基于iMOTION™智能驱动芯片的变频冰箱解决方案

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restricted

Agenda

1. 变频冰箱市场概况及应用理解
2. 为何会选择IMD111T用于变频冰箱?
3. 基于IMD111T的变频冰箱参考设计方案
4. 成功应用案例

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1.变频冰箱市场概况及应用理解

提高家用电器的能效意味着更多地节省能源消耗

Inverterization of all fridges in the world with Infineon semiconductors would save as much energy as Sweden consumes in one year

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变频化正在推动未来几年全球功率半导体的市场需求

	2020		CAGR$_{20-24}$	2024	
Room aircon		77% ~122m with VSD motors	13%	99% ~201m with VSD motors	3 VSD motors per device: compressor, indoor fan, outdoor fan
Washing machine		74% ~88m with VSD motors	10%	94% ~130m with VSD motors	2 VSD motors per device: drum, lye pump
Refrigerator		40% ~69m with VSD motors	21%	75% ~149m with VSD motors	1 VSD motor per device: compressor

Source: Omdia, “Major Home Appliance Market Report", November 2020

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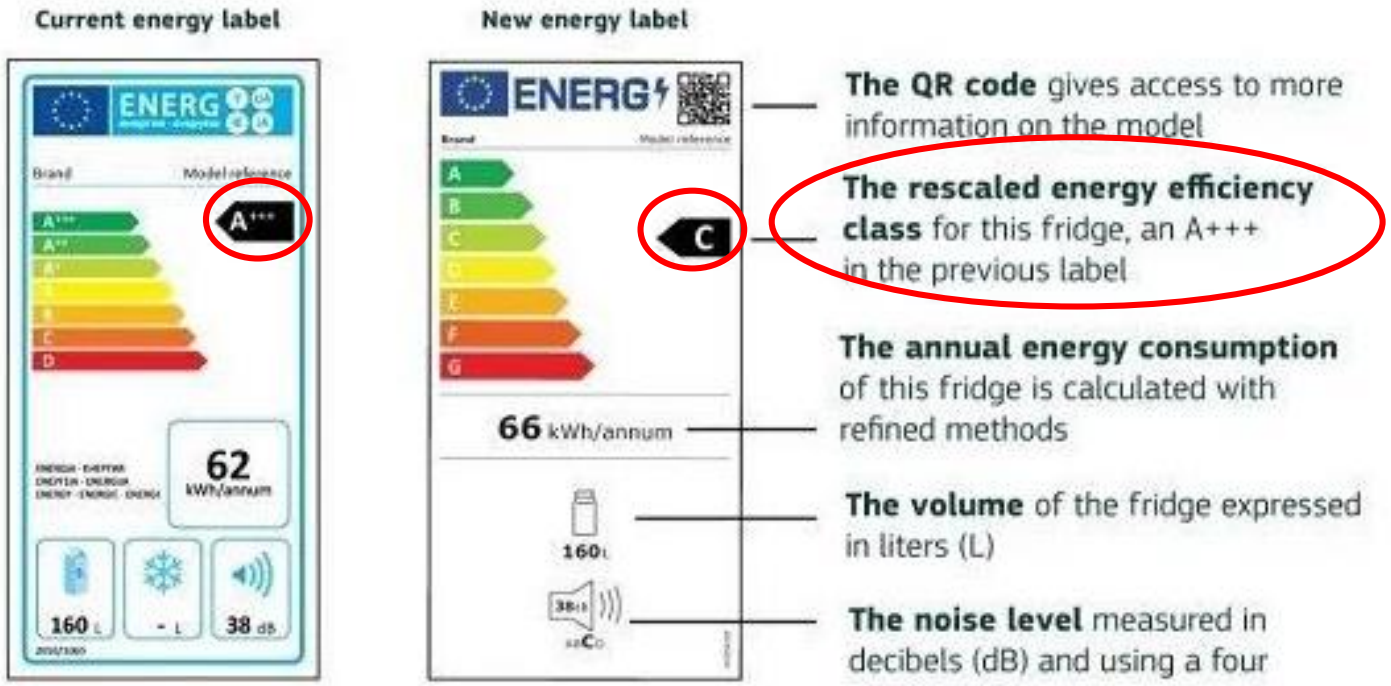
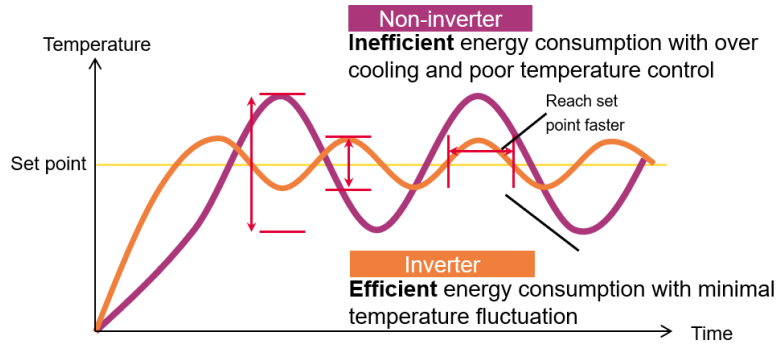
能效法规推动了冰箱变频化

