Developing servo drive and simulation software using Simulink code generation

ANCA motion

Agenda

Introduction

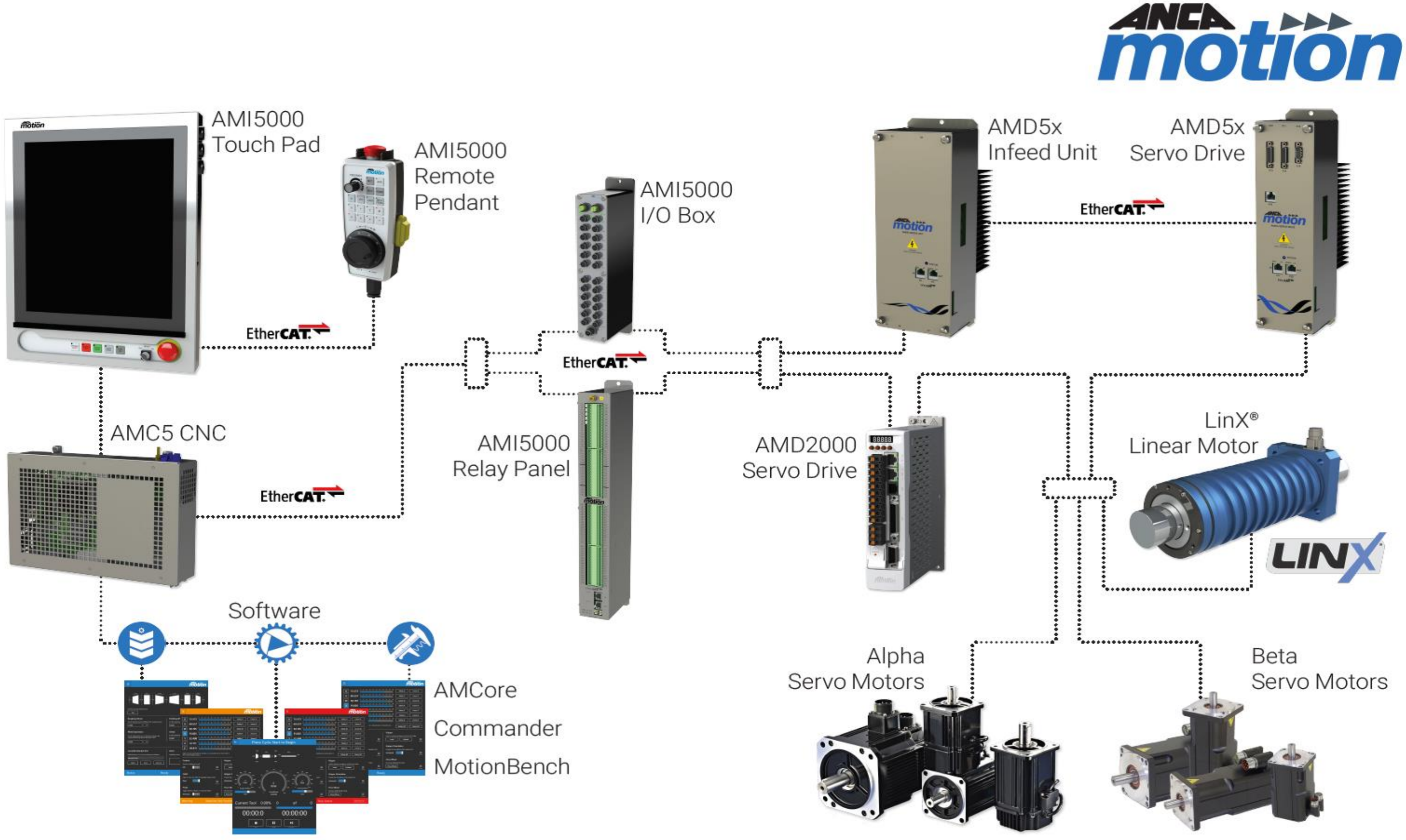
Adoption of automatic code generation at ANCA Motion

Engineering education initiative:

