Cypress
Math and Motor Control Library

CYPRESS
Embedded in Tomorrow™

CONTENTS

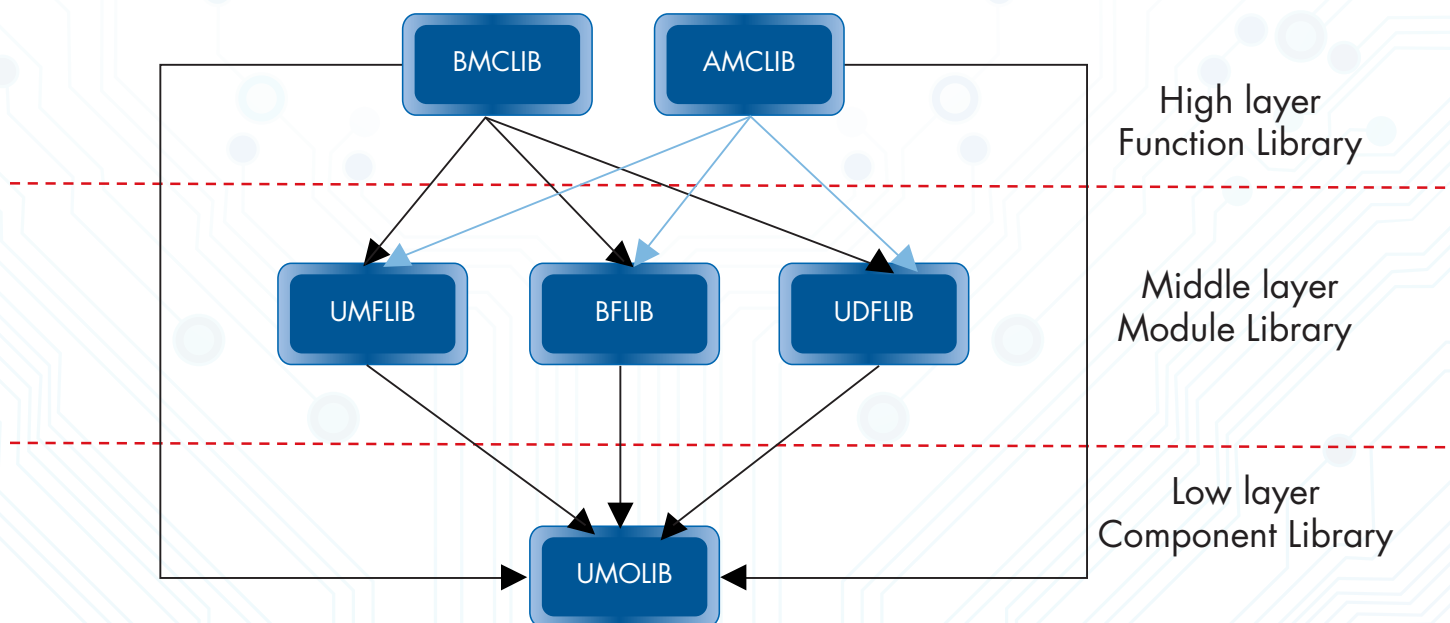## LIBRARY FEATURES

– Layered architecture

– Assembly code to do works which C language cannot do

– Some functions are written in assembly language and offer a C language interface

– Offer complete components to make a motor control system

– IAR EWARM is required

– Support full range of FM3 MCU

– Independent of the hardware platform

– Data format: fixed point

– A demo is shown as example which is to drive a low voltage BLDC motor

STRUCTURE

– Motor control library is specially designed for the application of motor control. It includes several sub-libraries. Some basic components are put in the lower layers, and some advanced modules are put in the higher layers (shown in below figure). All the functions in low and high layers can be called by users to build your own motor control system.

