

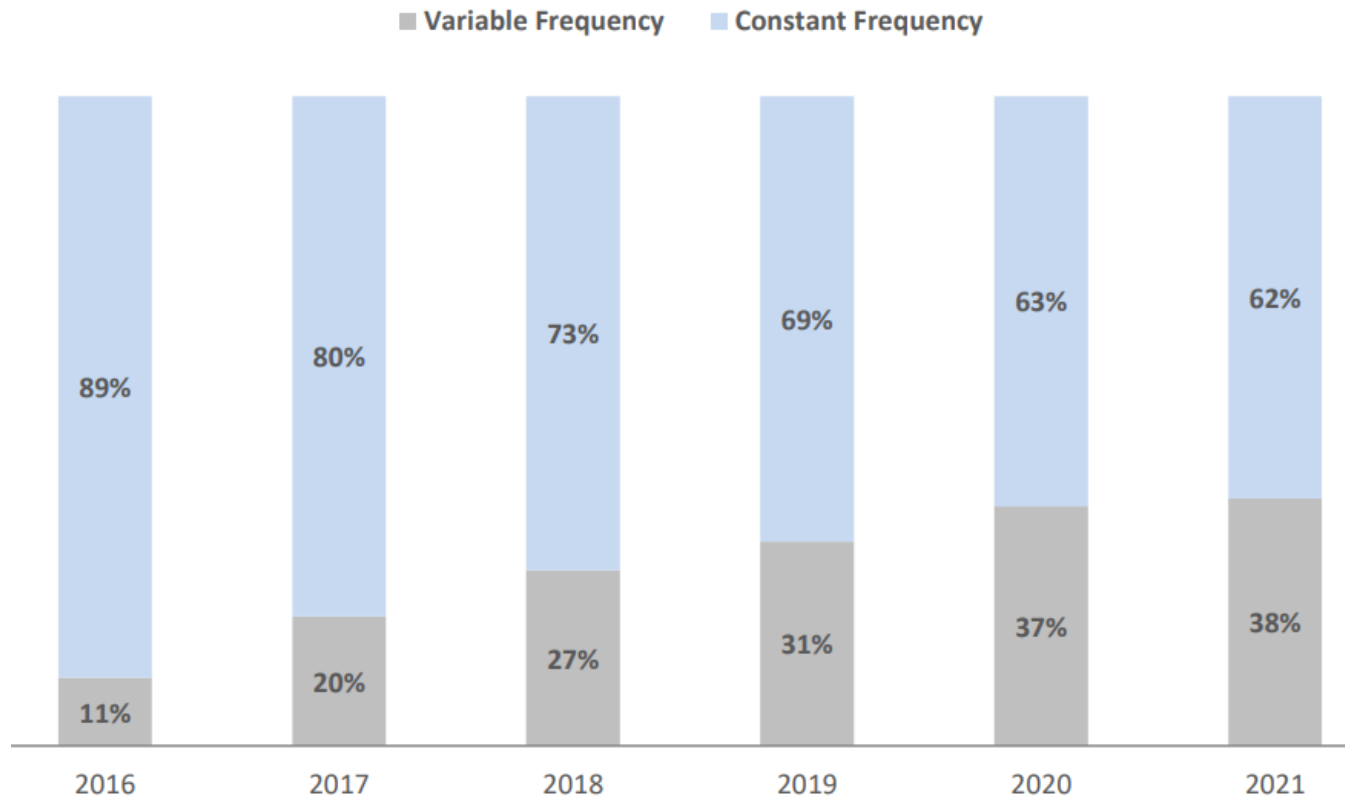
IFX Inverter Refrigerator Compressor Control Solution on PSoC

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Frequency Conversion Refrigerator Share Development in Domestic Market in 2016-2021

Changes in the Shares of Refrigerators and Freezers of Frequency Conversion in Domestic Market in 2016-2021 (%)



Source: ChinaIOL_-_Information_Report_on_Global_and_Chinese_Refrigerator_and_Freezer_Industry_2021.