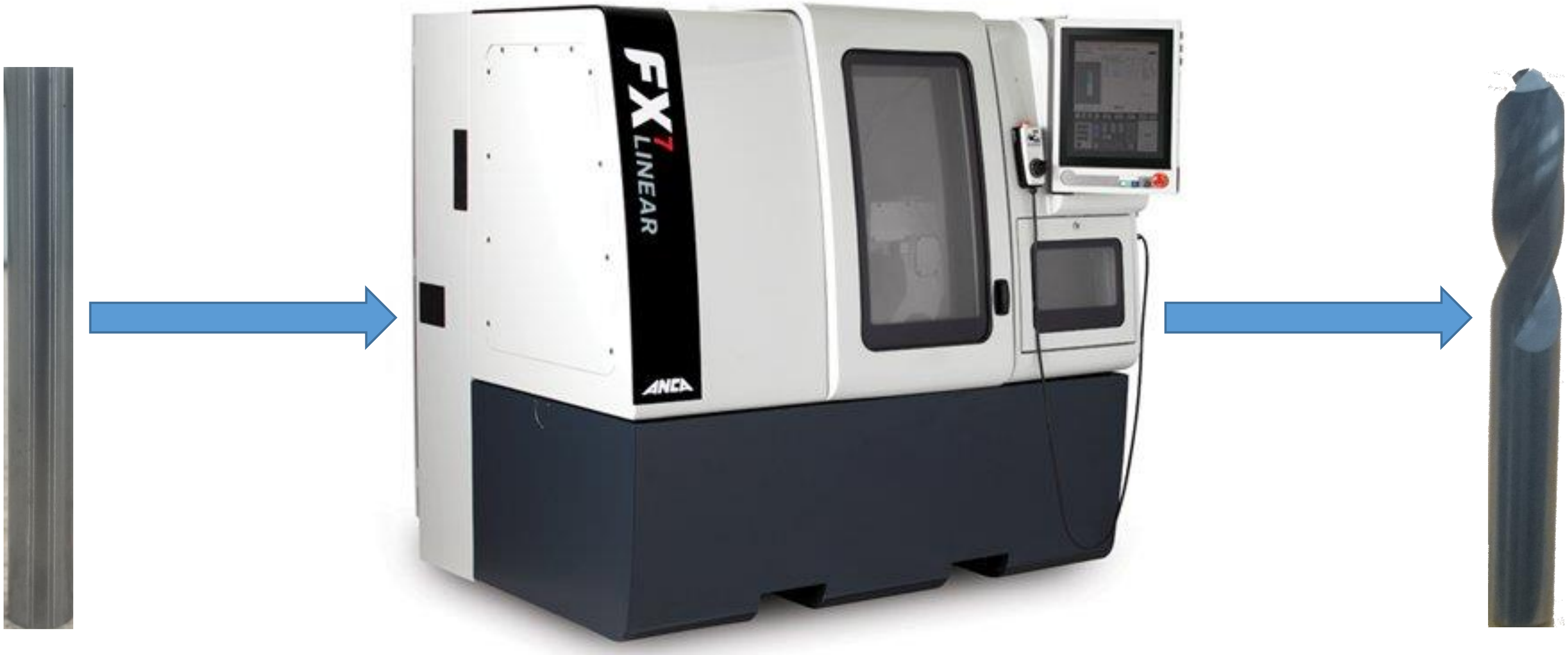
- Servo drive and motor simulator with a web based interface
- Synchronous motor Hardware in the Loop (HIL)

Introduction

ANCA Motion designs and manufacture flexible control systems, specialising in high precision solutions for CNC machines



Introduction – Typical CNC Machine



Introduction– Servo Drive

Servo drives enable position, velocity and torque control of permanent magnet synchronous motors