› Energy efficiency regulations drive the use of inverters for motor control.
(EN 60335-2-24:2010/A1:2019+A2:2019, implemented from March 1st, 2021)

› Motor speed is automatically controlled on inverter models, smaller temperature variations contribute to energy efficiency



The energy labels for a fridge without freezer



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变频冰箱的设计要求

- Full power 250W (up to 300W)
- Standby power < 0.5W
- High pressure compressor startup
- Complex system control logic:
  - State machine driven by power estimation
  - Error handler
- Control interface: frequency input 30~150Hz
- Rapid development cycle. (6 months Design-in/Design-win to production)
- Lower system cost – single layer PCB, size reduction (PCB, DC bus cap)

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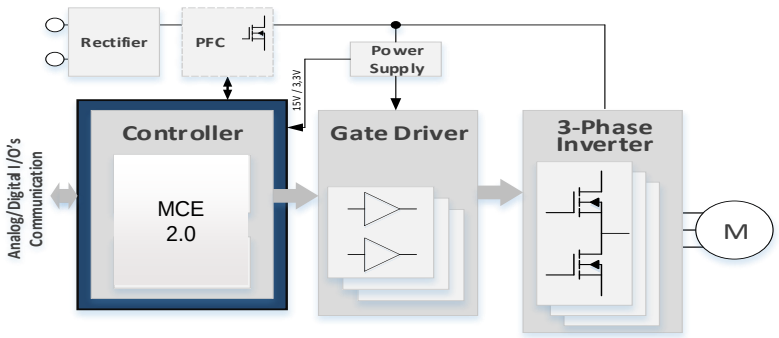
2.为何会选择IMD111T用于变频冰箱?