Refrigerator Compressor Control Solution

MCU

MPN	CY8C4146AZI-S423
Core	CM0+
Max Operation Frequency	48MHz
Pin account	48
Flash	64K
RAM	8K
GPIO	38
PWM	5ch TCPWM
Timer	5
Ext Interrupt	8
A/D	16CH(1)*12bit @1MSPS
DAC	Idac : 1*8bit
Comparator	2
Operation Amplifier	2
Serial Comm	5* SCB
DMA	Yes
Operation Voltage	1.75-5.5V
Package	TQFP48

Specifications and control characteristic

Technical Spec:

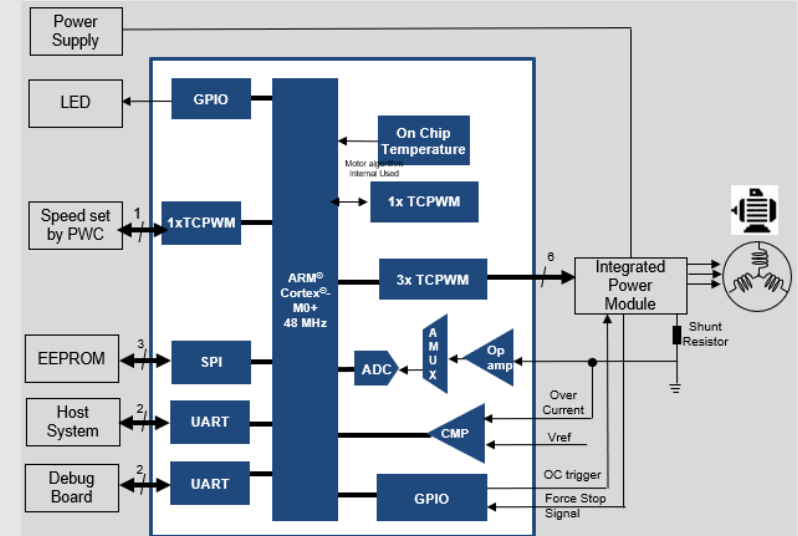
- Compressor carrier frequency: 4KHz-10KHz.
- Compressor motor speed: 1200rpm-4500rpm
- Max rise Speed: 5Hz/s (Mechanical rotation speed)
- Max reduction of speed: 3Hz/s(Mechanical rotation speed)
- Speed overshoot: 0.5Hz

Control Characteristic:

- Sensor-less motor control method based on FOC technology
- Optimized SVPWM with 4us
- 1-shunt sampling
- Directly close loop startup without open loop drag, no stop clamping, closed-loop smooth running at full speed
- Supporting the Field weakening function
- Full scale protection: over/under voltage, over current (phase current and AC input), motor running power real-time calculation and protection, IPM over temperature, sample hardware fault, phase loss, rotor lock
- Adopting the speed and current double closed loop PI control

Application block diagram

PSoC4100S Refrigerator Compressor Solution



BOM	MPN	QTY
MCU Controller	PSoC4100S (CY8C4146AZI-S423)	1
Discrete for Compressor	Pre-driver (6EDL04I06NT) MOS (IPN60R1K0PFD7 S x 6)	1
IPM for Compressor	IM231L6S1BALMA1	1



The solution can be discrete IC(pre-driver+MOS) or IPM .

HPFC+ Refrigerator Compressor Control Solution

MCU

MPN	CY8C4548AZI
Core	CM0+
Max Operation Frequency	48MHz
Pin account	48/64
Flash	256K
RAM	32K
GPIO	39/53
PWM	8ch TCPWM
Timer	8
Ext Interrupt	8
A/D	16CH(2)*12bit @1MSPS
DAC	Idac : 1*8bit
Comparator	2
Operation Amplifier	3
Serial Comm	5* SCB
MCA	Math Cal accelerator
DMA	3unit DMA
Operation Voltage	1.75-5.5V
Package	TQFP48/64