Various current ratings

Usually multiple drives are used in an individual CNC machine

AMD5x
Servo Drives

AMD2000
Servo Drives

Evolving requirements – Servo Drive

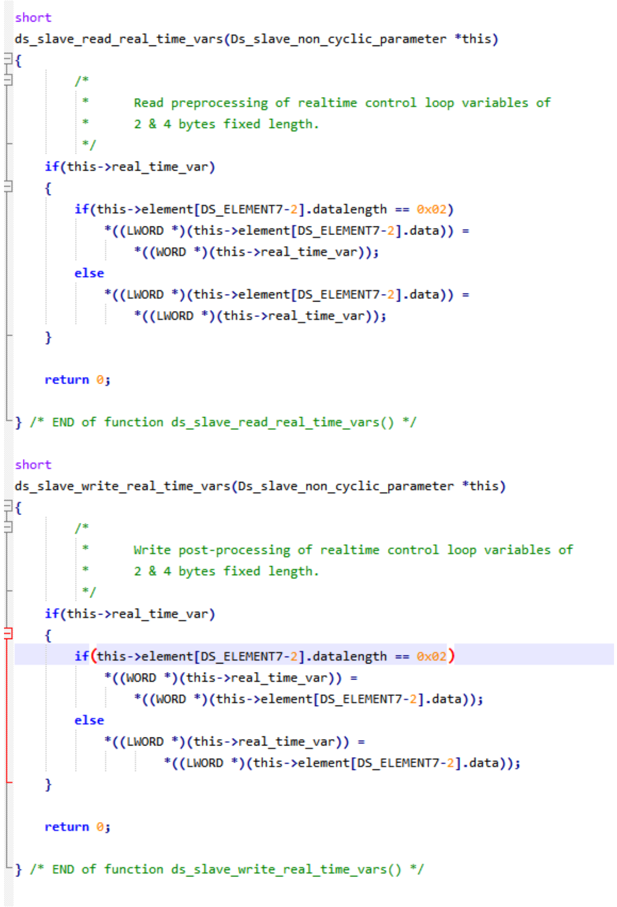
Faster and more accurate motor control

Increasing variety of applications each with different needs

How to keep up with increased demands and have robust code?

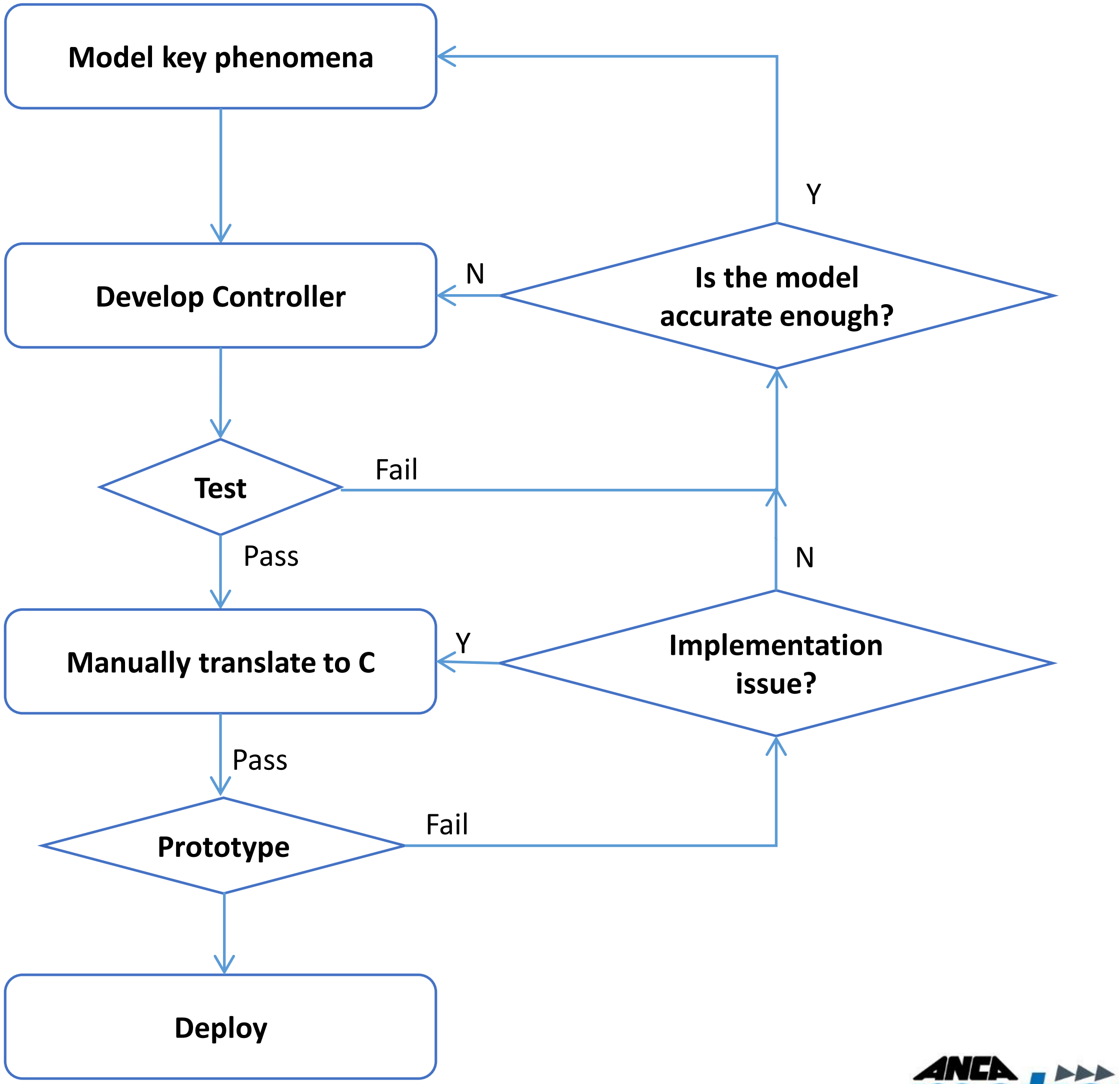
How to handle the increasing number of test scenarios?

