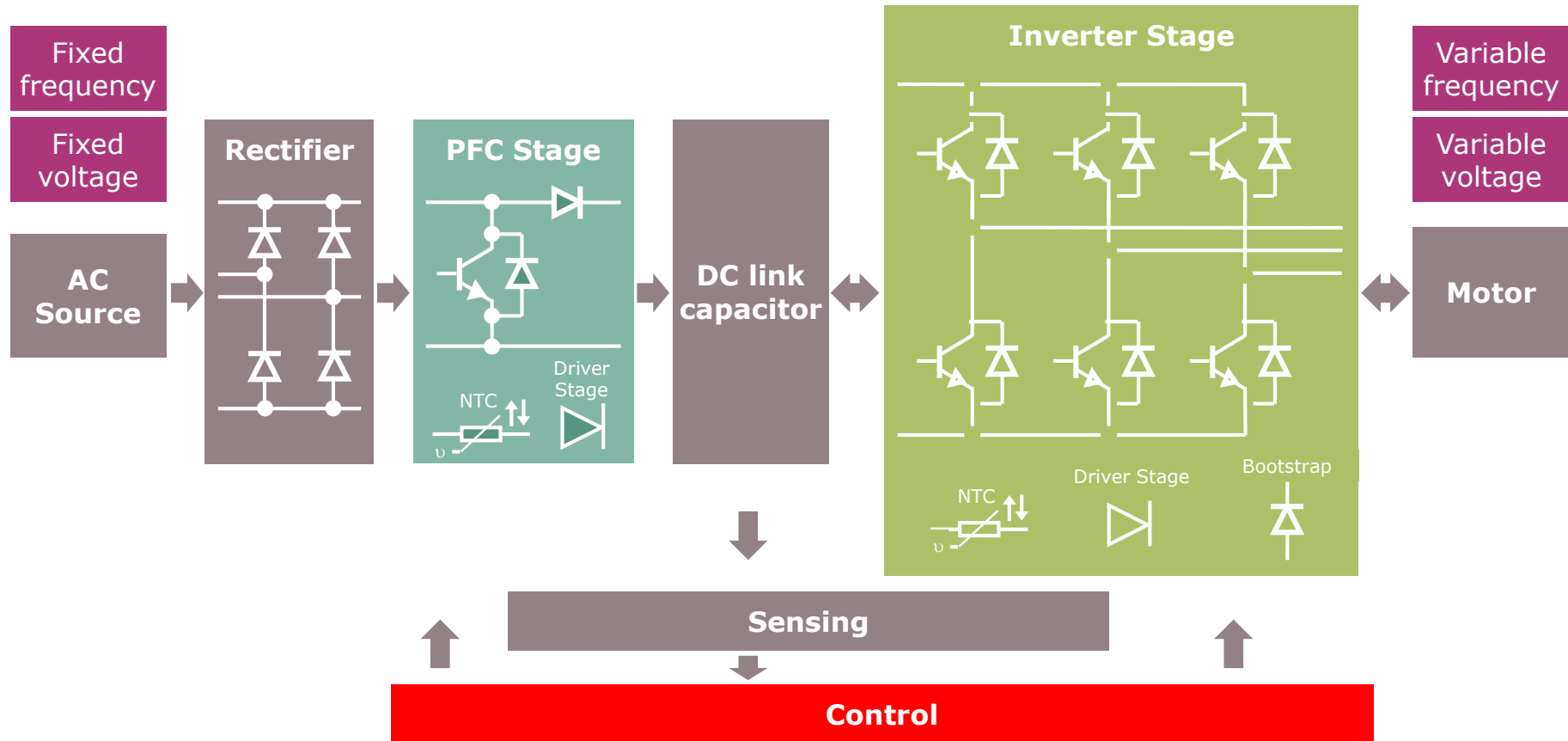
Gas Sensor

- › CO2 Sensor: PAS CO2 Sensor/Real PAS CO2 Sensor Module – XMC, MOSFET, PAS Sensor

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Infineon Offers Variable Speed Motor Drives



■ IPM
 ■ iMOTION
 ■ IPM / IGBT, Diode, Gate IC

What is iMOTION™ ?



iMOTION™

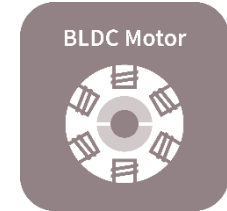
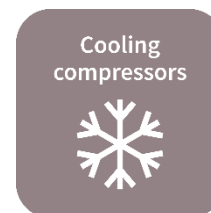
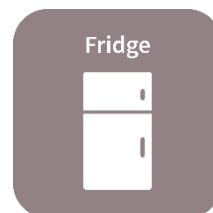
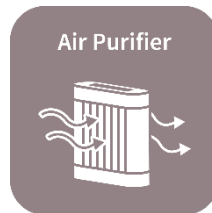
Solution Platform Dedicated to Motor Control