iMOTION™ 硬件集成方案

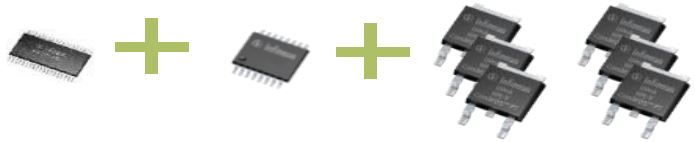
Flexibility → **Integration**

iMOTION™ 2.0 Controller



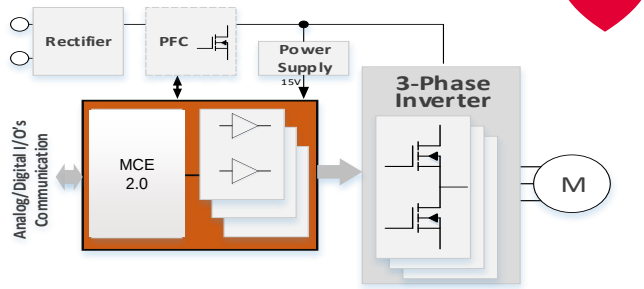
Digital Controller
MCE 2.0

Controller + Gate Driver + MOSFET's



Controller + IPM

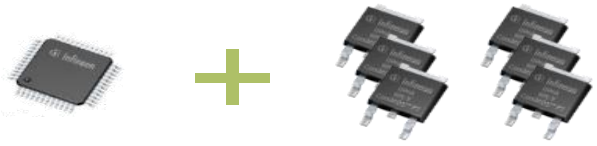
iMOTION™ 2.0 Smart Driver



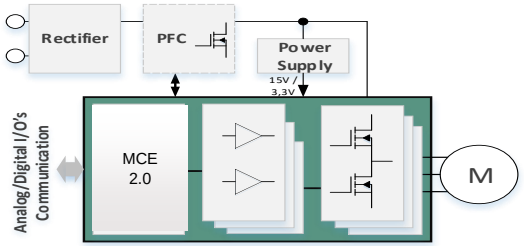
Digital Controller
MCE 2.0

+600V Gate Driver

Smart Driver + MOSFET's



iMOTION™ 2.0 Smart IPM

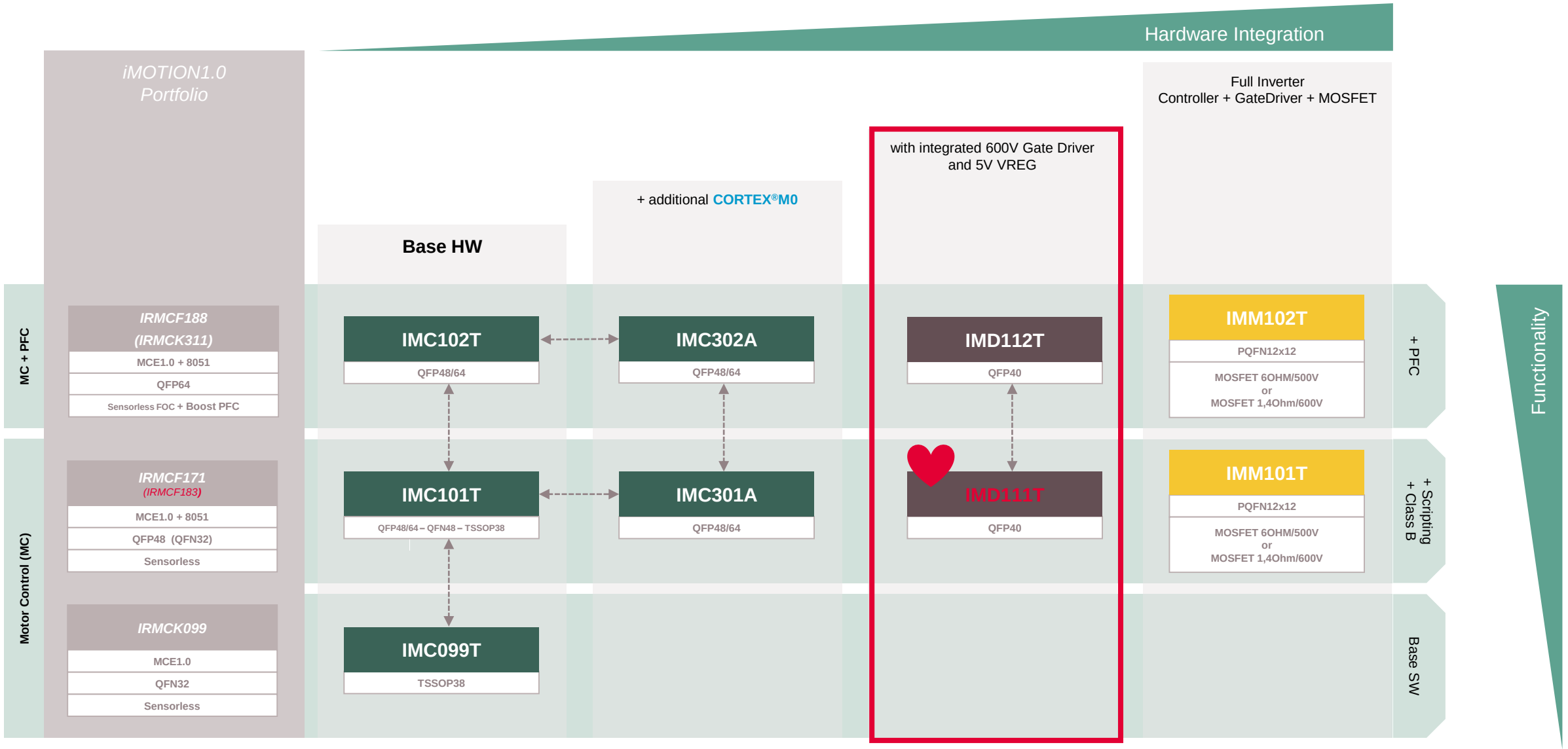


Digital Controller
MCE 2.0

+600V Gate Driver