Specifications and control characteristic

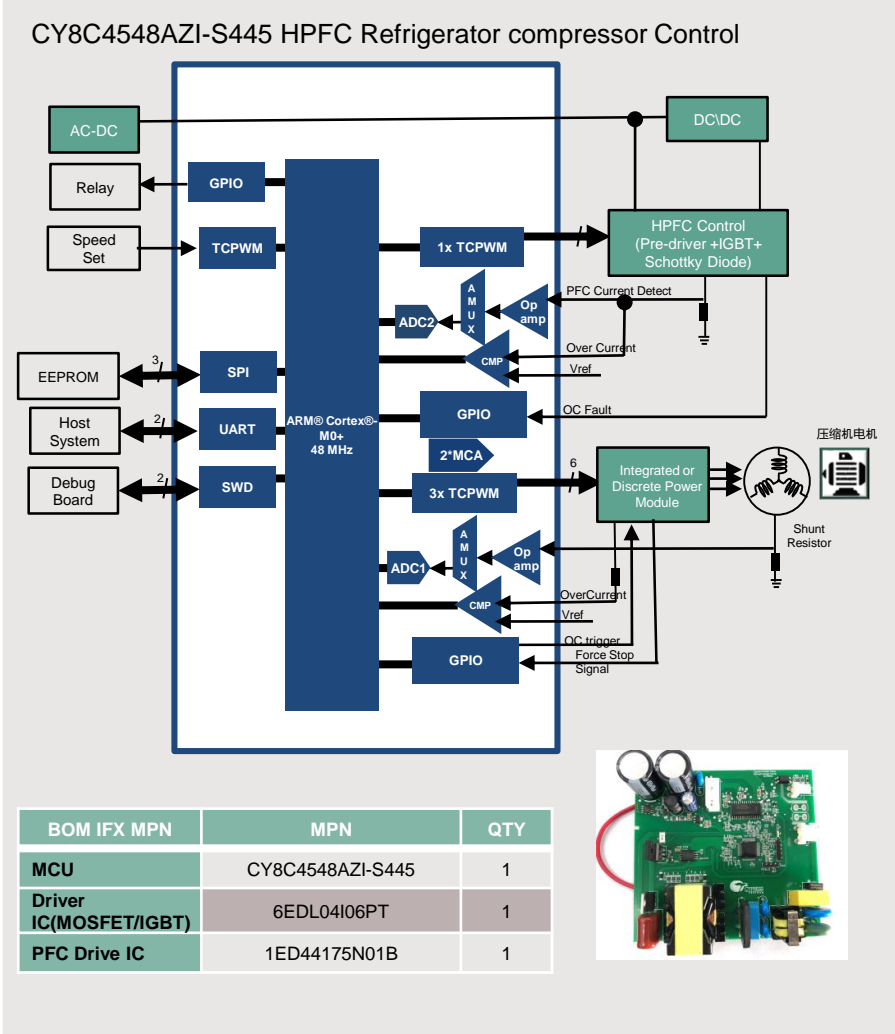
Technical Spec:

- Compressor carrier frequency: 5 KHZ.
- Motor efficiency: >94%
- PFC carrier frequency: 35~40KHz, PFC efficiency :95-99%
- Compressor motor speed: 1200rpm-4500rpm

Control Characteristic:

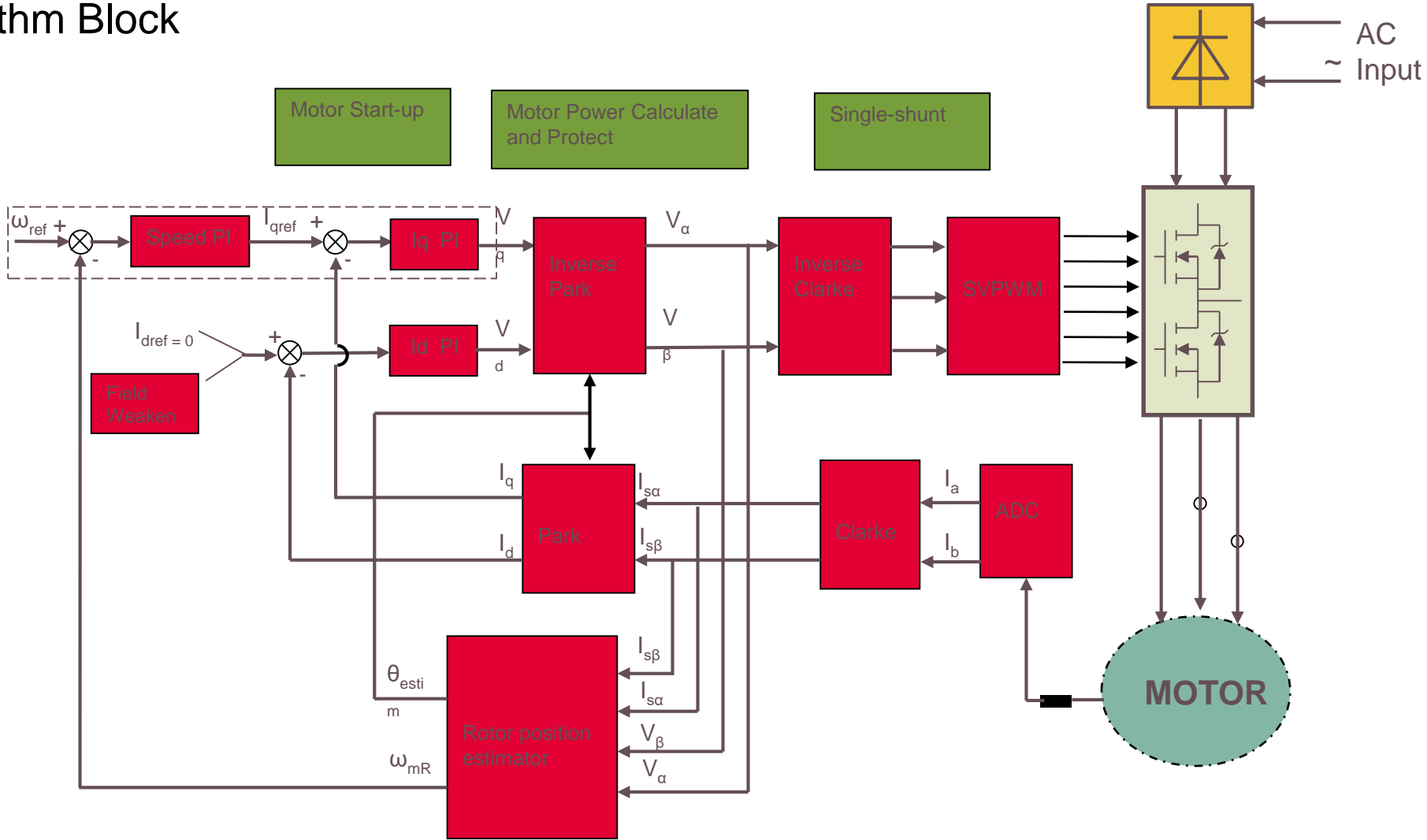
- Sensor-less motor control method based on FOC technology
- Optimized SVPWM with 4us
- 1-shunt sampling
- Directly close loop startup without open loop drag, no stop clamping, closed-loop smooth running at full speed
- Supporting the Field weakening function and dead-time compensation
- Full scale protection: over/under voltage, over current (phase current and AC input), motor running power real-time calculation and protection, IPM over temperature, sample hardware fault, phase loss, rotor lock
- Adopting the MCA accelerates execution time of the code