established in
2006

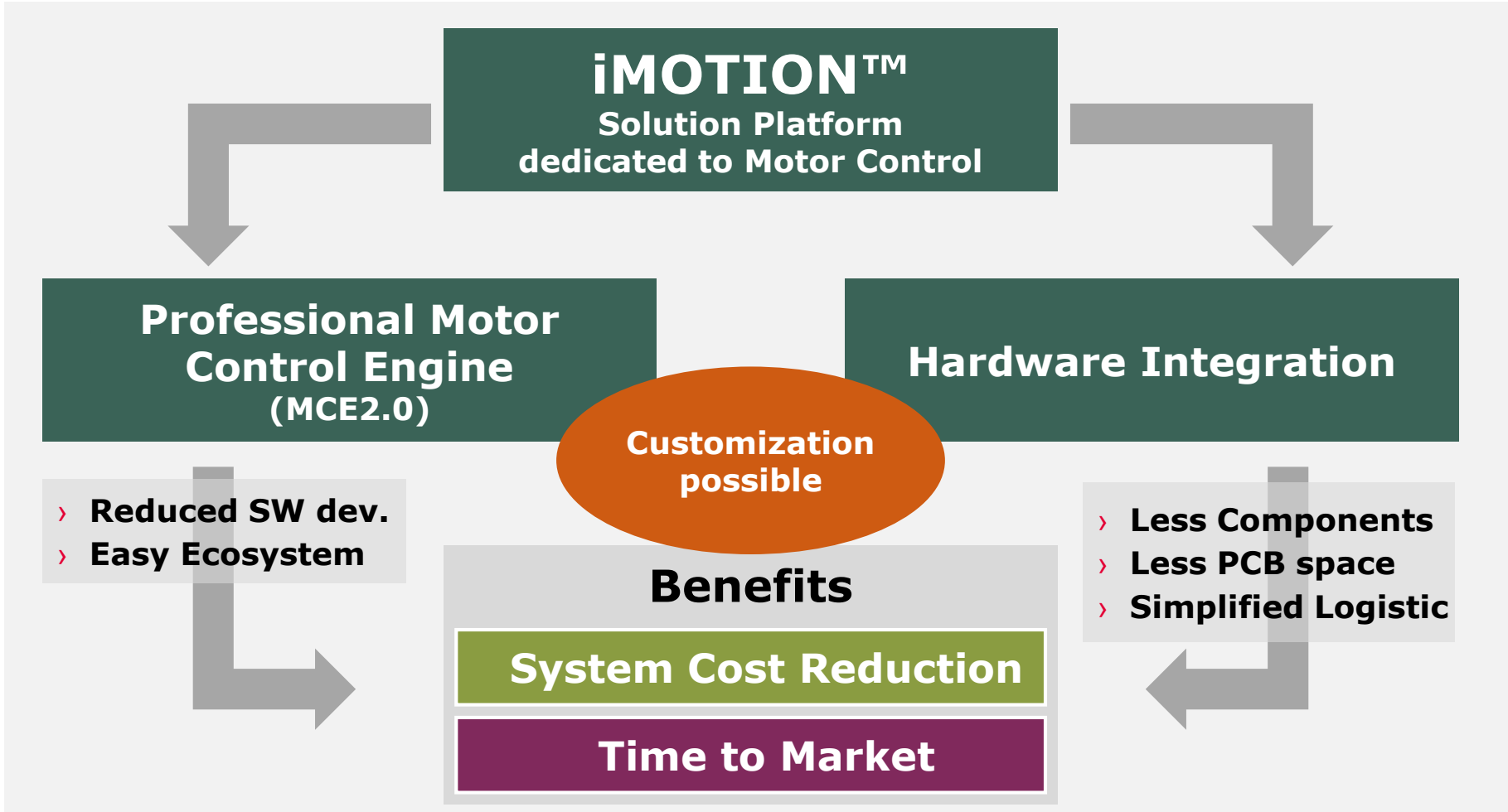
>30 productive
parts

High Volume
Production

Target Applications

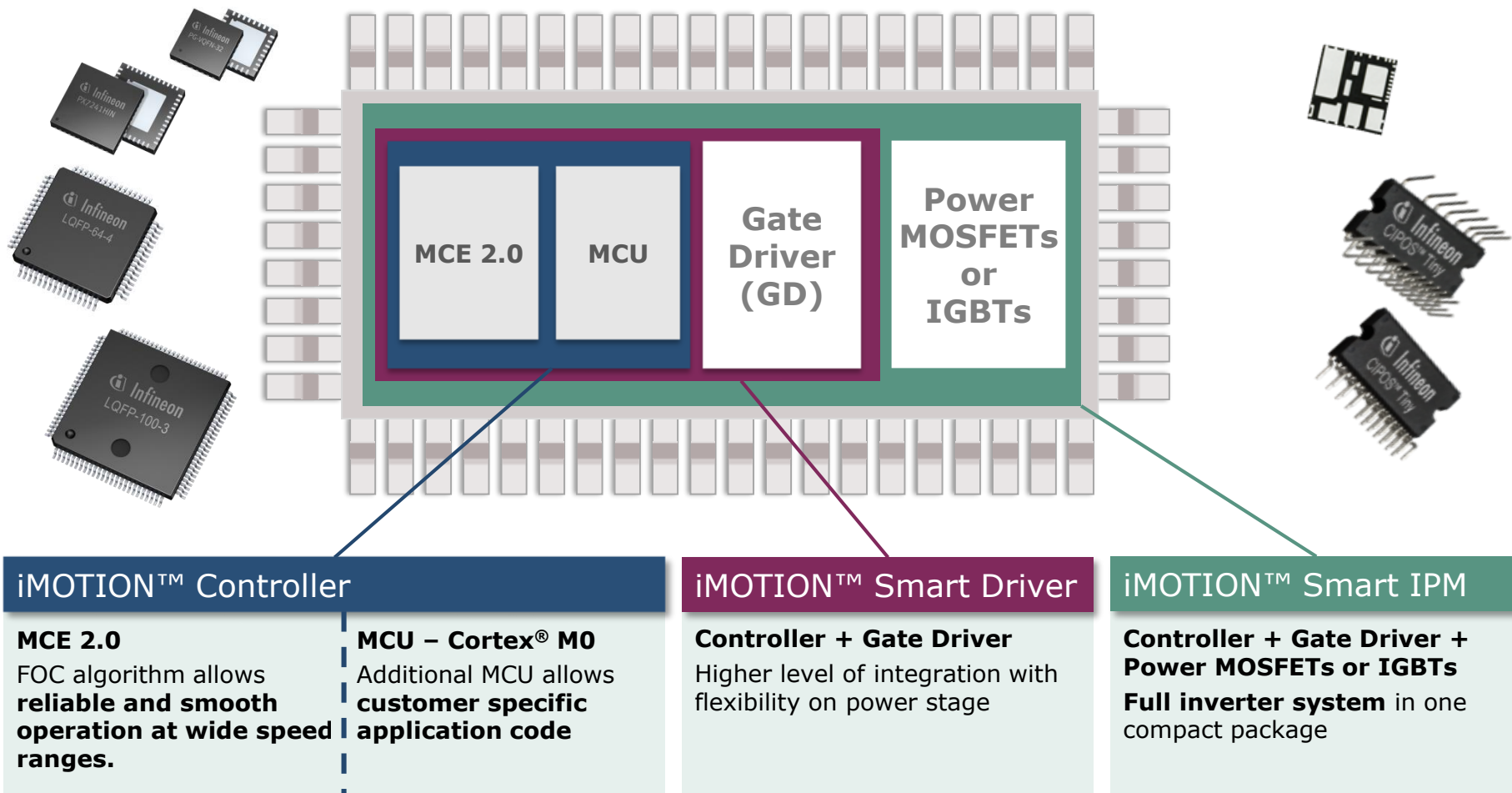


Our Solution



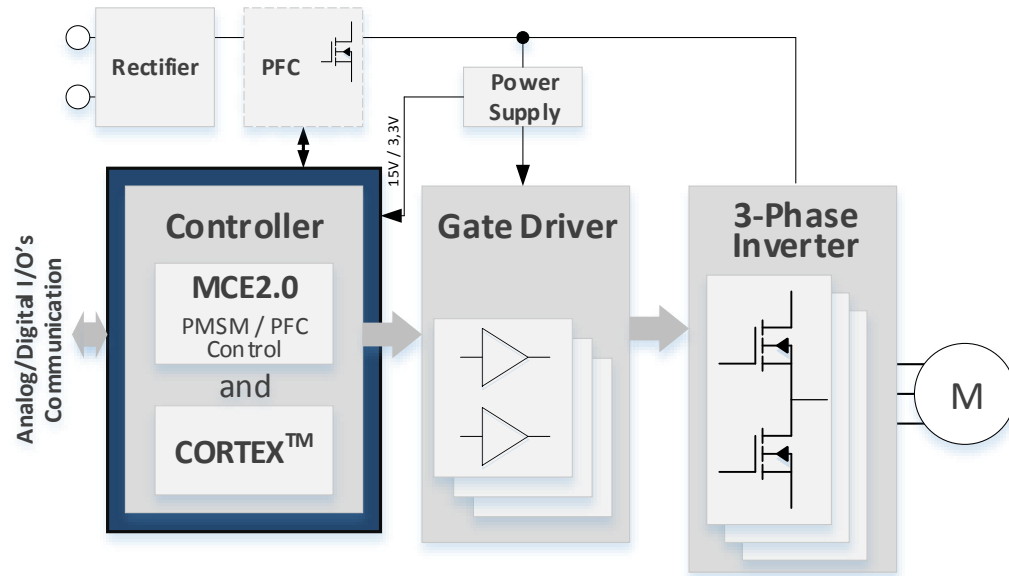
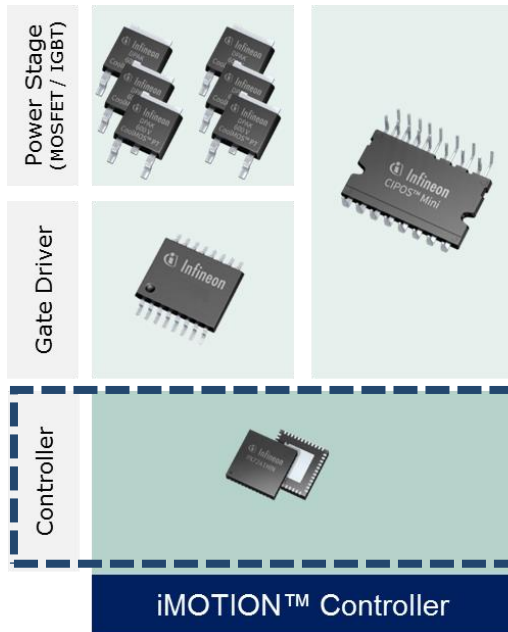
iMOTION™ 2.0

