Higher integration and intelligence for compact inverter design

IFPS IPC ISD DEV TM
Sep, 2018

Agenda

1. Intelligent Power Modules
2. Infineon CIPOS™ IPM Products
3. Applications
4. Supporting tools
5. New products and features

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Functional integration on system level is mainstream up to highest power

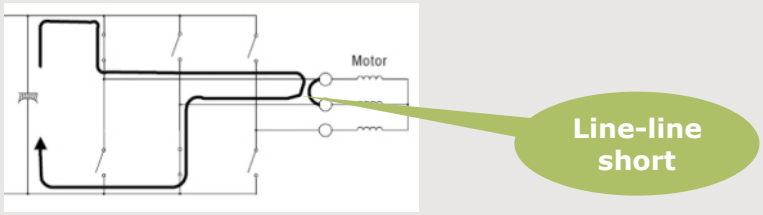
System benefits translate to **customer advantages**

IPMs improve **time to market**, **performance** and **reliability**

Functional integration on system level brings various benefits for our customers

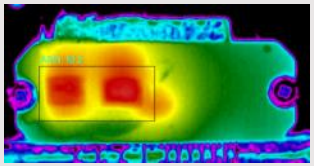
Over current protection

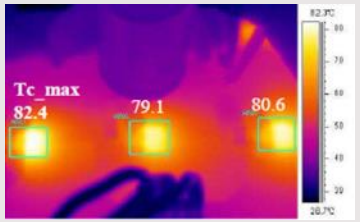
- IGBT with short circuit rating
- Integrated protection features



Temperature feedback & protection

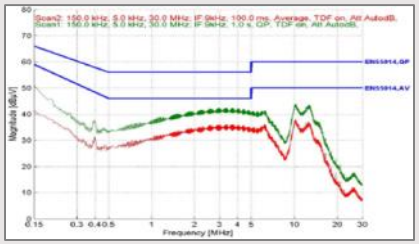
- Built-in thermistor
- Correlation between thermistor and IGBT temperatures





Designed for EMI

- Optimized trade-off between losses and EMI performance
- Homogenous dV/dt helps customers design a platform across different power ranges



Quality

- Fully qualified by Infineon
- Meets UL standards

Underwriters Laboratories

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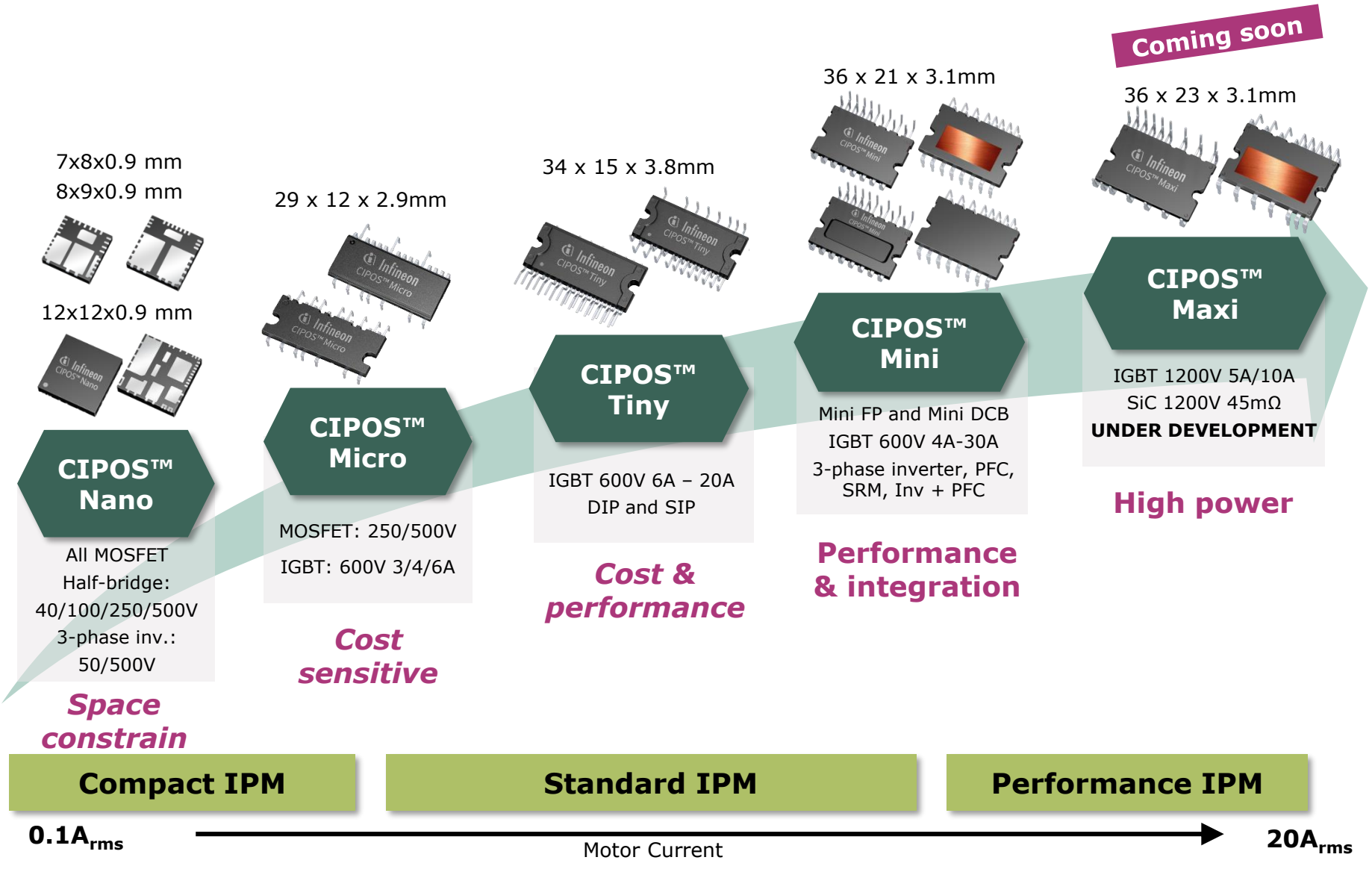
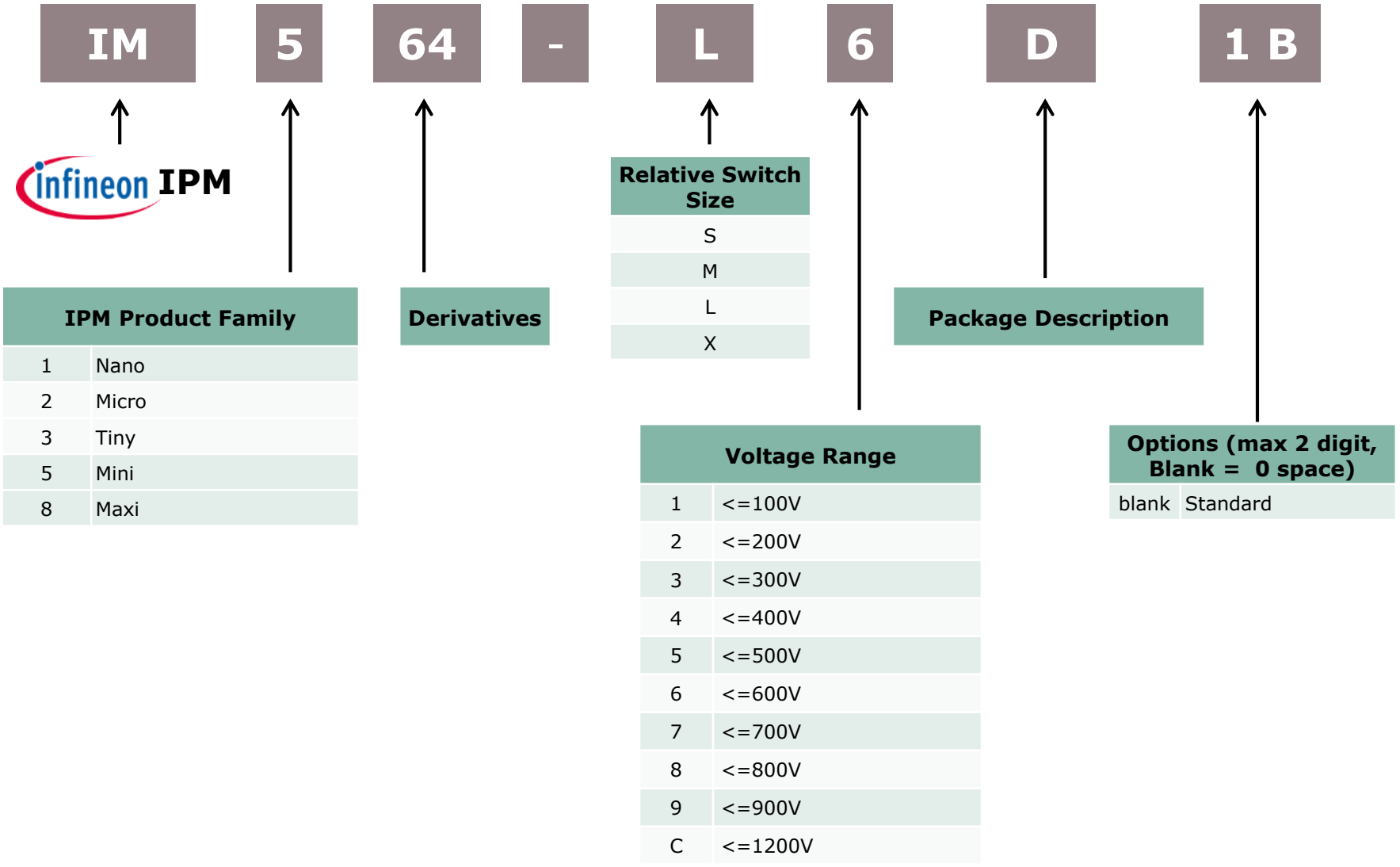
Control Integrated Power System (CIPOS™) Product Portfolio