+3ph 600V MOSFET power stage

iMOTION™ 2.0 系列产品



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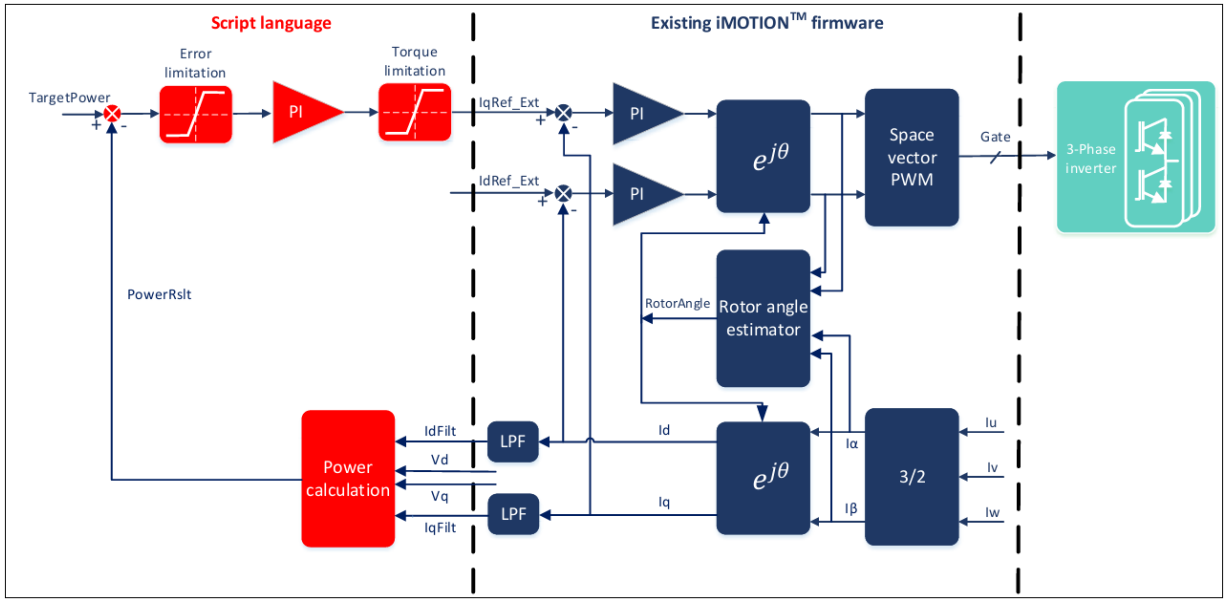
脚本引擎能够处理复杂的系统控制逻辑



› [Power calculation and constant-power control]

› **Script sample code in application note:**

```
001        DPwr = (IdFilt*Vd)>>12;   //Q12
002        QPwr = (IqFilt*Vq)>>12;   //Q12
003
004        TempVar = (PowerScl * (QPwr+DPwr))>>12;
005        //LPF Ts 1ms (2.5Hz -3db)
006        PwrMultiDEN= PwrMultiDEN + (TempVar - PwrRslt2);
007        PwrRslt = PwrMultiDEN >> 6;
```