– From Motion Controller to Smart IPM



iMOTION™ 2.0 Controller

Scalable integration for inverters

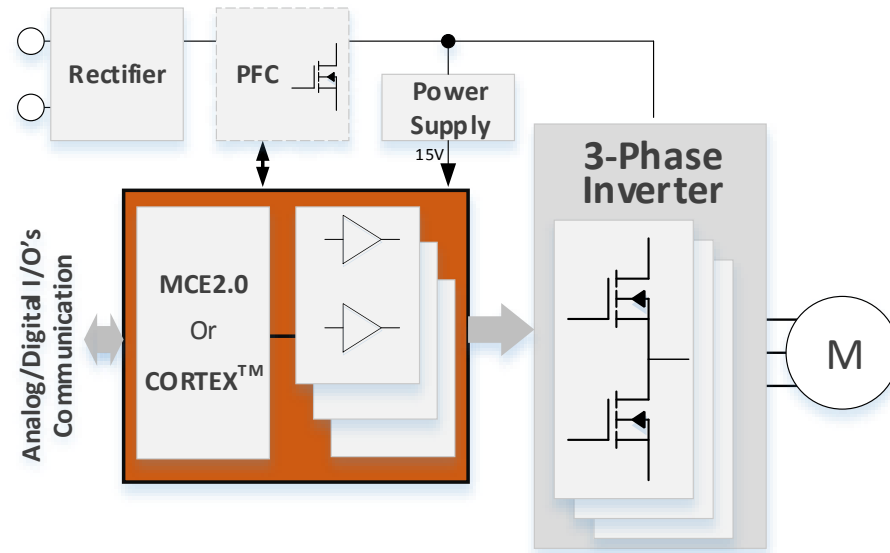
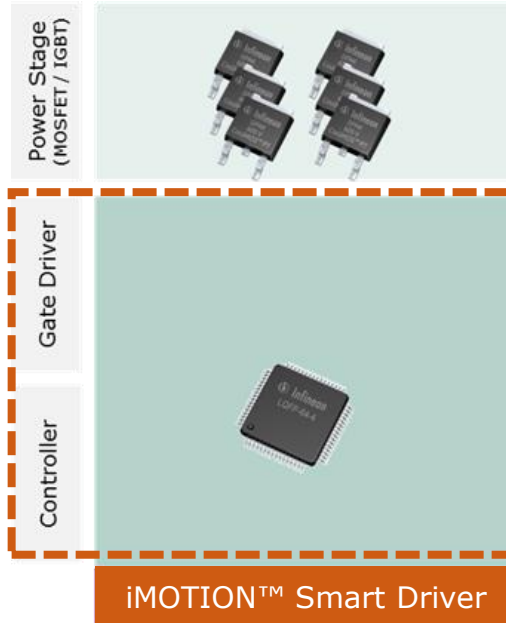


iMOTION™ CONTROLLER Benefits

- › MCE 2.0 – Proven Motion Control Engine – no software – only motor configuration
- › High performance algorithm for sensor less FOC + Boost/Totem Pool PFC
- › Optional additional Cortex® M0 for implementing customer application specific functions

iMOTION™ Smart Driver

Next level of integration

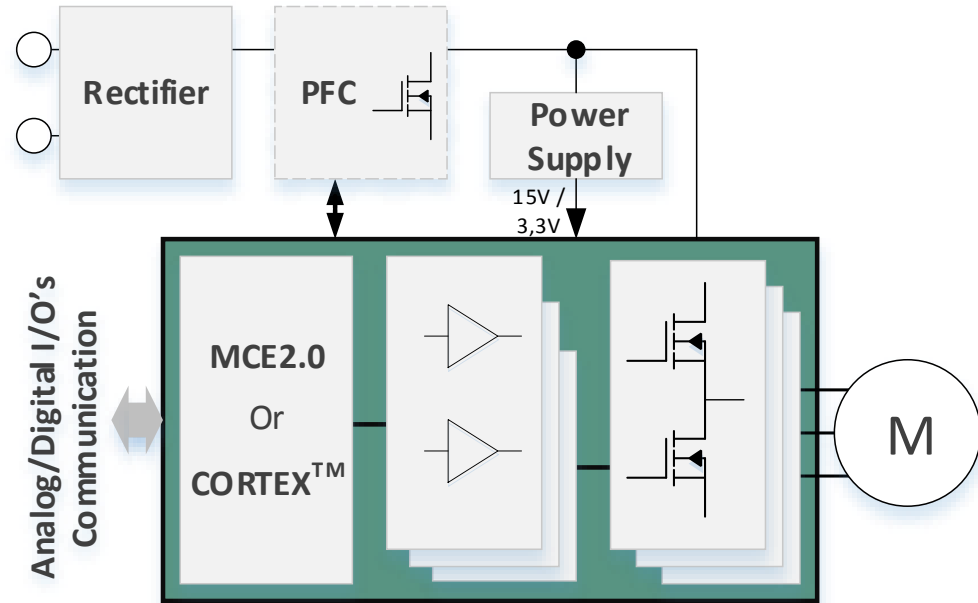
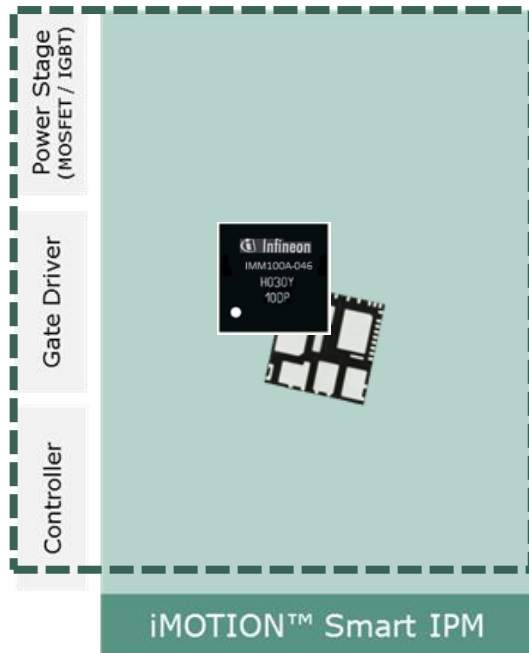


iMOTION™ Smart Driver Benefits

- › Cost saving integrated gate driver reducing BOM and board space
- › Full flexibility to choose the fitting power stage
- › A- Version: High flexibility – Standard ARM® Cortex®-M0 for implementing customer application code
- › T-Version: Easy to Use with MCE2.0 (Motion Control Engine) – multiple PMSM motor control algorithms

iMOTION™ Smart IPM

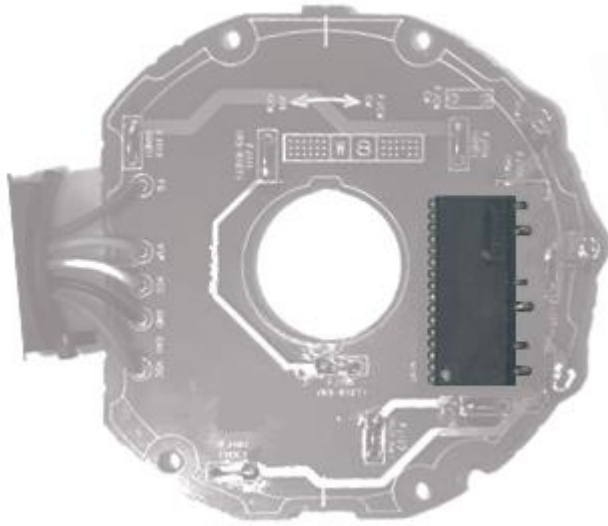
Full inverter in a package



iMOTION™ Smart IPM Benefits

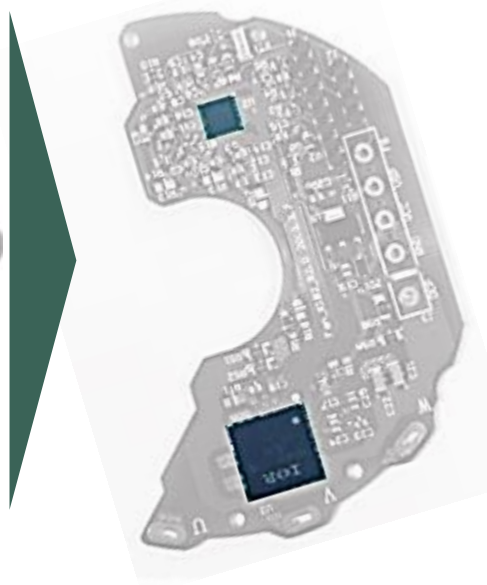
- › Full Inverter System in one Package – Multiple Power Stage Options available
- › A- Version: High flexibility – Standard Cortex®-M0 for implementing customer application code
- › T-Version: Easy to Use with MCE2.0 (Motion Control Engine) – multiple PMSM motor control algorithms
- › Reduced System Cost by reducing BOM count and PCB size

› Example: FAN Control for Indoor Aircons



- › Leaded power package
- › 2 side-mounted PCB as controller sits on the back side

Traditional IPM Solution



- Step1:
- › SMD power package (PQFN)
 - › Controller still separate package

Solution going to CIPOS™ Nano

+ significant PCB space savings



- Step2:
- › Full Integration in PQFN
 - › Only discrete / supply components separate

Solution with iMOTION™ Smart IPM

+ significant PCB space savings
 + reduced component count
 + simplified logistic

MCE
2.0

MCE 2.0

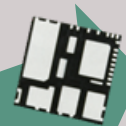
Motion Control Engine

- ❑ **Proven & Pre-Certified Motion Control Engine (MCE)** supporting sensor less FOC
- ❑ **New MCE 2.0 functionality** single or leg shunt, hall/encoder support, boost/totem pole PFC, support for Class B, ...