Before code generation



```
short
ds_slave_read_real_time_vars(Ds_slave_non_cyclic_parameter *this)
{
        /*
         *      Read preprocessing of realtime control loop variables of
         *      2 & 4 bytes fixed length.
         */
    if(this->real_time_var)
    {
        if(this->element[DS_ELEMENT7-2].datalength == 0x02)
            *((LWORD *)(this->element[DS_ELEMENT7-2].data)) =
                *((WORD *)(this->real_time_var));
        else
            *((LWORD *)(this->element[DS_ELEMENT7-2].data)) =
                *((LWORD *)(this->real_time_var));
    }

    return 0;

} /* END of function ds_slave_read_real_time_vars() */

short
ds_slave_write_real_time_vars(Ds_slave_non_cyclic_parameter *this)
{
        /*
         *      Write post-processing of realtime control loop variables of
         *      2 & 4 bytes fixed length.
         */
    if(this->real_time_var)
    {
        if(this->element[DS_ELEMENT7-2].datalength == 0x02)
            *((WORD *)(this->real_time_var)) =
                *((WORD *)(this->element[DS_ELEMENT7-2].data));
        else
            *((LWORD *)(this->real_time_var)) =
                    *((LWORD *)(this->element[DS_ELEMENT7-2].data));
    }

    return 0;

} /* END of function ds_slave_write_real_time_vars() */
```