› **Customer's script code for power calculation:**

```
/**********Power Derating and protection**************************/
    L_DPwr=(IdFilt*Vd)>>12; //Q12
    L_QPwr=(IqFilt*Vq)>>12; //Q12
//Power calculation code with DC bus compensation enabled
    L_TempVar1=(L_PwrScl*(L_DPwr+L_QPwr))>>12;
    L_Pwr_MultiplyDEN=L_Pwr_MultiplyDEN+(L_TempVar1-G_PwrRslt);
//Power calculation code with DC bus compensation disabled
    //L_TempVar1=((L_DPwr+L_QPwr)*VdcFilt)>>11;
    //L_TempVar2=(L_PowerScl*L_TempVar1)>>12;
    //L_Pwr_MultiplyDEN=L_Pwr_MultiplyDEN+(L_TempVar2-G_PwrRslt);
      G_PwrRslt=L_Pwr_MultiplyDEN>>6;//1count=0.01W
```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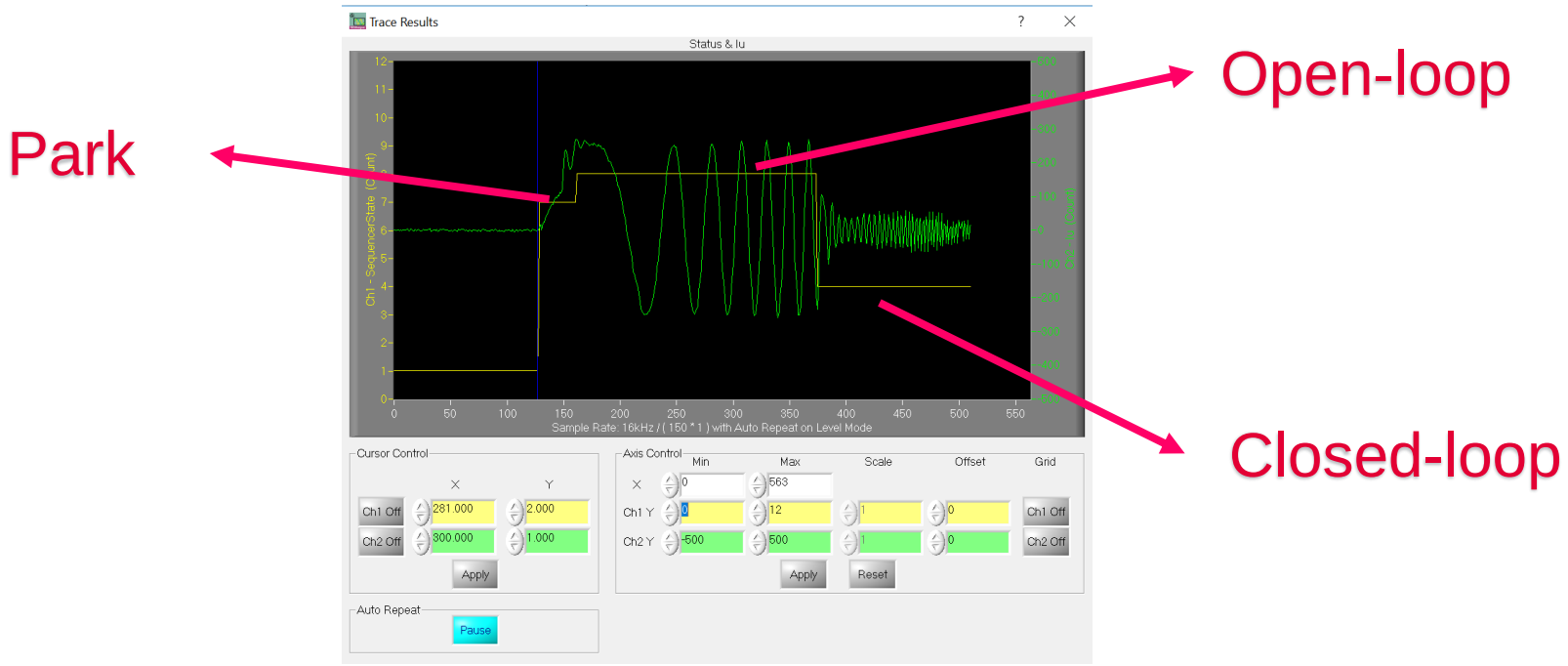
灵活的电机启动方式

- Direct Start-up
- **Park+Open-loop+Closed-loop: high pressure compressor startup**
- Catch Spin Start-up
- Angle Sensing Start-up