CIPOS™ IPM nomenclature



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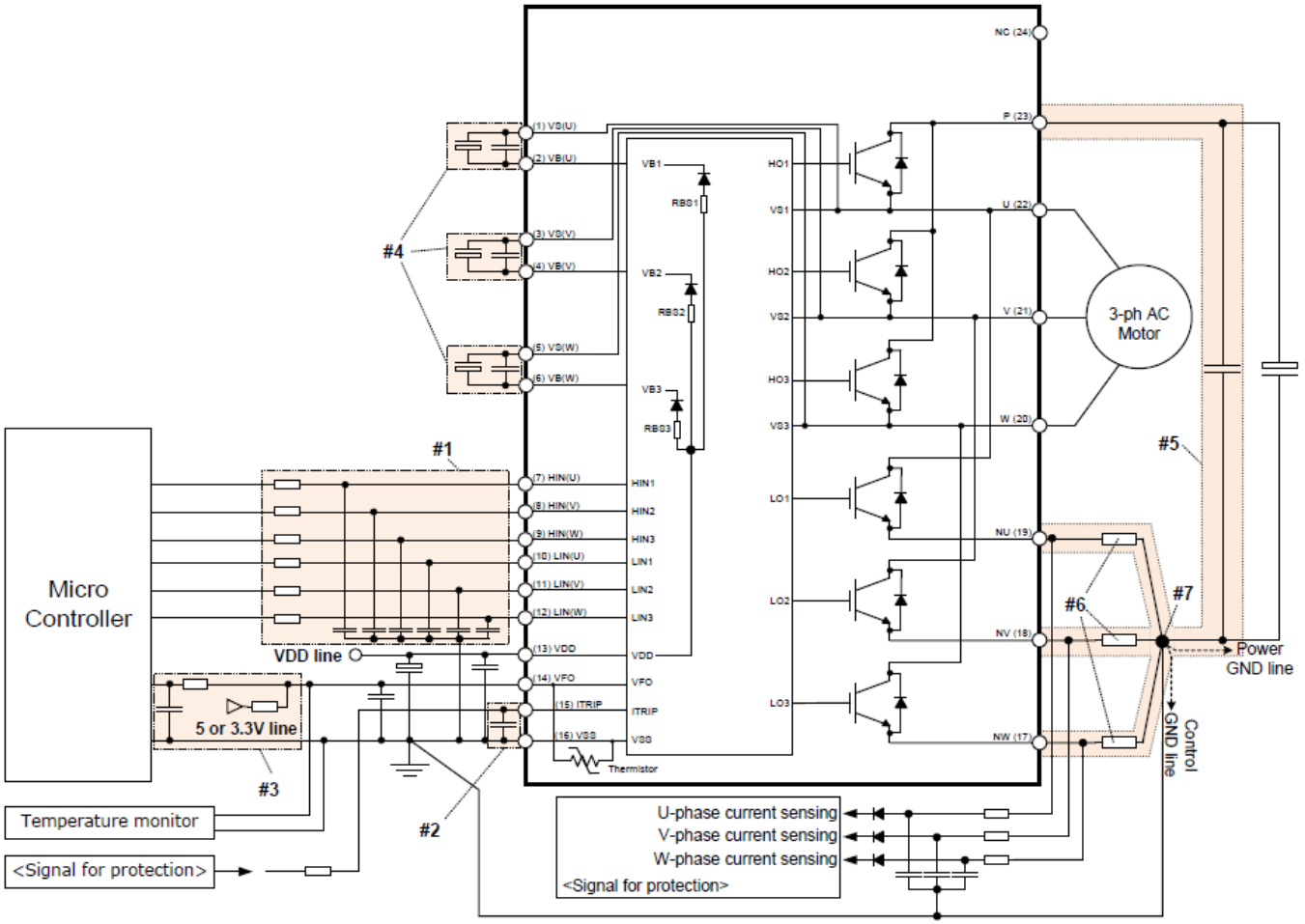
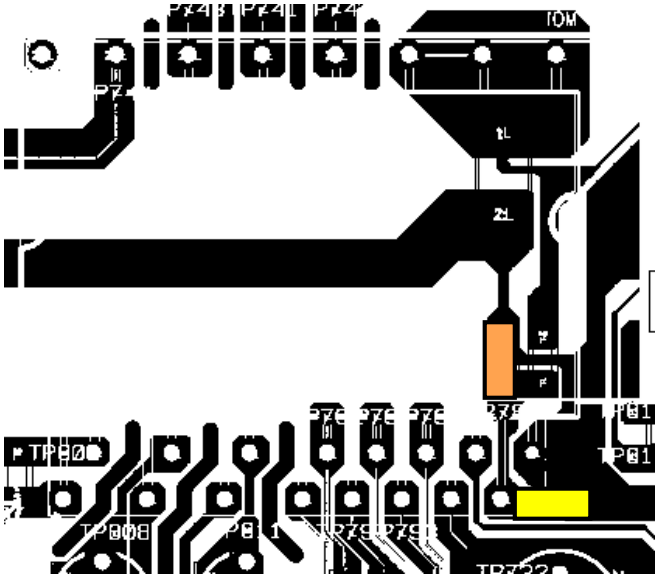
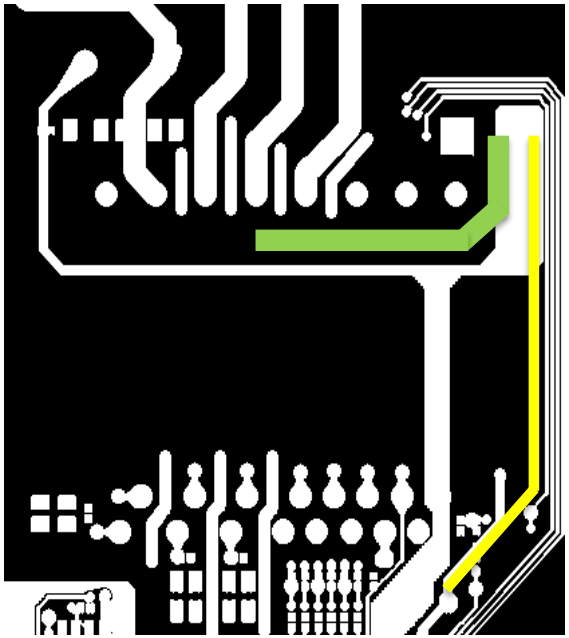
Typical application