High layer
Function Library

Middle layer
Module Library

Low layer
Component Library

3

UMOLIB FEATURE

COMPONENT LIBRARY

- Universal math operation library - UMOLIB

  – Including the following operations

  - Addition, subtraction, multiplication, division

  - Absolute value, opposite value, rounding value, reciprocal value

  - Logic shift, rotational shift

  - Qn format transformation

  – Do the operations that cannot done by C language

  - Saturation operation

  - Logic and rotational shift

UMFLIB FEATURE

MODULE LIBRARY

- Universal math function library - UMFLIB

  – Including the following operations

  - Sine, cosine, tangent

  - Arc-sine, arc-cosine, arc-tangent

  - Square root, linear interpolation, sign

BFLIB FEATURE

MODULE LIBRARY

- Basic function library - BFLIB

  – Including the following operations

  - Limit value to a given scope

  - Ramp output

  - Hysteresis function

  - Integration

  – Saturation is applied in the following function

  - Integration

UDFLIB FEATURE

MODULE LIBRARY

- Universal digital filter library - UDFLIB
  - Including the following operations
    - Average filter
    - Sliding average filter
    - Fast 1-order filter

BMCLIB FEATURE

MODULE LIBRARY

- Basic motor control library - BMCLIB
  - Including the following operations
    - Clark, Park, inverse Clark, inverse Park transformation
    - PID regulator
    - SVPWM initialization and calculation
    - Over-SVPWM initialization and calculation
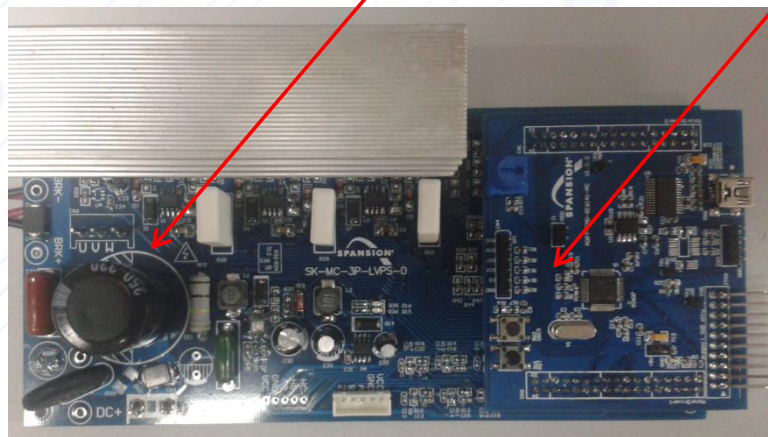
AMCLIB FEATURE