Analog & Power

All building blocks available to allow integration ...from Controller to Smart IPM

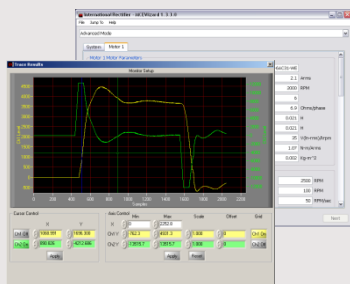
- ❑ Digital Controller (MCE 2.0, Cortex®-M0)
- ❑ Gate Driver
- ❑ MOSFETs / IGBT's



Fully Integrated Inverter System

Digital Controller

**iMOTION™
2.0**



MCE Wizard

Generate drive parameters for your target motor

MCE Designer

Tune your software

ARM®CORTEX®

- ❑ Cortex®-M0 on A-versions allows **customization** and implementation of own **application code**.

Ecosystem

Makes it easy to setup the device

Cortex®-M0

Allow easy customer adaptations

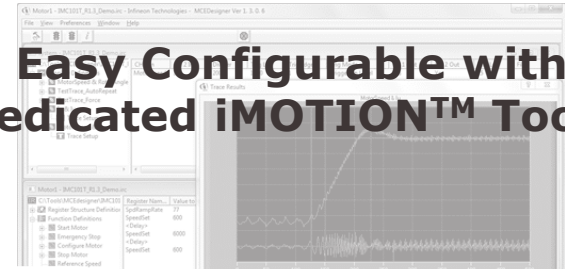
Motion Control Engine (MCE) Overview



High End Sensorless FOC solution

- Highly configurable to meet wide range of applications
- Multiple protections integrated to safeguard motor and power stage

Easy Configurable with dedicated iMOTION™ Tools



all iMOTION™ products can be used with **analog & digital hall-sensors**

Hall
Sensor
Support

Sensor-
less FOC

PFC
Control

Integrated PFC Control algorithms, for **high frequency Boost or Totem Pole PFC** Control.

MCE

MOTION Control
Engine

iMOTION™ products are also available with an integrated **CORTEX(R) M0** core.

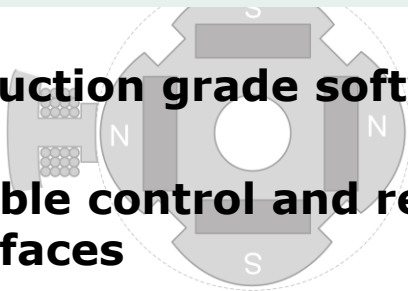
Cortex®
M0

Class B

iMOTION™ 2.0 products are **Class B (ICE60353)** pre-certified to reduce the effort on system level.

Production grade software

Flexible control and reporting interfaces



Scripting

iMOTION™ Turnkey products are equipped with a **Scripting Engine**, allowing simple adaptations to system needs (adding protocols, sensors,..)

Agenda

1 Home Appliances Market Overview

2 iMOTION

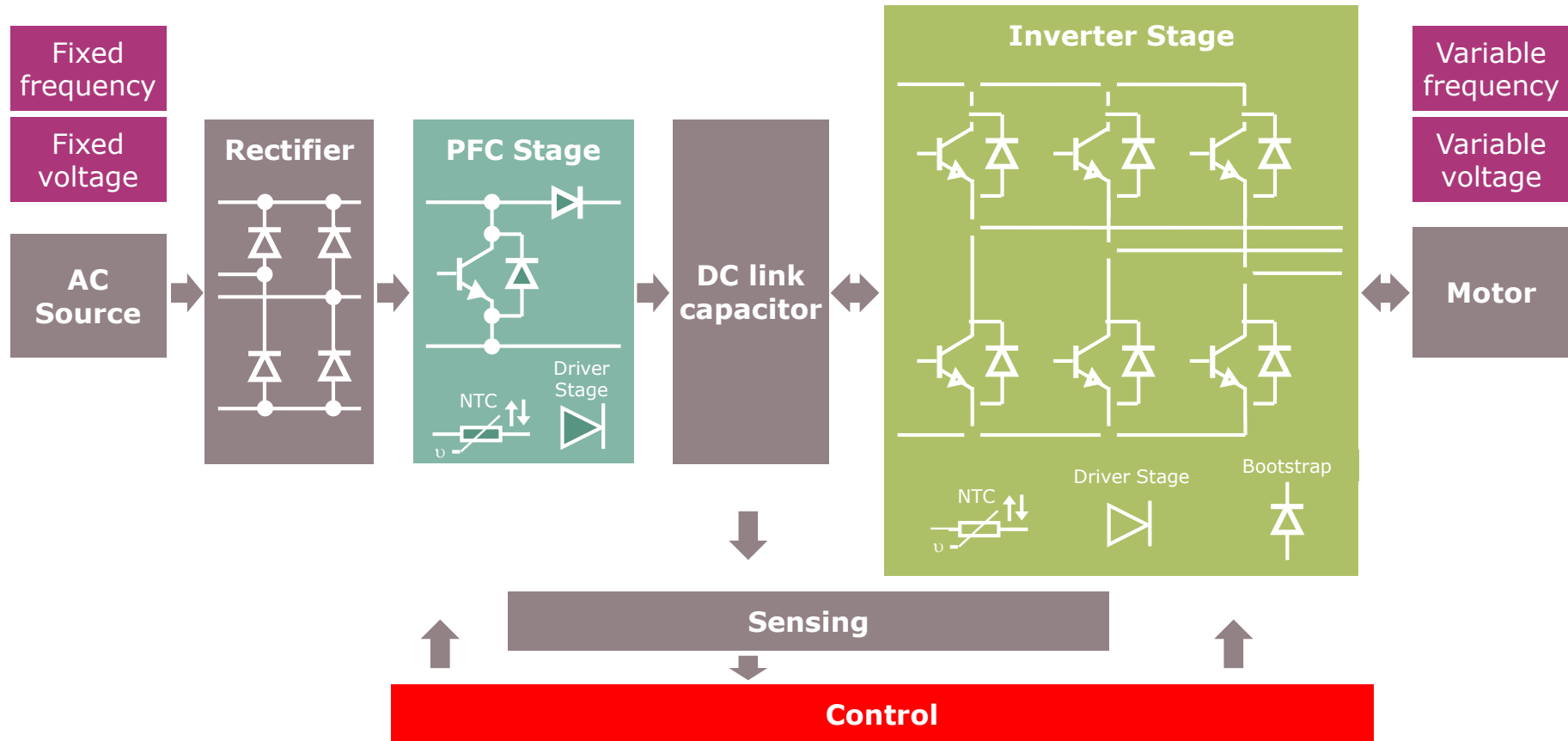
3 IPM (Intelligent Power Module)

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5 Advanced isolation

6 Summary

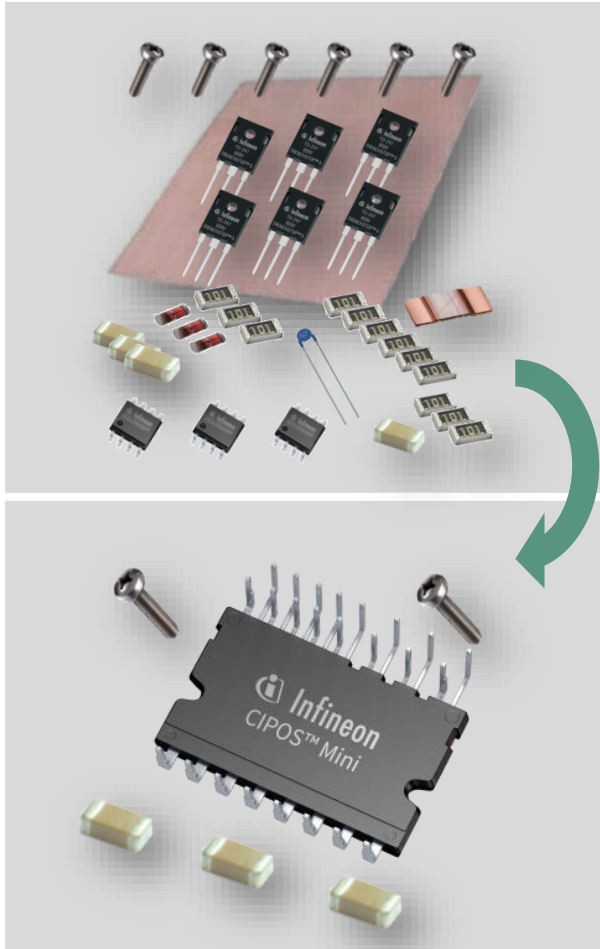
Infineon Offers Variable Speed Motor Drives