PCB layout

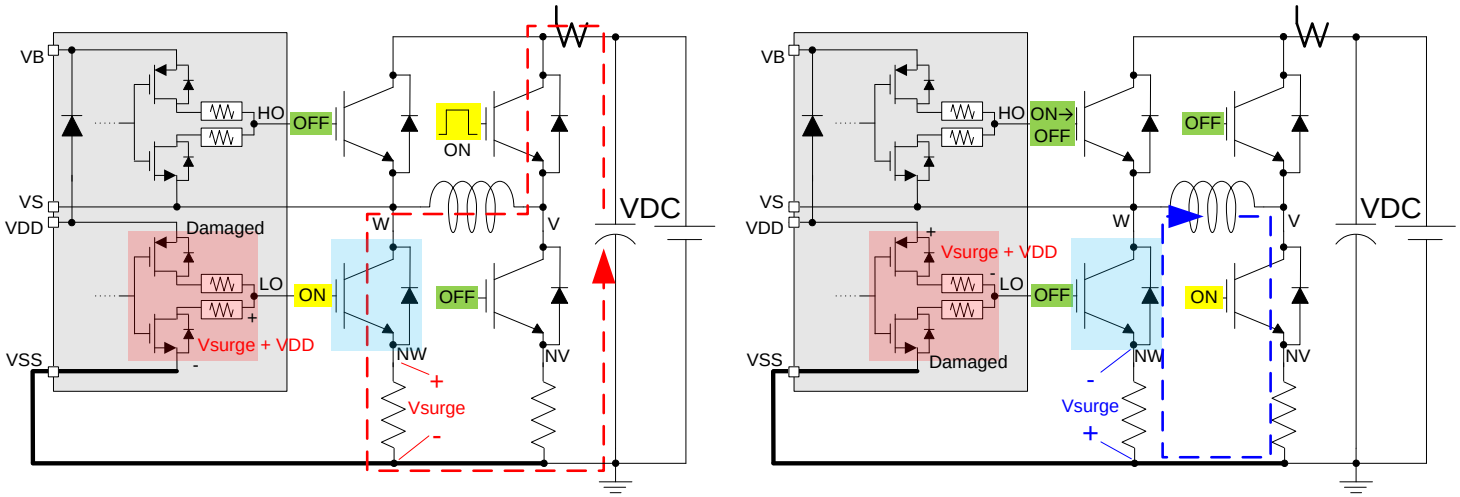
- Trace between shunt resistor and Vss
- Location of ITRIP filter capacitor





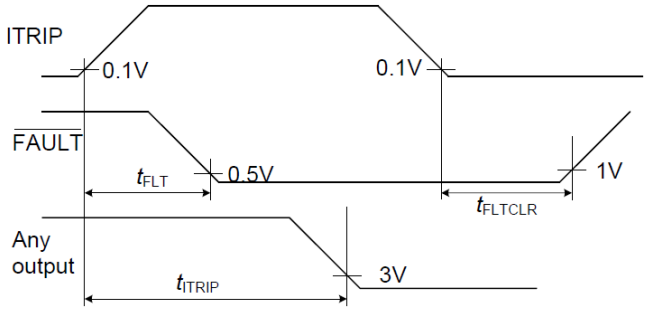
IPM damage by N-Vss surge voltage

- Vsurge is induced due to parasitic inductance of PCB pattern and shunt resistor when current flows into low-side IGBT or free-wheels through anti-parallel diode.
- Vsurge+VDD is applied to output buffer stage of drive IC.
- After drive IC has damaged, IGBT could be failed as well.
- Non-inductive type shunt resistor is recommended.
- Need to minimize distance between shunt resistor and IPM.