Translation step is an extra source of error



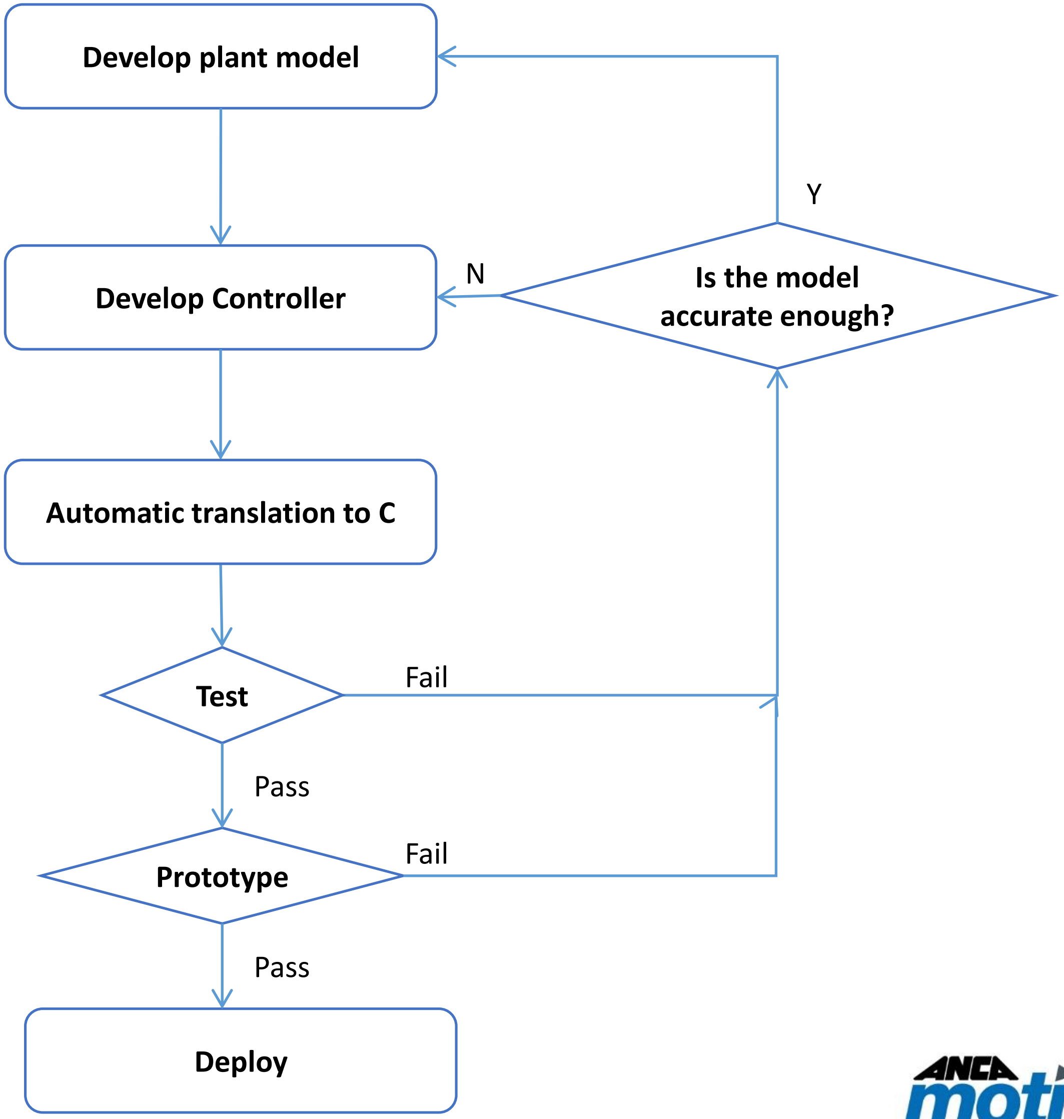
Using Code Generation

Encourages development of more accurate models

More testing in simulation

Shorten test-develop-debug cycle

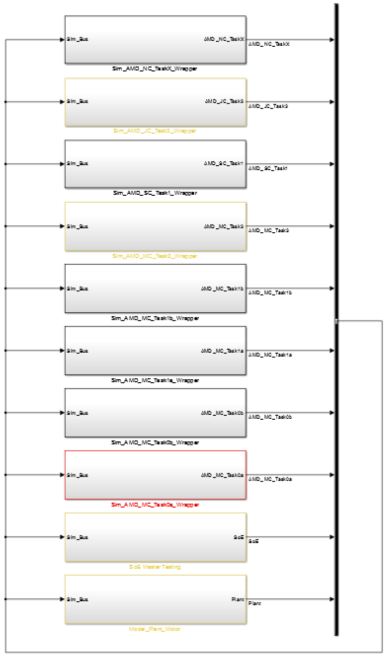
Automates translation step



Software in the Loop (SIL)

Detailed plant model and code generation have allowed us to create an automated Software in the Loop (SIL) test system.

Integrated with our Continuous Integration (CI) server and run nightly.