Application block diagram



Solution Overview

> FOC Algorithm Block



Solution overview

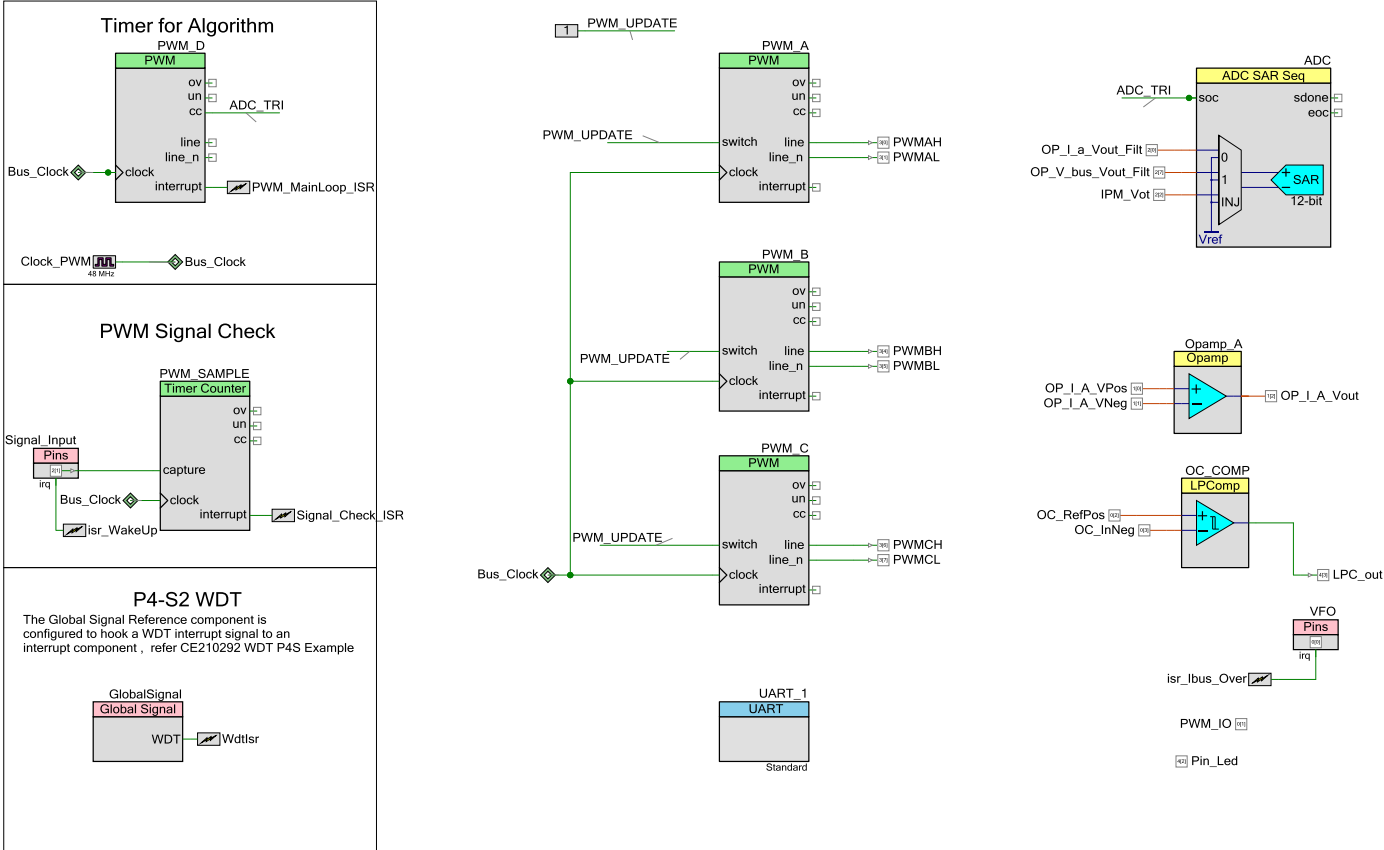
› Basic Algorithm List

- Field orientation control (FOC)
- Frame transform (Clarke, Park)
- PID regulator
- SVPWM generator
- Single shunt solution
- Math
- Filter
- Full-scale protection function

› Core Algorithm List

- PLL estimator
- Field weaken
- Self-adaption start-up
- Motor power calculation