■ IPM
 ■ iMOTION
 ■ IPM / IGBT, Diode, Gate IC

Functional integration on system level is mainstream up to highest power

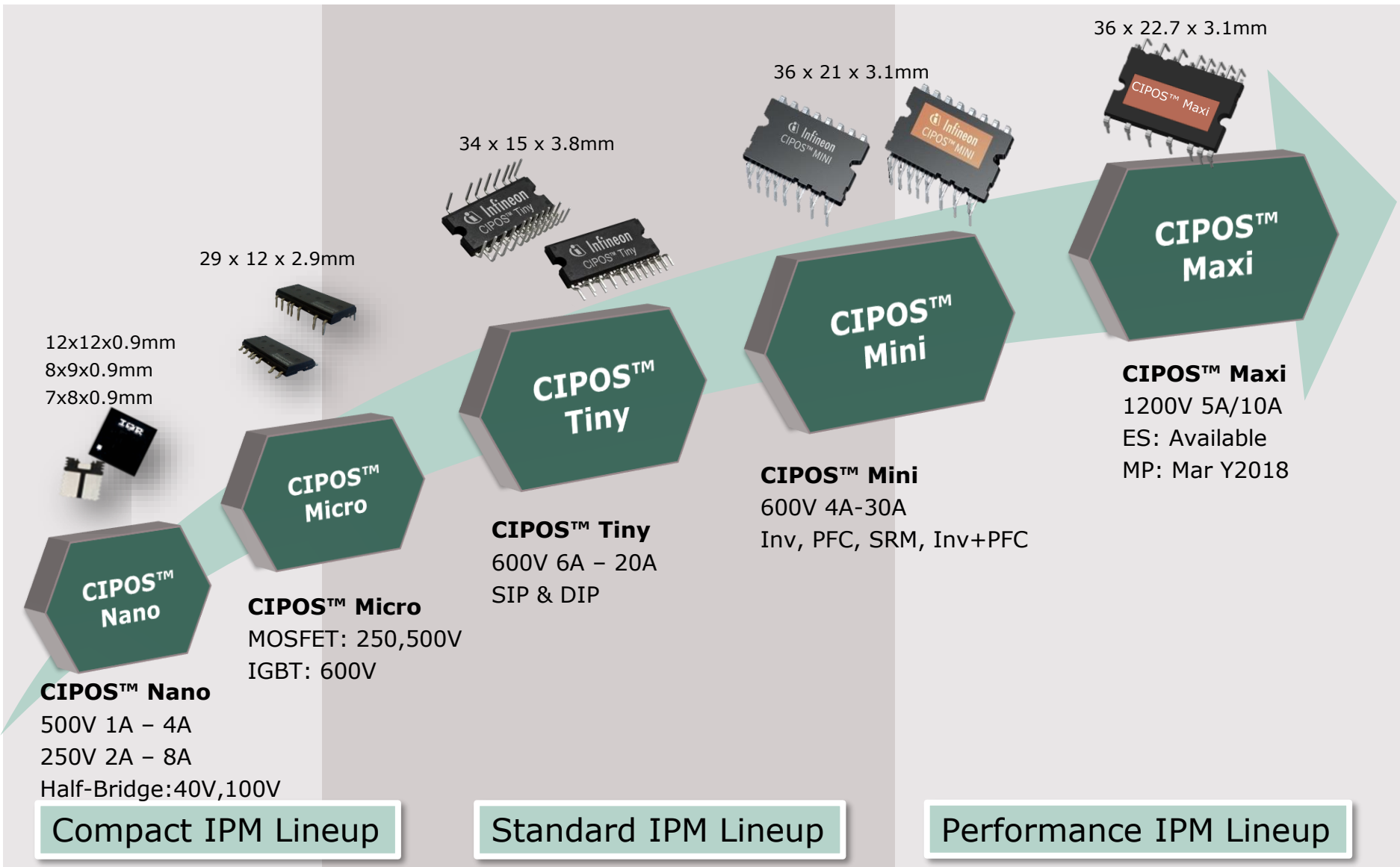
Integration: Complete inverter stage in one compact package



Benefits

- > Shorter time to market
- > Reduced system cost
- > Reducing PCB/system size, less connection
- > Simplified logistics
- > Higher integration, easy to optimize
- > Fewer components (suppliers to deal with)
- > With short and optimized internal layout
- > Increased reliability

Infineon CIPOS™ IPM Family Lineup



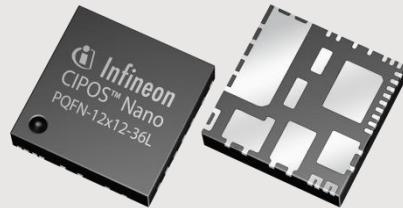
Product Family

What does the customer value?

Product Portfolio

CIPOS™ Nano

Differentiation



Smallest Form Factor

PCB as Heat Sink

Integrated Protection

PCB design & assembly attention required

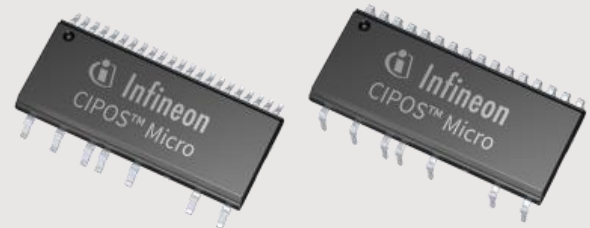
250 V
0.45 – 2.4Ω

500 V
1.7 – 6.0Ω

600 V
Under Development

CIPOS™ Micro

Fast Time to Market



4 Leadform Options

Pin Compatible with Others

Basic functionality

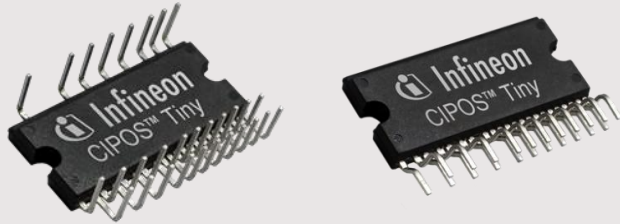
For any PCB substrate

250 V
0.45 – 2.4Ω

500 V
1.4 – 6.0Ω

600 V
 $V_{CE(SAT)} = 1.7 V$

Product



Package size: 34 x 15 x 3.8 mm

Application

- > Fan / Refrigerator
- > Air conditioning
- > Washing Machine
- > General motor drive applications with power range from 250W to >1kW

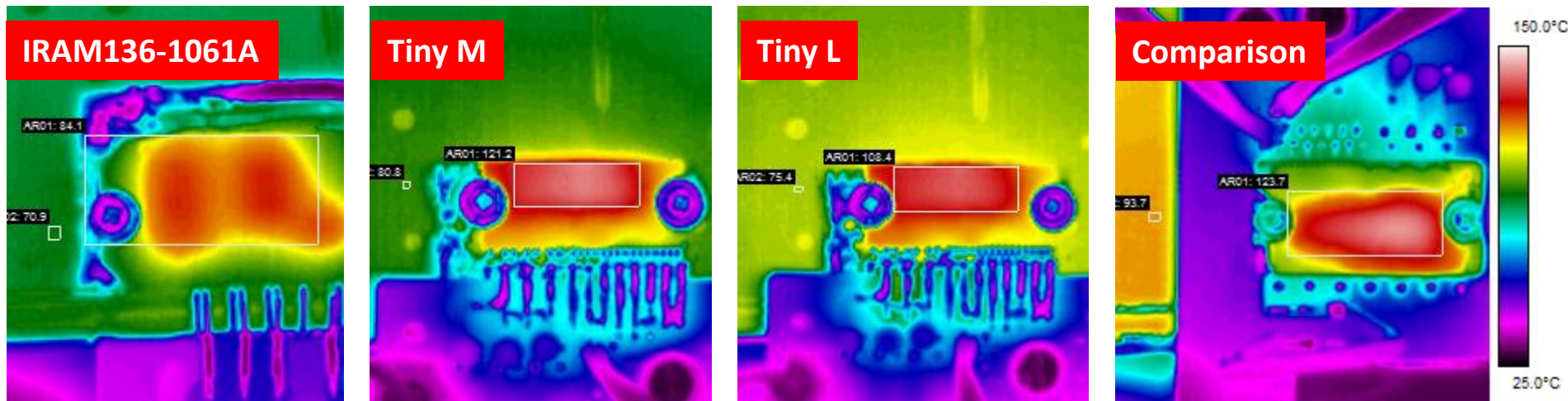
Features

- > Smallest IPM with current rating up to 20A
- > Offered in both DIP and SIP package
- > Integrated bootstrap function