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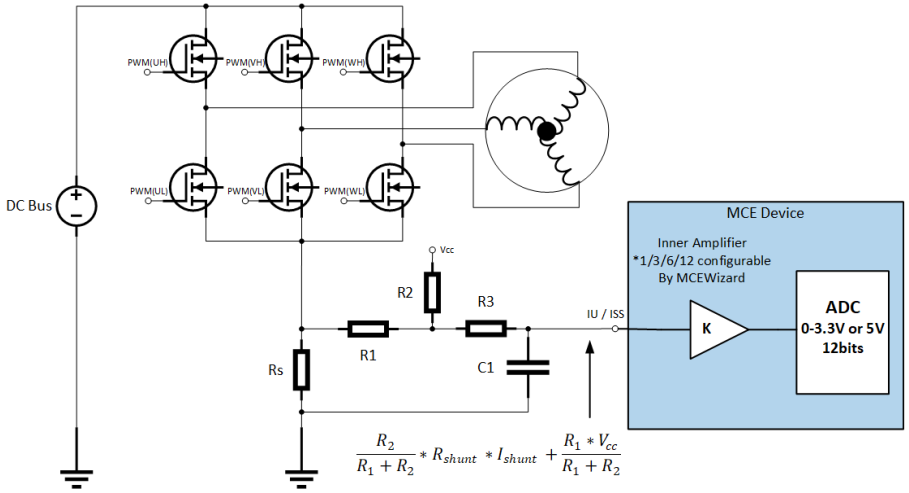
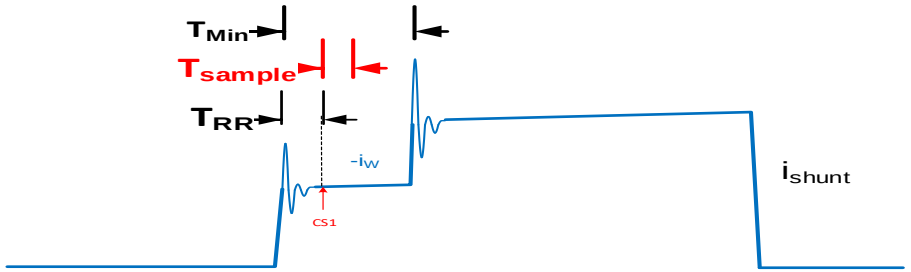
最低成本的电机电流检测方案

- IMD solution can provide lowest cost motor current sensing:
  - No additional external OP-Amp are required (Internal Gain can be set via MCEWizard: 1x, 3x, 6x,12x).
  - Good current reconstruction with single shunt configuration.
    - Phase shift SVPWM can guarantee the AD sampling quality.





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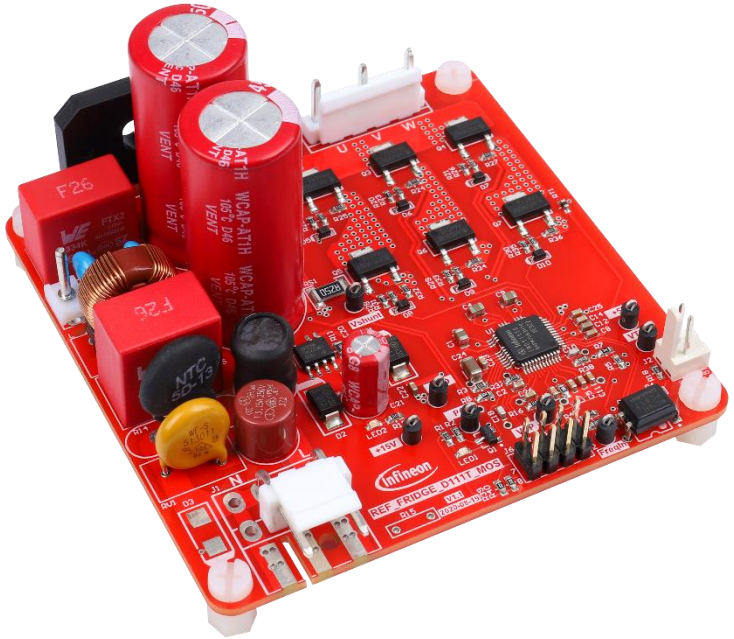
3.基于IMD111T的变频冰箱参考设计方案

变频冰箱参考设计板(双面板)

- **REF_Fridge_D111T_CoolMOS SOT223**
  - IMD111T-6F040 + CoolMOS SOT223
- REF_Fridge_C101T_IM231
  - IMC101T-T038+IM231-L6S1B
- REF_Fridge_C101T_6ED_IGBT DPAK
  - IMC101T-T038+6EDL04I06PT+IGBT RCD2 DPAK
- Dimension: 78*78 mm
- Application: Fridge, Fans, Motor Drive etc.