PSoC Design Reference



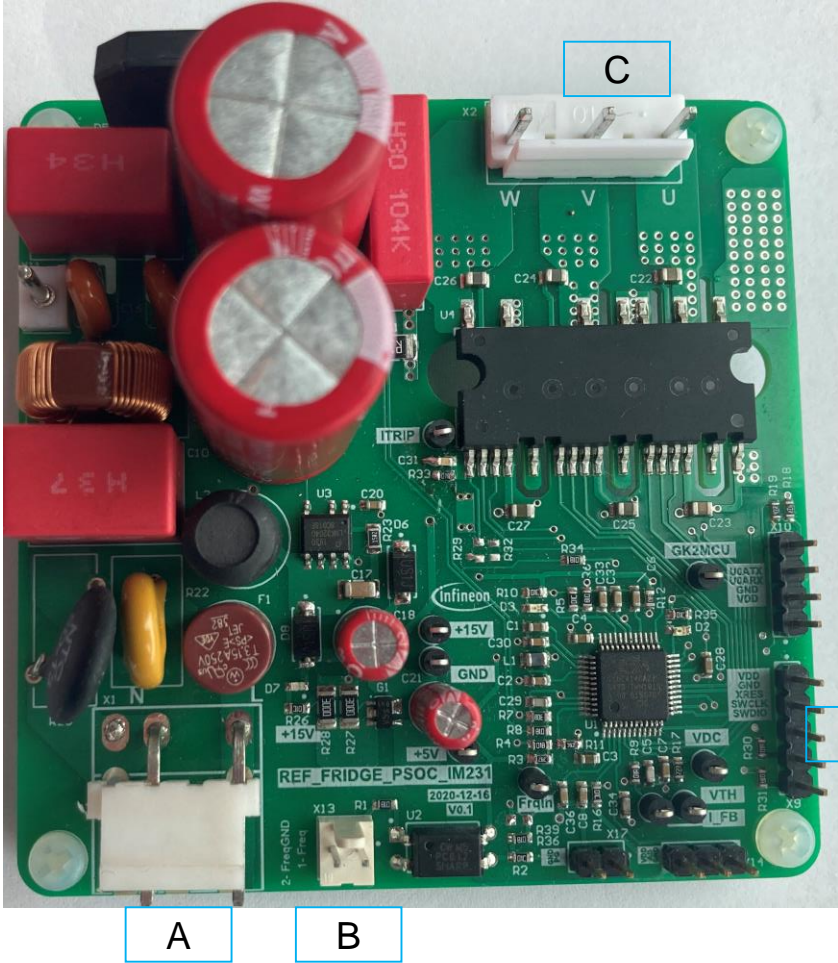
Top-Design Reference for Single-shunt Sampling

PSoC4 Design Reference

Name	Port	Pin
\ADC:Bypass\	P1 [7]	1
Signal_Input	P2 [0]	2
IPM_Vot	P2 [1]	3
OP_I_a_Vout_Filt	P2 [3]	5
OP_V_bus_Vout_Filt	P2 [4]	6
PWMCH	P2 [6]	8
PWMCL	P2 [7]	9
PWMAH	P3 [0]	12
PWMAL	P3 [1]	13
PWMBH	P3 [4]	17
PWMBL	P3 [5]	18
\UART_1:rx\	P4 [0]	22
\UART_1:tx\	P4 [1]	23
Csc	P4 [3]	25
VFO	P0 [0]	28
OC_IN_Pos	P0 [2]	30
OC_RefNeg	P0 [3]	31
Pin_Led	P0 [5]	33

FW Structure and Pins Assignment Reference

Solution Board



Port	Description
A	AC voltage input: 220V
B	Square wave signal input: 30Hz~150Hz
C	Connected with motor: U V W
D	SWD port

Success Story

Haier



Haier HMI/System
 CY95F636KPMC-G-UNE2
 CY95F698KPMC1-G-UNE2
 CY8C4025AZI-S413
 CY8C4126AZI-S433
 CY8C4127AZI-S445

Hisense



Hisense HMI/System/Compressor
 CY95F636KPMC-G-UNE2
 CY95F698KPMC1-G-UNE2
 CY8C4014SXI-421T
 CY8C4025AZI-S413

TIANYIN/Hisense
 Inverter Compressor control
 CY8C4146AZI-S423+6EDL04I06NT



GREE



Gree HMI/System
 CY8C4014SXI-421
 CY8C4127AZI-S433

Compressor control
 ZhengBang/Gree
 HuaLian/Gree
 Donper/Gree
 Inverter Compressor control
 CY8C4146AZI-S423



TCL



Donper/TCL
 Inverter Compressor control
 CY8C4146AZI-S423



Homa



TOPBAND
 Topband/Homa
 Inverter Compressor control
 CY8C4146AZI-S423+6EDL04I06NT

Whirlpool



Refrigerator

Whirlpool HMI
 CY8C4014LQI-422
 CY8C4045LQI-S411T



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