ANCA Motion - Code generation advantages

Automates translation step, reducing development time and a potential source of errors

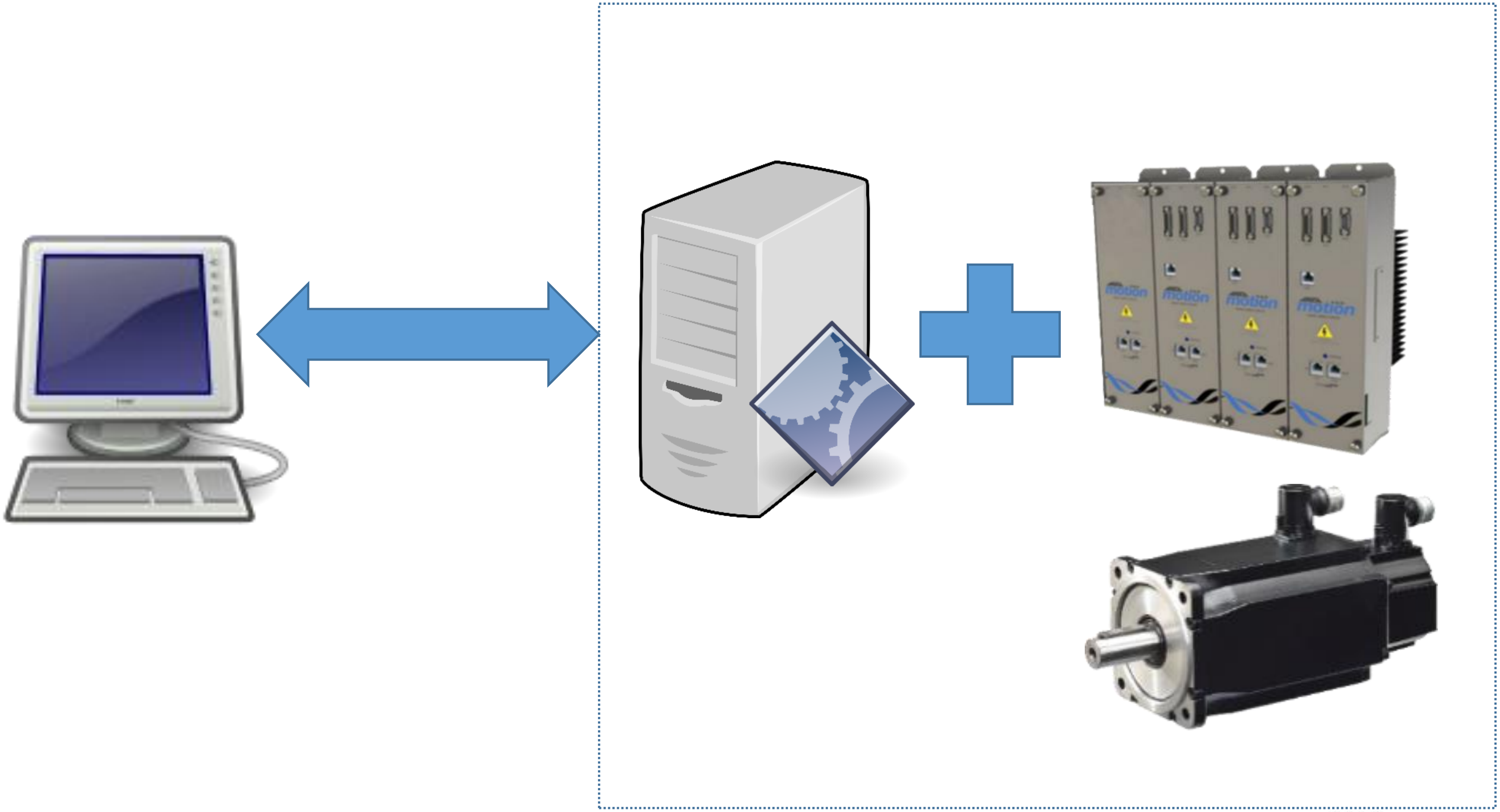
Easier to achieve code consistency between developers

SIL testing has reduced the need for physical hardware.