Customer Benefits

- SIP option allows PCB size reduction and alternative heatsink mounting
- UL certified package and temp sensor

Part #	Package	V	I	F _{PWM}	T _J MAX
IM393-S6E(F)	Tiny DIP/SIP	600V	6A	20kHz	150°C
IM393-M6E(F)			10A		
IM393-L6E(F)			15A		
IM393-X6E(F)			20A		



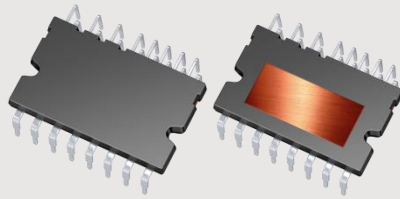
- > Tiny IM393-L/X have highest efficiency at typical high switching frequency condition ($V_{dc}=400V$ / $f_{sw}=16kHz$ / $I=3.5A_{rms}$).
- > Tiny modules are rated at $125^{\circ}C$ for max case temperature, while Comparison modules are rated at $100^{\circ}C$.

	IRAM136-1061A	IM393-M	IM393-L	IM393-X	Comparison
Measured T(HS)	71°C	81°C	75°C	74°C	94°C
Loss	29W	30W	27W	26W	44W

- > $F_{mod} = 50Hz$, $PF = 0.6$, $MI = 0.8$, $DT=1\mu s$. Fixed heatsink with $R_{thca} = 1.56C/W$ and $T_a=25^{\circ}C$
- > Tiny modules were tested with smaller heatsink with $R_{thca} = 1.8C/W$ and $T_a=25^{\circ}C$

Key Features

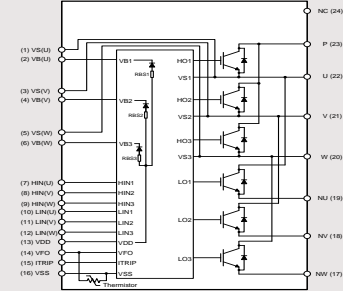
- › Dual-in-line transfer molded package with DCB or Fullpack substrate
- › Current rating from 4A to 30A, power rating up to 3kW
- › Used for home appliances and motor drives
- › Rugged SOI gate driver technology
- › Advanced protection features
- › 600 V voltage rating
- › UL1577 certificated



Typical Applications



Sample Schematic

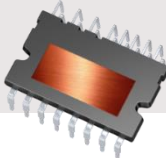


Value Proposition

- › High integrations (bootstrap circuit, thermistor) for easy design and saving system space
- › Single platform possible from 4A to 30A
- › Enhanced robustness of the advanced IGBT, gate driver IC technology
- › Smaller package and high power density
- › Two kinds of substrates provide cost efficient solution for home appliances
- › UL certified thermistor

Key Features

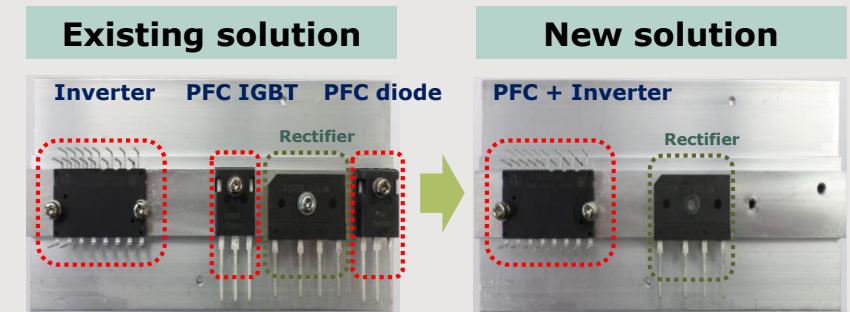
- › Dual-in-line molded module with DCB substrate
- › Inverter + PFC in one package
- › Inverter current rating 10/15A
- › Various PFC switching available: 20kHz or 40kHz
- › PFC 650V rating for IGBT and diode
- › Customer can control switching speed of IGBT(open gate)
- › Targeting room air conditioner application
- › Power capability: 2 kW
- › UL certificated thermistor (85kΩ)



Typical Applications



Solution configuration on a heatsink



Value Proposition

- › System size reduction with PFC integration into inverter module
- › Cost down due to less BOM counts and less assembly cost
- › Smaller and cheaper heatsink
- › Customer can design switching performance of PFC IGBT by using external driver circuit

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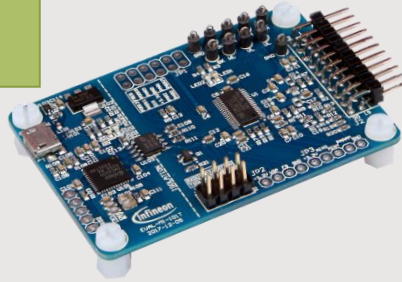
iMOTION™ MADK

For any motor up to 1kW



NEW

EVAL-M1-101T
IMC101T-T038
Control card



M1

EVAL-M1-CM610N3
CIPOS™-Mini power board
IKCM10H60GA ~220V/750W



EVAL-M1-05-65D
CIPOS™ Micro-power board
IRSM505-065DA2 ~220V/300W



EVAL-M1-05F804
CIPOS™ Nano-power board
IRSM005-800MH -40V/200W

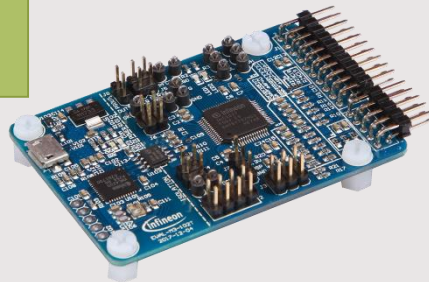


IMC101T – PMSM motor control

Wide range of power boards

NEW

EVAL-M3-102T
IMC102T-F064
Control card



M3

EVAL-M3-CM615PN
CIPOS™ mini with PFC
IFCM15S60GA 600 V



IMC102T – motor control + PFC

New power boards with PFC

MADK - Modular Application Design Kit

iMOTION™ Tools Easy Setup and Tuning



Get any motor running in less than 1 hour

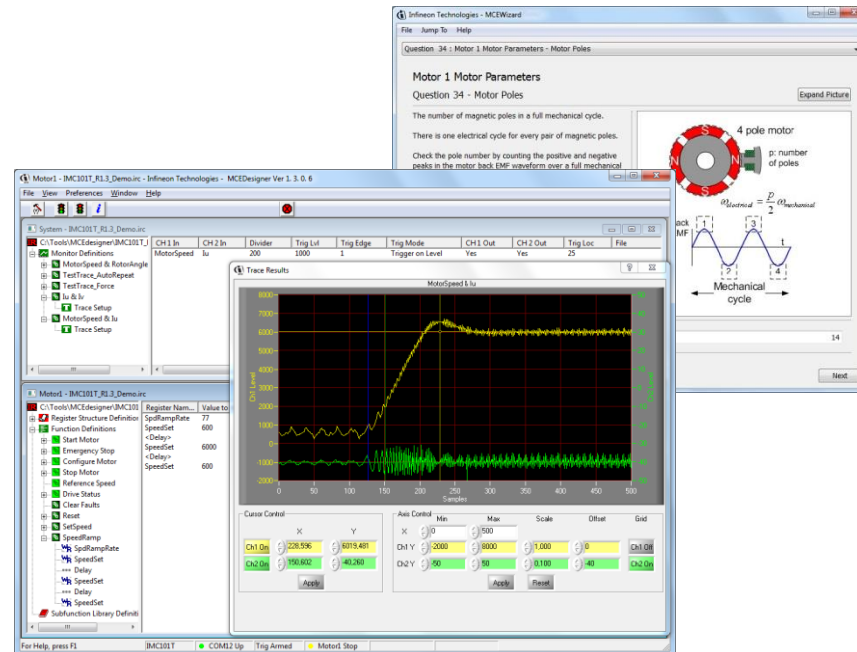
- › **PC Tools** for easy drive setup and tuning
- › Download latest motor control software (MCE) from Infineon website
 - › Guaranteed compatibility via Secure Chip-ID
- › **Three easy steps** to get the drive up and running
 - › Generate initial parameters for motor (& PFC)
 - › Download parameter set to Evaluation Board
 - › Start, monitor & fine-tune the motor drive