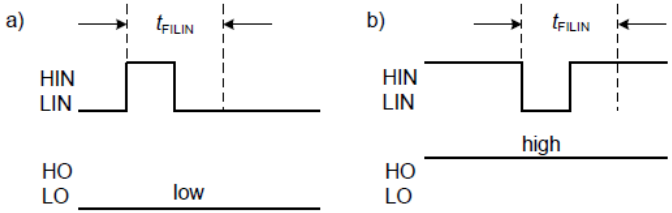


Considerations from MCU side

- Fault clear time
  - IPM restarts after fault clear time
  - Repetitive short circuit conditions should be avoided



- Input filter time
  - PWM input
  - Over current



Input filter time ITRIP	V_{ITRIP} = 1V	$t_{ITRIPmin}$	-	530	-	ns
Input filter time at LIN, HIN for turn on and off	$V_{LIN, HIN}$ = 0V & 5V	t_{FILIN}	-	290	-	ns

Mini

Input filter time (HIN, LIN, ITRIP)	T_{FILIN}	V_{IN} = 0 or V_{IN} = 5V	-	350	-	ns

Tiny

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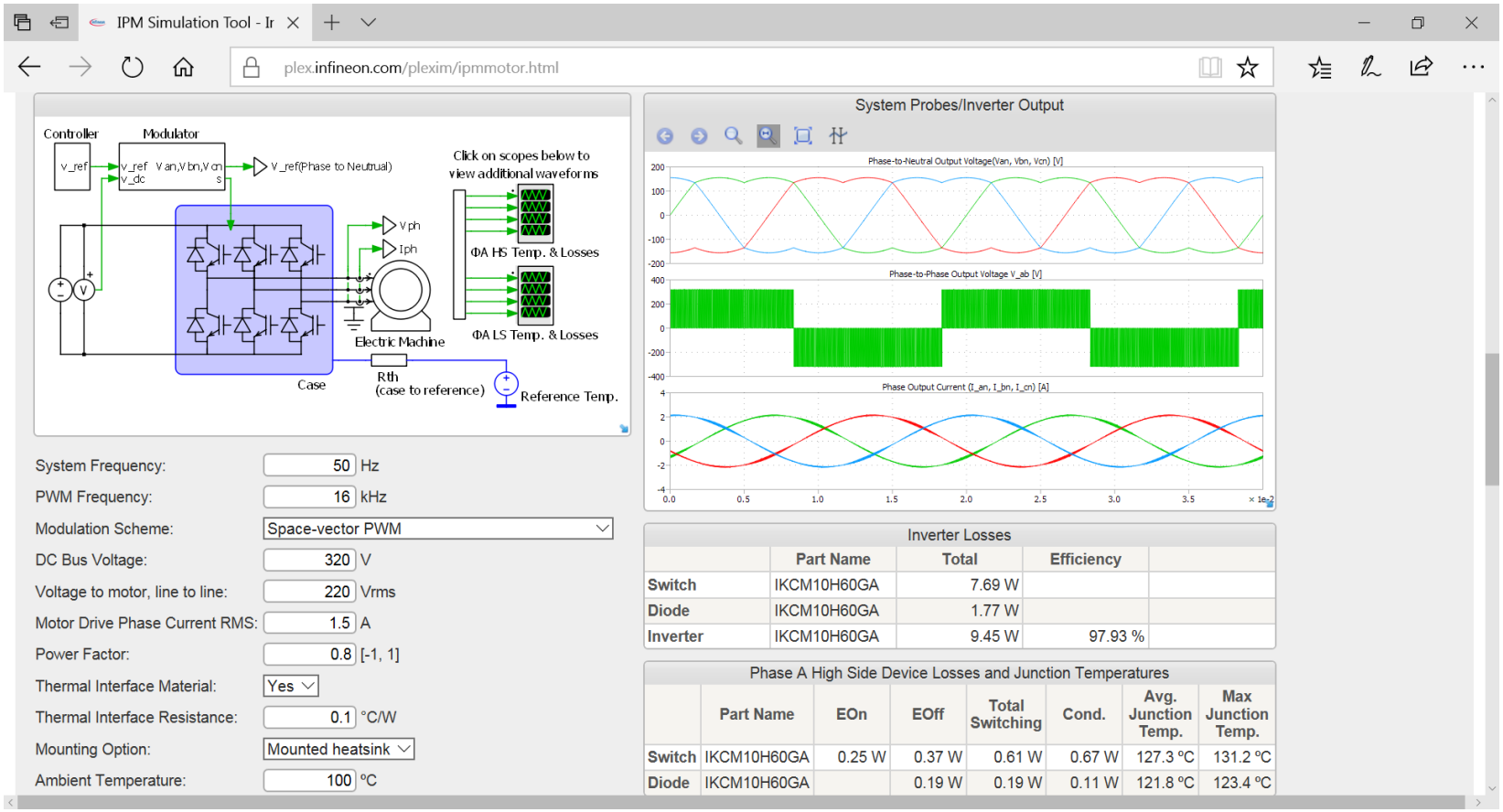
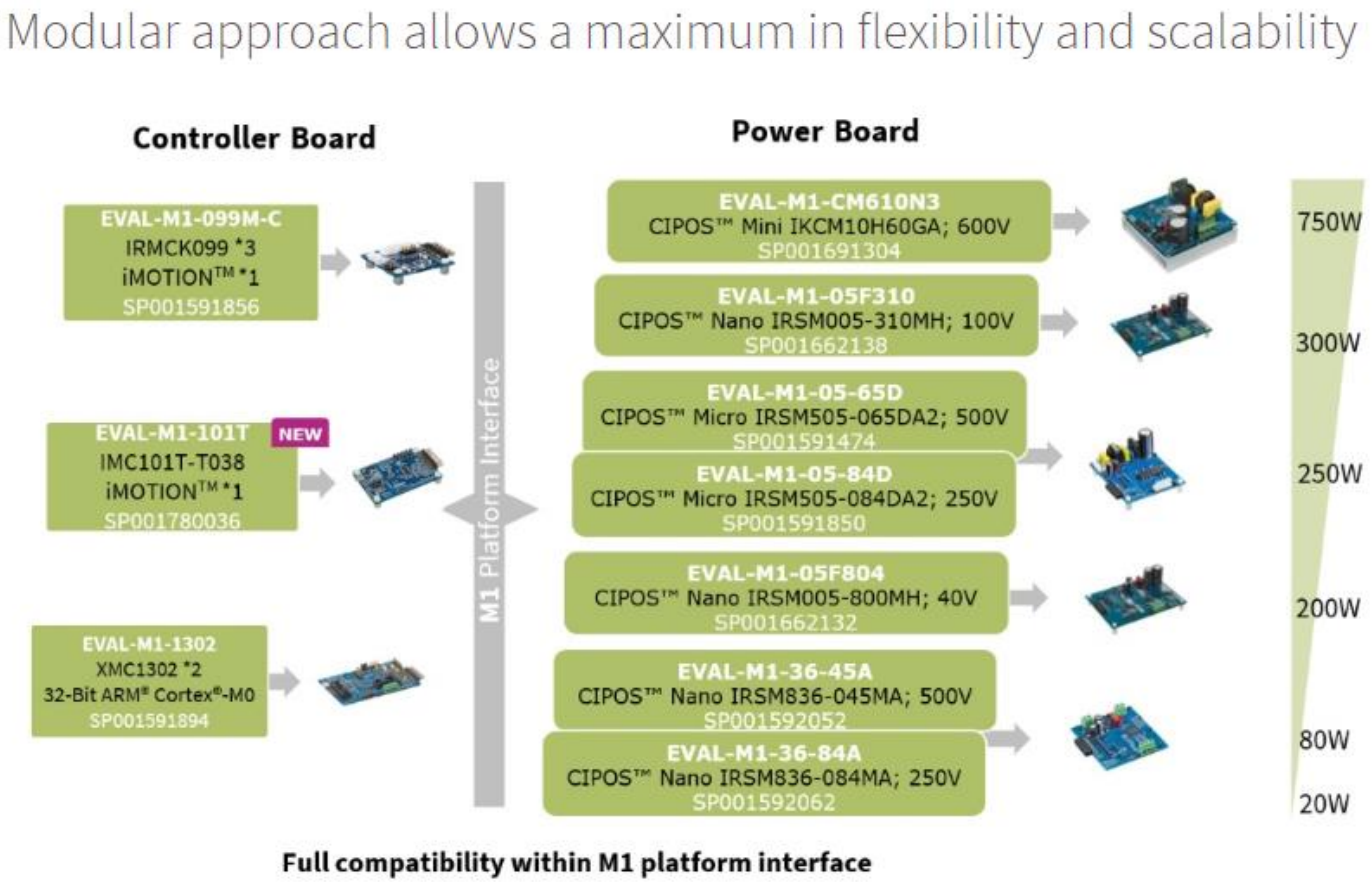
Simulation Tools