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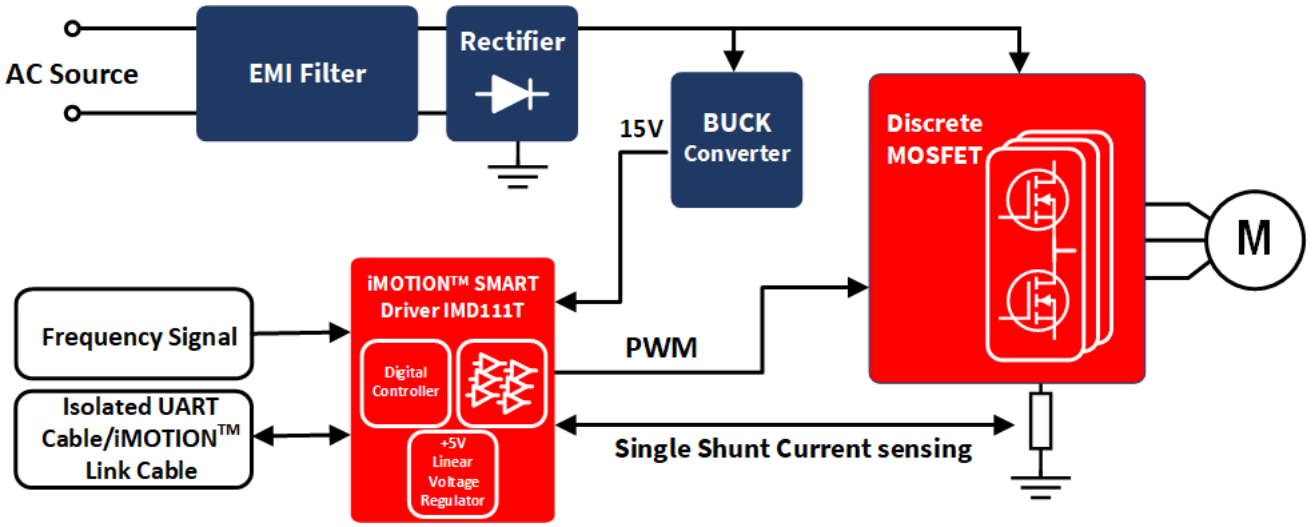
REF_Fridge_D111T_IGBT SOT223 参考设计板特征

- iMOTION™ SmartDriver IMD111T-6F040
- Ready-to-use motion controller with scripting engine and 6-channel SOI driver
- 600V CoolMOS™ PFD7 – optimized technology with lowest Qrr, ESD protection and compact SOT223 SMD package
- System solution enables best light load efficiency and compact design