MCEWizard

- › Generate initial drive control parameters
- › Guiding through several self-explanatory questions

MCEDesigner

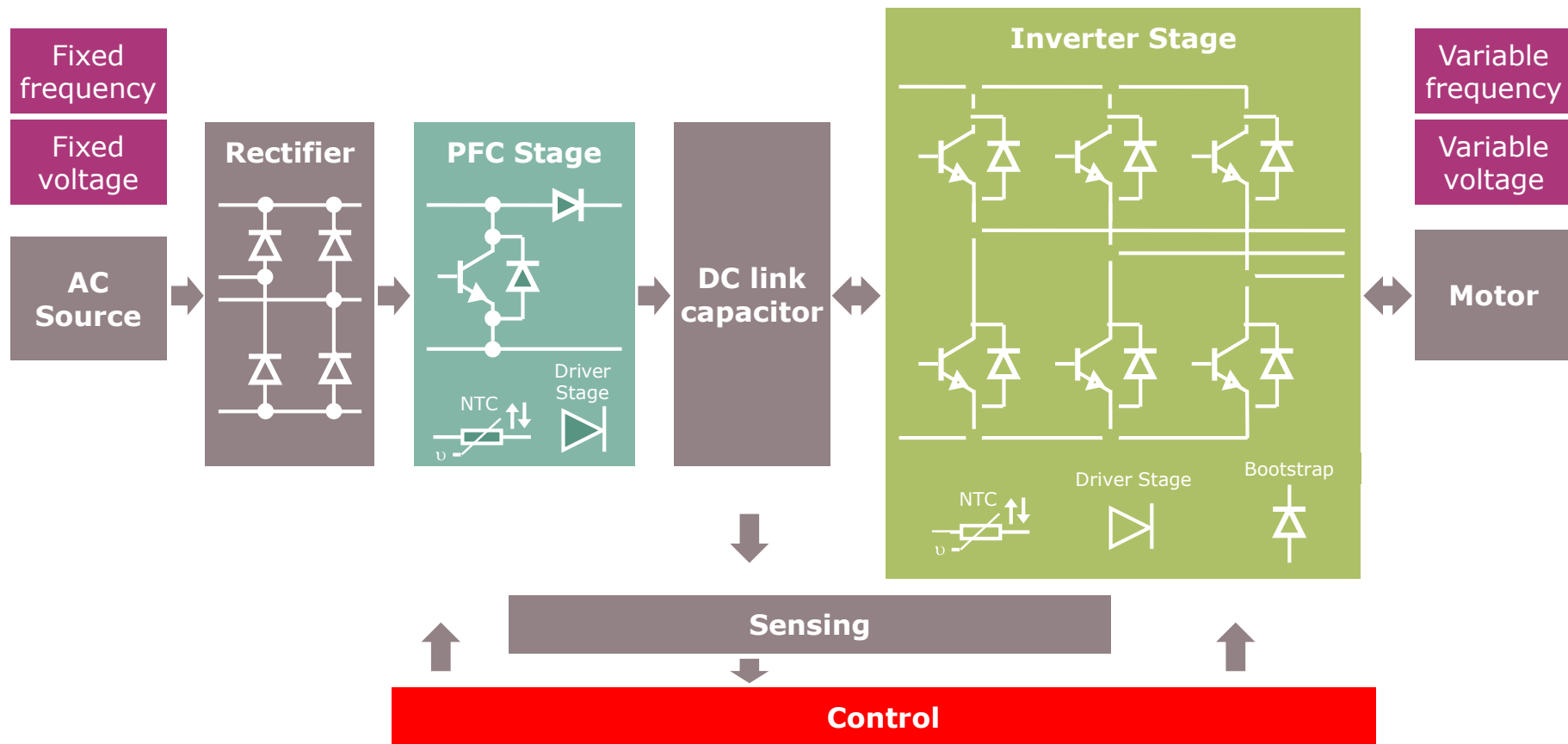
- › Program and update MCE and drive parameters
- › Control, monitor and tune the drive



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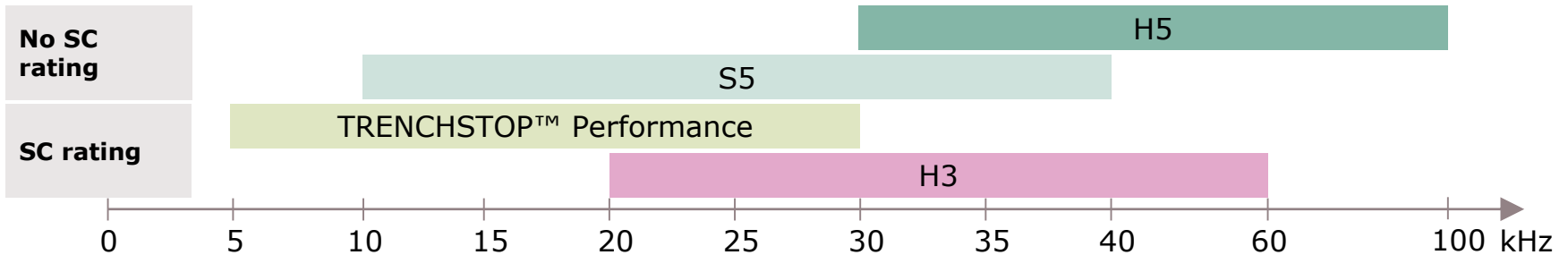


■ IPM
 ■ iMOTION
 ■ IPM / IGBT, Diode, Gate IC

Home Appliance PFC Discrete IGBT Product Portfolio



Ic 100°C	D2PAK	TO-220		TO-220FP	TO-247-3*			
	H3	H5	H3	H5	S5	H5	TRENCHSTOP™ Performance	H3
8		IKP08N65H5		IKA08N65H5				
15		IKP15N65H5		IKA15N65H5				
20	IKB20N60H3	IKP20N65H5	IKP20N60H3					IKW20N60H3
30		IKP30N65H5			IKW30N65ES5	IKW30N65H5	IKW30N60DTP	IKW30N60H3
40		IKP40N65H5			IKW40N65ES5	IKW40N65H5	IKW40N60DTP	IKW40N60H3
50					IKW50N65ES5	IKW50N65H5 IKW50N65EH5	IKW50N60DTP	IKW50N60H3
60								IKW60N60H6
75					IKW75N65ES5	IKW75N65EH5		IKW75N60H3








*Other current classes and package variations available – most commonly used shown as recommendations

Home Appliance PFC

Rapid 1 & Rapid 2 Diodes Portfolio



		TO-220 (real 2-leg) 	TO-220 FullPAK (real 2-leg) 	TO-220 - 3 (Common Cathode, 3-leg) 	TO-247-3 	TO-247 - 3 (Common Cathode, 3-leg) 
Rapid1	8A	IDP08E65D1				
	15A	IDP15E65D1				
	20A		IDV20E65D1			
	30A	IDP30E65D1			IDW30E65D1	IDW30C65D1
	40A				IDW40E65D1	
	60A					IDW60C65D1
	75A					IDW75D65D1
	80A					IDW80C65D1
Rapid2	8A	IDP08E65D2	IDV08E65D2			
	15A	IDP15E65D2	IDV15E65D2		IDW15E65D2	
	20A	IDP20E65D2		IDP20C65D2		IDW20C65D2
	30A	IDP30E65D2	IDV30E65D2	IDP30C65D2		IDW30C65D2
	40A	IDP40E65D2			IDW40E65D2	