› https://plex.infineon.com/plexim/ipmmotor.html

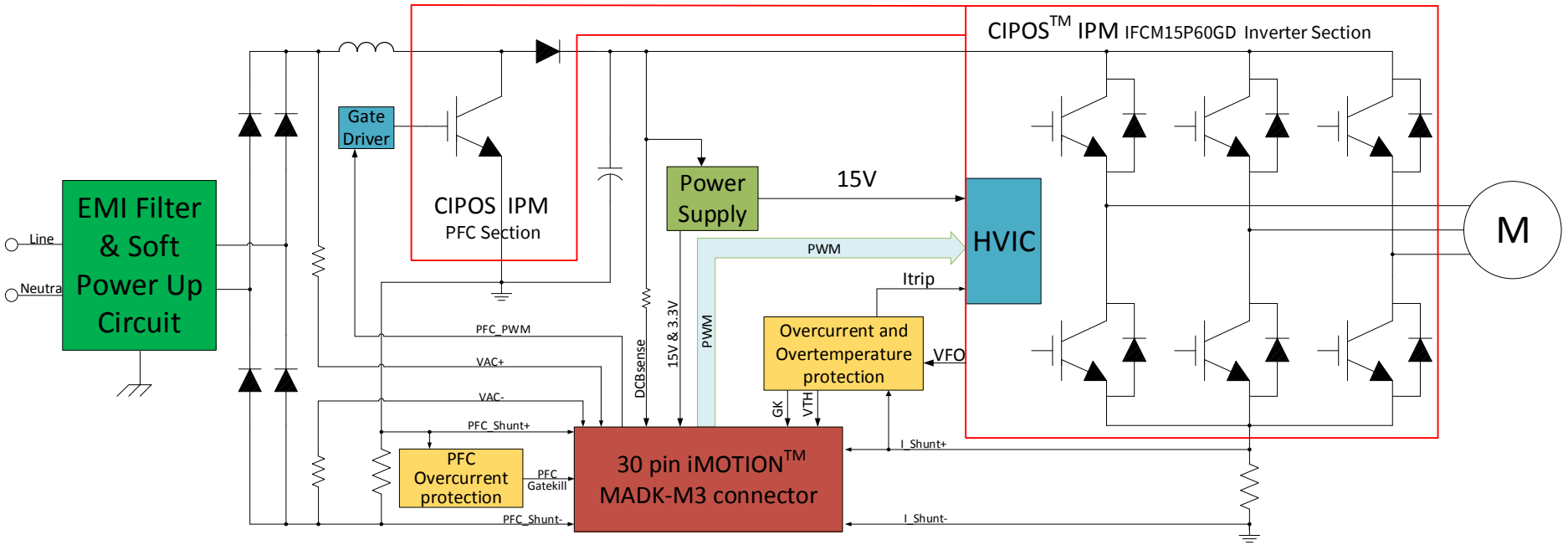


Reference Designs and Modular Evaluation Boards

› www.infineon.com/MADK

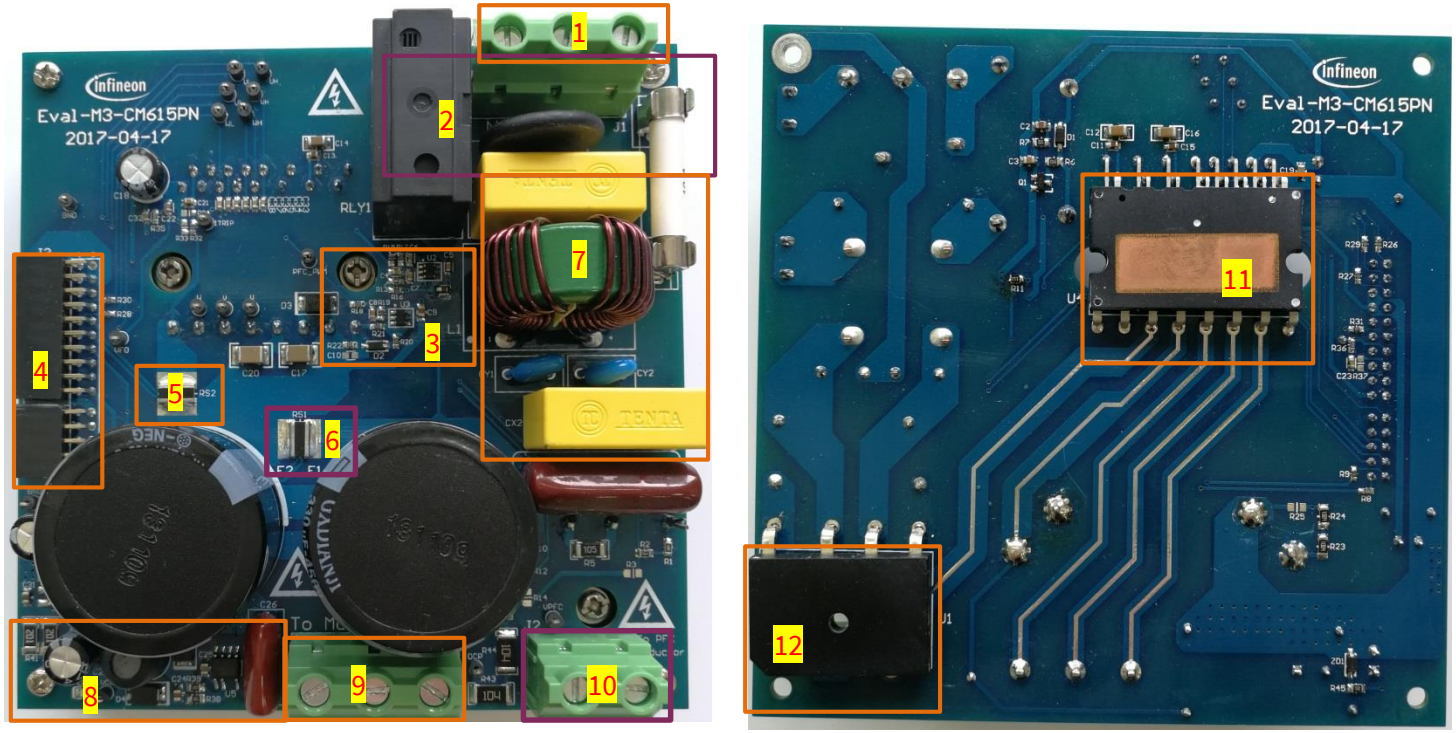


PFC Integrated IPM
: MADK(Modular Application Design Kit) Board



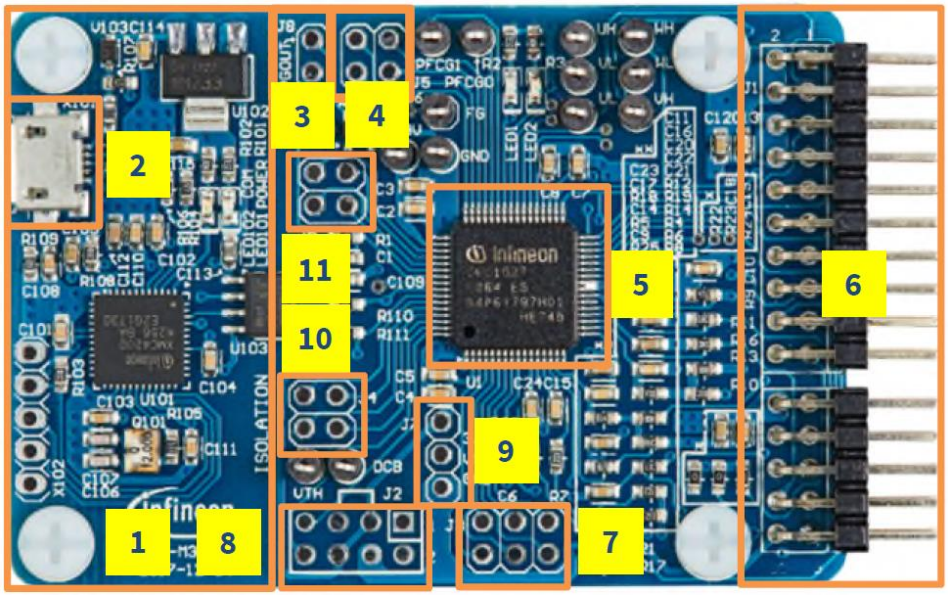
[Block Diagram of eval-M3-CM615PN]

PFC Integrated IPM
: MADK(1) – [Eval-M3-CM615PN]



1. J1 - AC Input connector
2. Relay, NTC and Fuse
3. PFC gate drive and PFC overcurrent protection circuits
4. J3 - 30 pin iMOTION™ MADK-M3 interface connector for controller board
5. Current sensing shunt resistor RS2
6. PFC Current sensing resistor RS1
7. EMI filter
8. Auxiliary power supply
9. J4 - Motor phase connector
10. J2 - PFC inductor connector
11. U4 - CIPOS Mini PFC Integrated IPM(IFCM15P60GD)