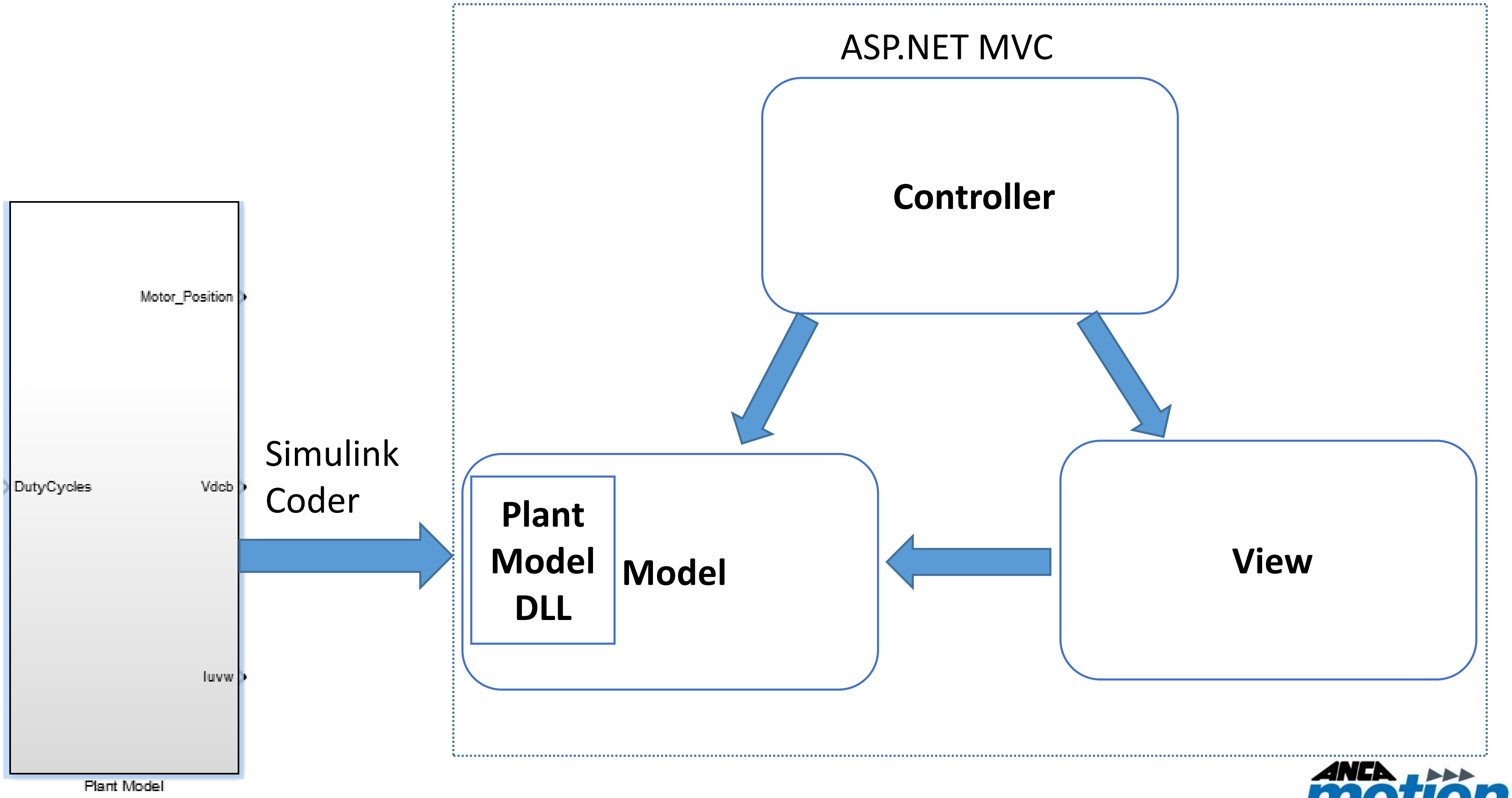
With SIL, errors can be detected earlier in the development cycle