FUNCTION LIBRARY

- Advanced Motor Control Library - AMCLIB
  - Including the following operations
    - Calculating delta angle by encoder
    - Detecting hall position by look-up
    - Detecting hall position and calculating rotor speed by interrupt
    - Sensor-less estimator
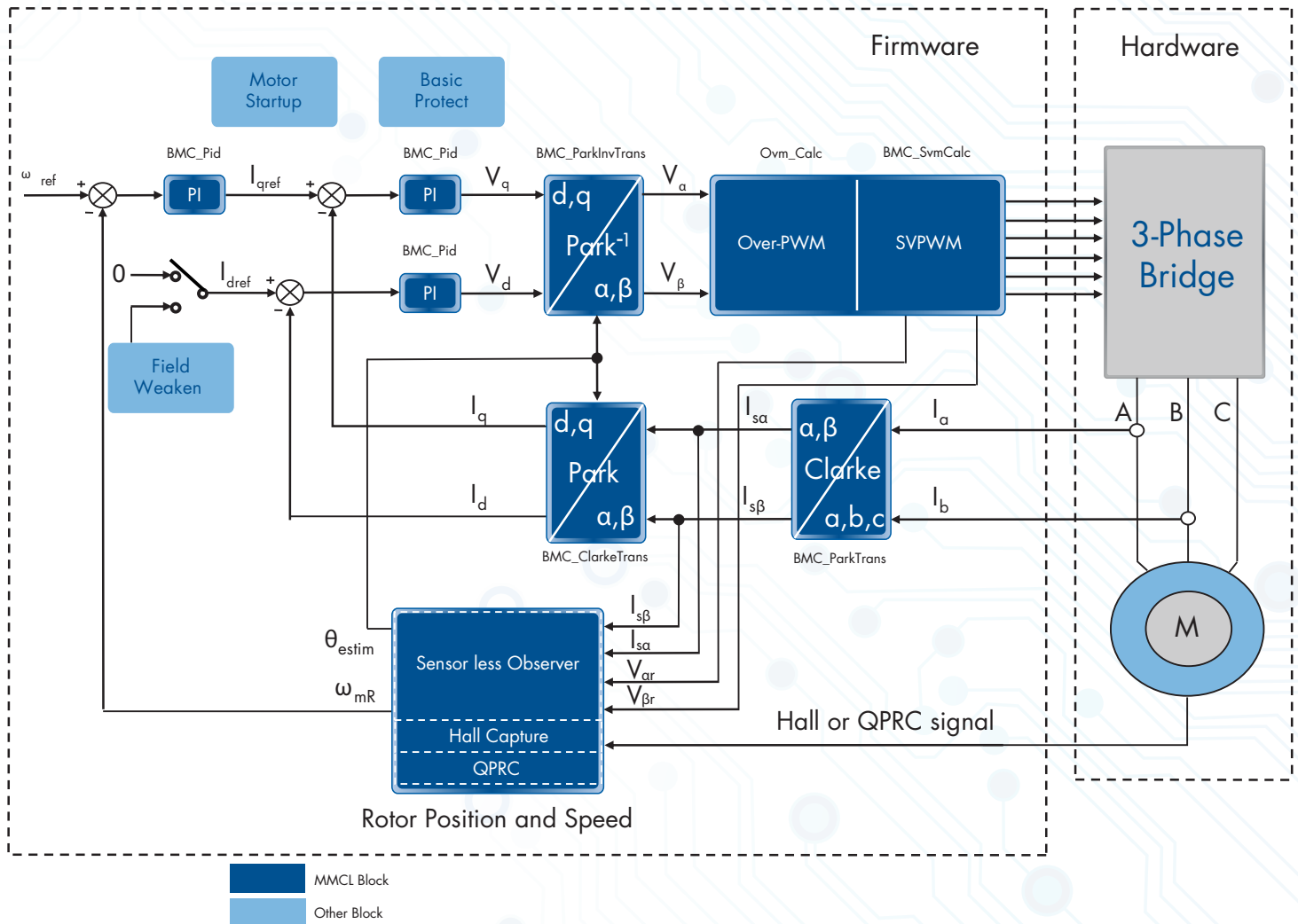
DEMO HARDWARE FEATURE

HARDWARE

• The demo hardware is composed of the following parts:

  – Bottom control board

    • 24V dc-bus voltage input

    • Three-phase full-bridge inverter with discrete component

    • Sampling by three shunts

    • One three-phase motor driving socket

    • One hall sensor socket

    • One encoder socket

    • One MCU control board socket

  – MCU control board

    • One bottom control board socket

    • One system reset key

    • One tunable resistor

    • Two serial communication sockets

    • One 20-pin J-Link socket

    • One 6-pin SPI socket

  – BLDC motor (24V)

Bottom control board

MCU control board

DEMO SOFTWARE BLOCK DIAGRAM

Firmware

Hardware

Motor Startup

Basic Protect

BMC_Pid

ω_{ref}

PI

I_{qref}

BMC_Pid

PI

V_q

BMC_ParkInvTrans

d,q Park^{-1} α,β

V_α

V_β

Ovm_Calc

BMC_SvmCalc

Over-PWM

SVPWM

3-Phase Bridge

0

I_{dref}

BMC_Pid

PI

V_d

Field Weaken

I_q

d,q Park α,β

$I_{s\alpha}$

$I_{s\beta}$

α,β Clarke a,b,c

I_a

I_b

BMC_ClarkeTrans

BMC_ParkTrans

I_d

A B C

θ_{estim}

ω_{mR}

Sensor less Observer

$I_{s\beta}$
$I_{s\alpha}$
$V_{\alpha r}$
$V_{\beta r}$

Hall Capture

QPRC

M

Hall or QPRC signal

Rotor Position and Speed

MMCL Block

Other Block

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