12. U1 - Bridge Rectifier

PFC Integrated IPM
: MADK(2) – [Eval-M3-102T]



1. On-board debugger
2. USB Connecter (X101)
3. Test Signal Pin Connecter (J8)
4. Test Signal Pin Connecter (J5)
5. MCE -control IC IMC102-T064
6. iMOTION™ MADK-M3 30 pins interface connector (J1)
7. Test Signal Pin Connecter (J3)
8. iMOTION™ Linker connector (J2)
9. VSP Signal Pin Connecter (J7)
10. Test Signal Pin Connecter (J4)
11. Test Signal Pin Connecter (J6)

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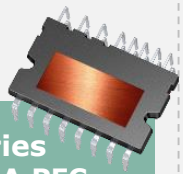
CIPOS™ IPM Upcoming Products

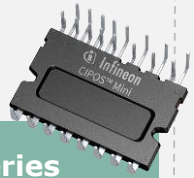
CIPOS™ Maxi | CIPOS™ Mini | CIPOS™ Tiny | CIPOS™ Micro | CIPOS™ Nano



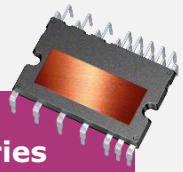
IFCM series
650V 20/30A PFC
600V 10/15A PFC + 3ph