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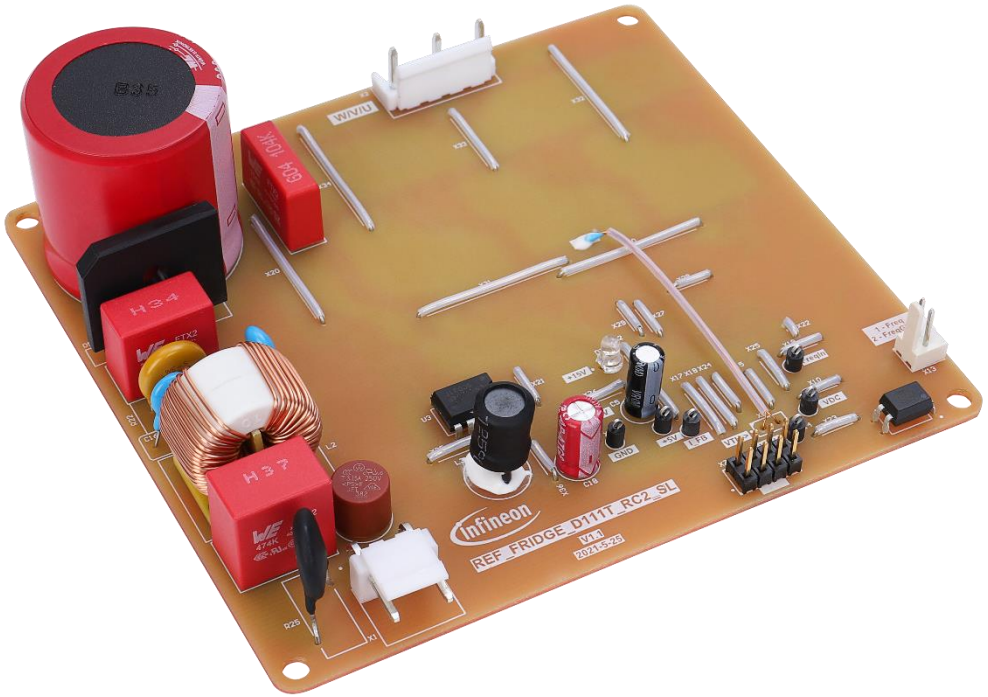
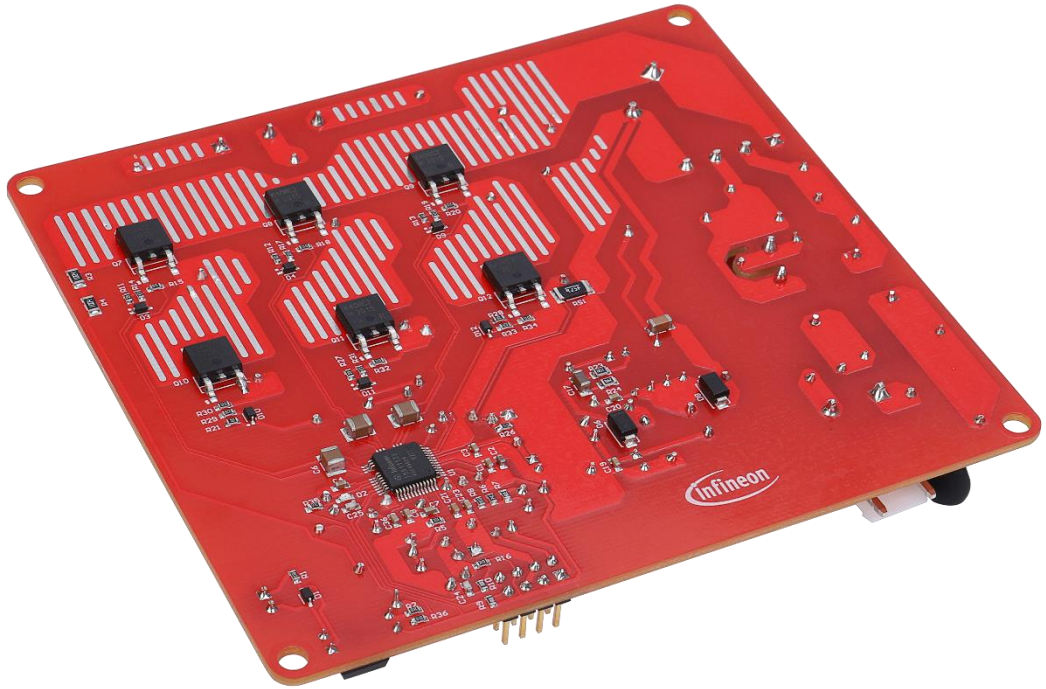
IMD111T 单面参考设计板(开发中)





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4.成功应用案例

变频冰箱压缩机

iMOTION™ 2.0 Smart Driver: IMD111T + IGBT RCD2 SOT223

Application	Fridge compressor				
Region	GC	**Quantity**	1M / year	**Competition**	ST, Active-semi(Qorvo)

Challenge	Heat dissipation for single-layer PCB, current sensing layout, Smooth startup for compressor.
Solution	IMD111T smart driver and IGBT RCD2 SOT223.
Action	SYS & TM provided the customer with comprehensive training based on the topics of IMD device and MCE software features. Multiple rounds of PCB design review. TM AE direct technical support during development of drive solution.
Benefit	Save system cost and fast time to market.
Achievement	Thanks to IMD’s pinout, it’s the first single-layer PCBA board for the fridge application based on the iMOTION2.0 Smart Driver and is a very competitive solution.

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