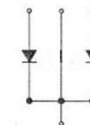


AC PFC

IDW75D65D1



Common Anode



Common Cathode

IDW80C65D1

Isolation papers for discrete

Power semiconductors are often mounted on a shared heatsink



Today's solutions for isolation

Most common solutions

FullPA

- › Highest R_{th}
- › Limited power density
- › Expensive package

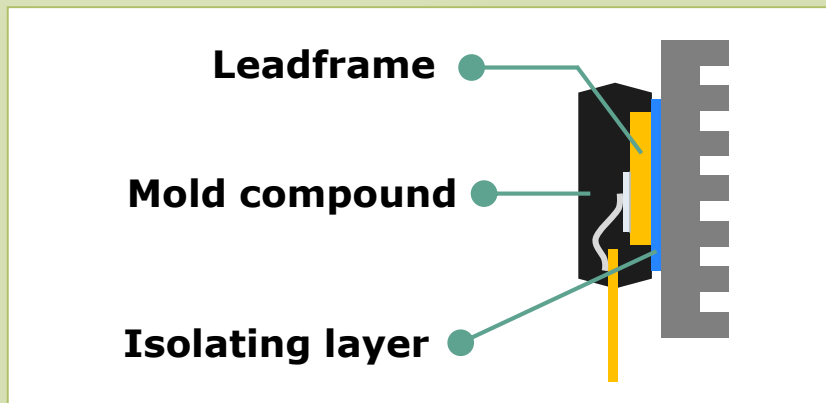
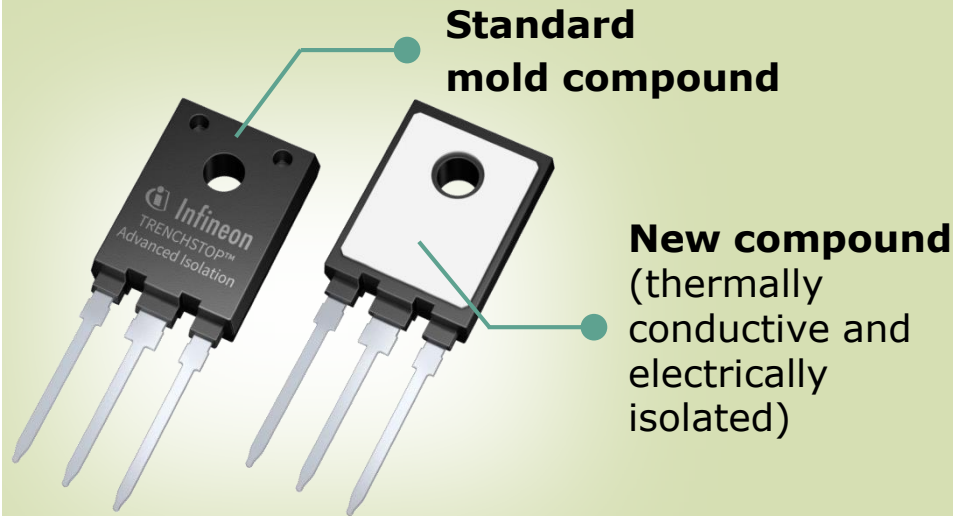
TO-18

Isolation material

- › High R_{th}
- › Complicated manufacturing
- › Expensive package
- › Reliability issues

A better solution

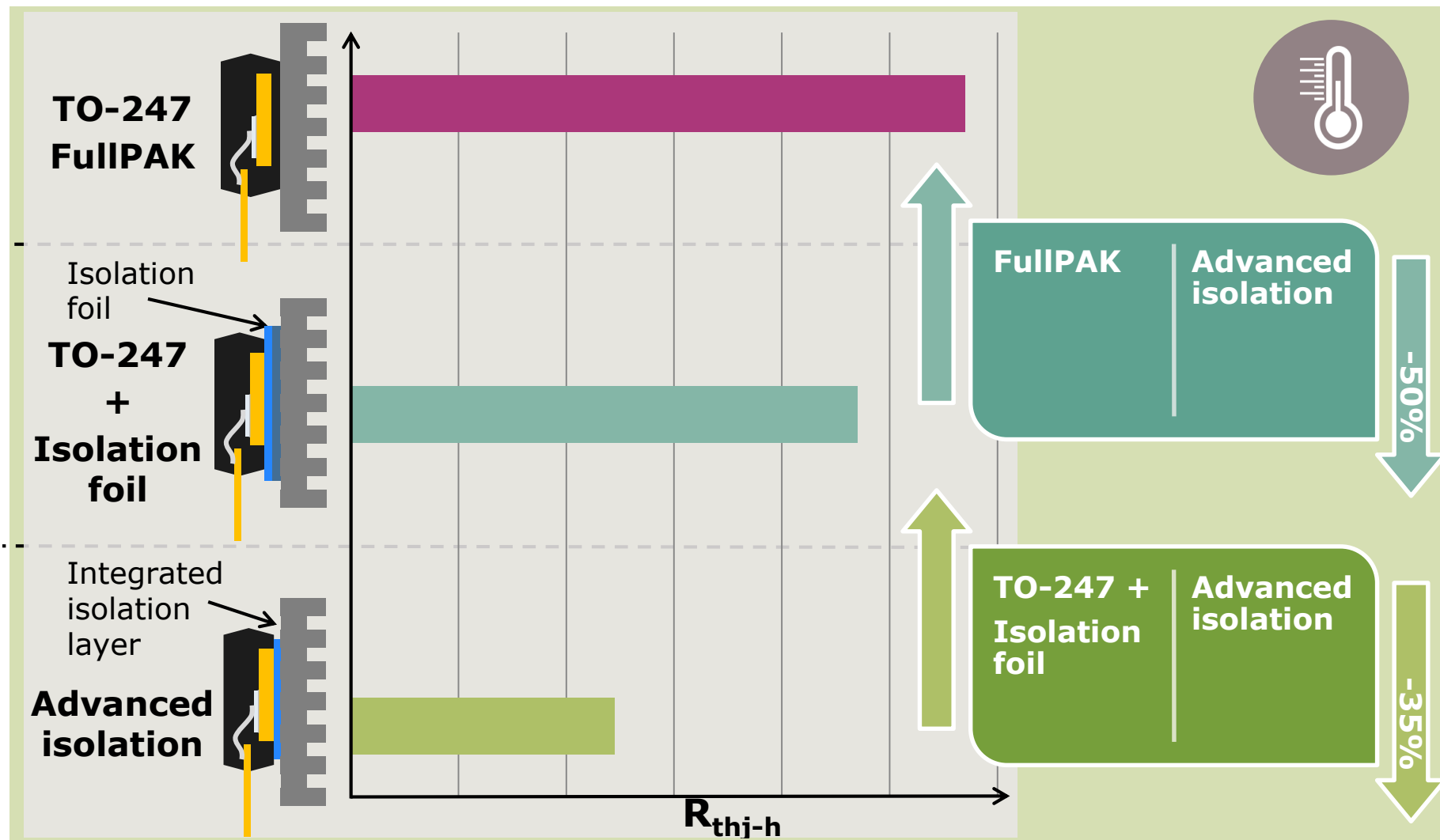
Advanced isolation



Package description

- > Same footprint of a TO-247
- > Fully isolated package: no exposed leadframe on the back or sides
- > Better thermal performance
- > 2 compounds molded together
- > Material is not TIM
- > Properties remain constant with temperature
- > No need for thermal grease: compresses slightly to make excellent contact with heatsink

Lowest R_{th} leads to lower cooling effort



Improved thermal performance

TO-247 FullPAK



TRENCHSTOP™
Advanced Isolation



-10°C



- ✓ Lower IGBT losses
- ✓ Improved reliability
- ✓ Increased product lifetime
- ✓ Reduced heatsink size
- ✓ Increased power density

Agenda

- 1 Home Appliances Market Overview
- 2 iMOTION
- 3 IPM (Intelligent Power Module)
- 4 MADK (Modular Application Design Kit)
- 5 Advanced isolation
- 6 Summary

Summary

- › 최근 소형 가전 시장을 중심으로 전력 효율 향상 및 다양한 고객 요구를 실현하기 위하여 가변속 드라이브에 대한 수요가 증가하고 있다.
- › Modular Application Design Kit는 컨트롤러와 인버터 보드가 각각 모듈화된 3상 모터 시스템 솔루션 플랫폼으로서 Motion Control Engine이 내장된 iMOTION controller는 필수적인 하드웨어와 제어 알고리즘을 통합하여 시스템 개발 비용 및 시장 출시 기간을 단축할 수 있다.



Part of your life. Part of tomorrow.