IKCM/IGCM series
600V 4-30A 3ph

New



IM51x series
600V 0.33Ω 2/3ph
CoolMOS™ MOSFET

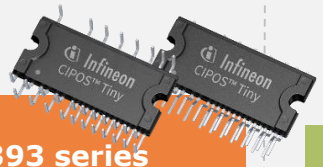


*IM818 series
1200V 5/10A 3ph

IRSM506
600V 4A 3ph

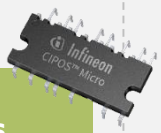
IRSM5x5 series
250/500V
4.5mΩ-6.0Ω 3ph

New

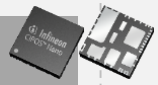


IM393 series
600V 6-20A 3ph

*IM240 series
600V 3/4A 3ph



*IM231 series
600V 4/6A 3ph



IRSM8xx series
40V-500V
4.5mΩ-6.0Ω
Half-bridge/3ph

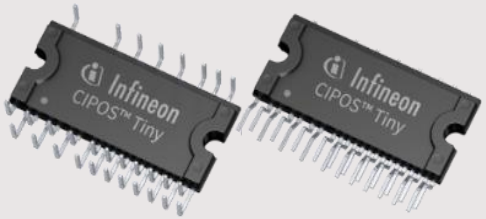
*Sample Available NOW

Released Products | CY18Q3 | CY18Q4

CIPOS™ Tiny IPM product family

Products

DIP34x15
SIP34x15
package

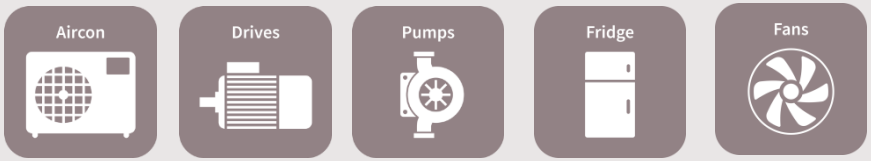


Dimension [mm]		34x15x3.8		
Configuration		3-phase inverter		
Voltage Rating		600V		
Package		DIP 34x15	SIP 34x15	
Current rating	6A	IM393-S6E	IM393-S6F	Lead length options for DIP 5.55/2.9/3.6 mm
	10A	IM393-M6E	IM393-M6F	
	15A	IM393-L6E	IM393-L6F	
	20A	IM393-X6E	IM393-X6F	

Features

- Smallest IPM with current rating up to 20A
- Newest low $V_{CE(sat)}$ TRENCHSTOP™ IGBT technology
- Better EMI performance thanks to new IGBT
- Under voltage lockout for all channels
- Cross-conduction prevention logic
- Integrated bootstrap functionality
- Built-in NTC thermistor for temperature monitor
- Offered in both DIP and SIP package with various lead length options

Typical Applications



Value Proposition

- Enables cost reduction for home appliance motor drives
- SIP option allows PCB size reduction and alternative heatsink mounting
- UL certified package and temp sensor
- Improve system efficiency

CIPOS™ Tiny(IM393) : Basic Comparison

Items		CIPOS™ Tiny	CIPOS™ Mini	Competitor A
Package area		32 x 15 mm² (100%)	36 x 21 mm² (144%)	32.8 x 18.8 mm² (117%)
Line up		6A, 10A, 15A, 20A	4A ~ 30A	5A, 15A
Thermistor		Yes	Yes	No (temp. sensor on IC)
Single driver IC benefits		1 driver	1 drivers	2 drivers
Built-in dead time		Typ. 275 [ns]	Typ. 380 [ns]	None
All IGBTs turn off @ protection		All 6 IGBTs	All 6 IGBTs	3 low side IGBT
Anti cross conduction		Yes	Yes	None
Performance comparison		**IM393-L6E**	**IKCM15L60GA**	**Competitor 15A**
IGBT Thermal resistance		Typ. 4.30 [°C/W]	Max. 4.57 [°C/W]	Max. 4.00 [°C/W]
Min. dead time (DT_{min})		1.0 [µs]	1.5 [µs]	1.0 [µs]
IGBT typ. $V_{CE(sat)}$ @ I_C=15A	T_J=25°C	1.8 [V]	1.8 [V]	1.6 [V]
	T_J=150°C	2.2 [V]	2.2 [V]	1.8 [V]
V_{DC}=300V, V_{DD}=15V, I_C=15A	E_{ON} @ T_J=25 / 150℃	520 / 710 [µJ]	750 / 880 [µJ]	920 / 1170 [µJ]
	E_{OFF} @ T_J=25 / 150℃	270 / 370 [µJ]	290 / 350 [µJ]	170 / 220 [µJ]
	E_{rr} @ T_J=25 / 150℃	78 / 130 [µJ]	34 / 62 [µJ]	210 / 280 [µJ]

CIPOS™ Micro IPM: IM231 Series

IM231-**L**6 (600V, 6A)
IM231-**M**6 (600V, 4A)

Overcurrent Protection (±5% Accuracy)

Fault Reporting + Auto Fault Clear

Accurate UL Certified NTC

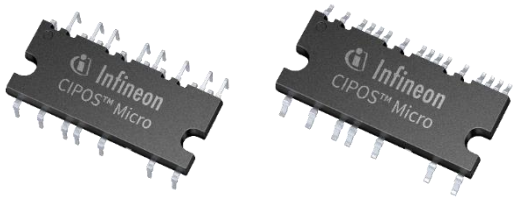
Shoot-Through Protection

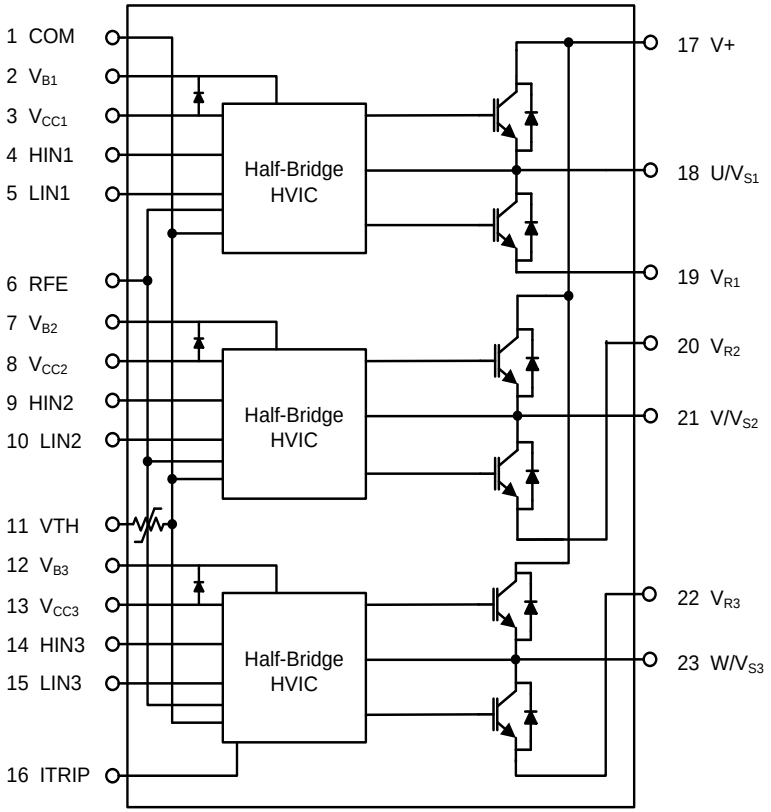
Surface Mount & Through Hole Options

Mounting Holes

Target Power: Up to ~450W

12 x 29 x 3.2mm





Ruggedness & Reliability: Advanced reliability

IM231 is qualified beyond standard quality specs for higher reliability

IM231-L6 subject to standard Infineon industrial qualification **PLUS:**

1. **High Voltage H3TRB (480V per switch, 85% RH, 85C, 1000h)**
   - **PLUS: 125C bake for 24hrs, 30C/60%RH soak for 192hrs, 3x reflow at 245C**
   - High reliability with humid environment
2. **Extended Temperature Cycling (TC) to 1500 cycles**
   - TC evaluates package reliability including bondwires, die attach.
   - Typical TC is run for 1000 cycles only
3. **Extended IOL to 15000 cycles**
   - IOL simulates thermal and power stresses during drastic load changes
   - IGBT junction temperature changes by 90C within each cycle
   - IOL is typically run to 10000 cycles.

CIPOS™ Maxi IPM: IM818 series

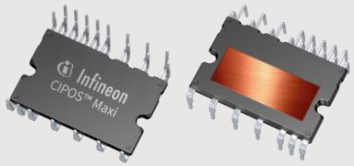
Key Features

- Fully isolated Dual In-Line molded module with TRENCHSTOP™ IGBT 4
- Rugged SOI gate driver technology (6ED)
- Allowable negative VS potential up to -11V for signal transmission at VBS=15V
- Integrated bootstrap functionality
- Over current shutdown
- Independent temperature Thermistor
- Under-voltage lockout at all channels
- Low side emitter pins accessible for all phase current monitoring (open emitter)

Typical Applications

Product line-up

Product no.	Voltage Rating	Current Rating	Package
IM818-SCC	1200V	5A	DIP36X23D
IM818-MCC	1200V	10A	DIP36X23D



Value Proposition

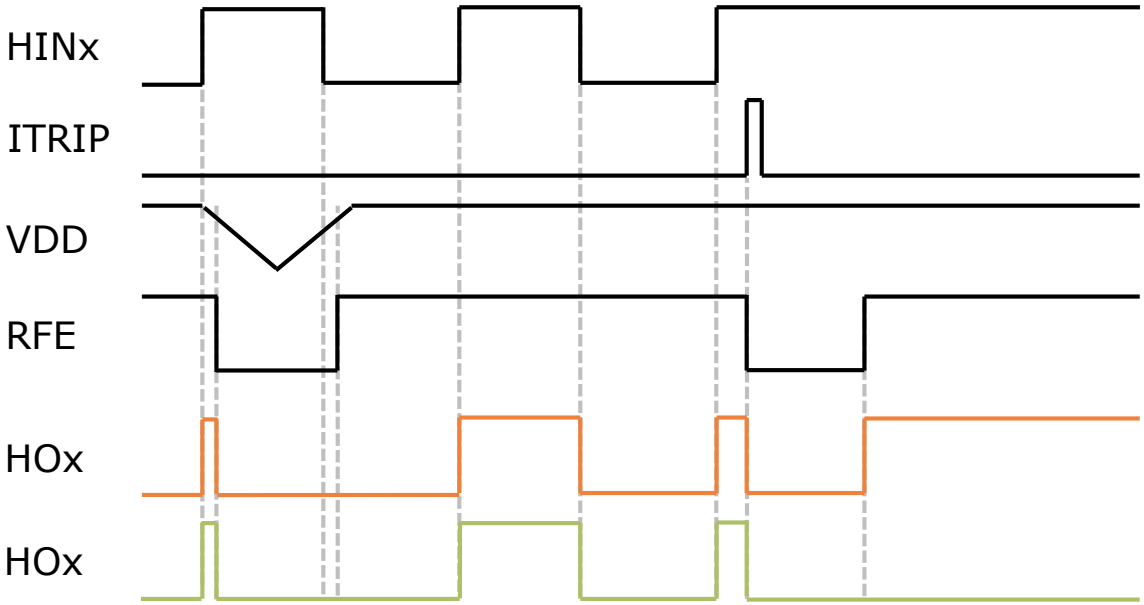
- System cost saving
- Time to market
- High power density with small package

CIPOS™ Maxi(IM818) : Basic Comparison

Items		CIPOS™ Maxi	Competitor A	Competitor B
Package area		36 x 22.7 mm² (100%)	52.5 x 31 mm² (200%)	44 x 26.8 mm² (144%)
Line up		5A, 10A	5A, 10A	10A, 15A, 20A
*Dummy pin(Live)		No	Yes	Yes
Gate Driver IC		Silicon On Insulator	PN junction	PN junction
Single driver IC benefits - Built-in dead time - Anti cross conduction - Matched propagation delay - All IGBTs turn off @ protection		Yes 1 gate driver	No 4 gate drivers (3 for high side, 1 for low side)	No 4 gate drivers (3 for high side, 1 for low side)
Built-in Bootstrap		Yes	Yes	No
Thermistor		Yes	No (temp. sensor on IC)	No (temp. sensor on IC)
Performance comparison		**IM818-MCC**	**Competitor A 10A**	**Competitor B 10A**
IGBT Thermal resistance		Max. 1.85 [°C/W]	Max. 1.50 [°C/W]	Max. 1.80 [°C/W]
IGBT typ. $V_{CE(sat)}$ @ I_C=10A	T_J=25°C	2.1 [V]	1.5 [V]	2.0 [V]
	T_J=150°C	2.4 [V]	1.6 [V]	2.4 [V]
BVCES @ I_{CES}=250 [µA]		1330 / 1400 [V]	1430 / 1502 [V]	1330 / 1214 [V]
Min. dead time(DT_{min})		0.5 [µs]	3.0 [µs]	2.0 [µs]
V_{DC}=600V, V_{DD}=15V, I_C=10A	E_{ON} @ T_J=25 / 150℃	1070 / 1560 [µJ]	1150 / 1860 [µJ]	1260 / 1880 [µJ]
	E_{OFF} @ T_J=25 / 150℃	560 / 860 [µJ]	740 / 1110 [µJ]	460 / 750 [µJ]
	E_{rr} @ T_J=25 / 150℃	310 / 670 [µJ]	370 / 810 [µJ]	300 / 610 [µJ]

Sleep function

- Sleep function is activated after each trigger of ITRIP or UVLO.
- A new edge of LIN and HIN is required for LO or HO after release of fault out.



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Mouser Electronics

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