Student Project – Web based servo sim

Create a servo drive and synchronous motor simulator with a web interface



Web based servo sim – Simulink & ASP



Simulink Coder

ASP.NET MVC

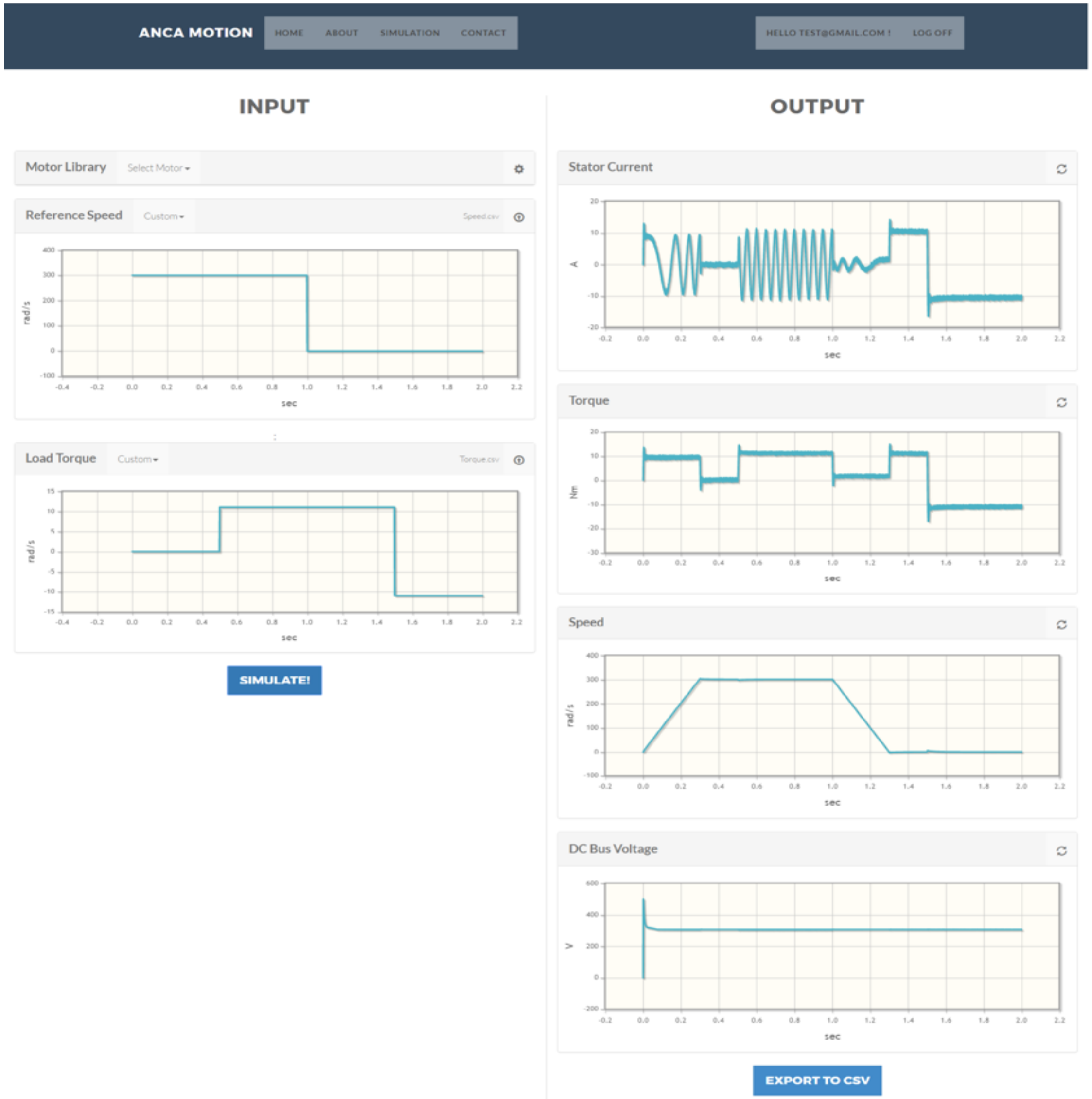
Controller

Plant Model DLL

Model

View

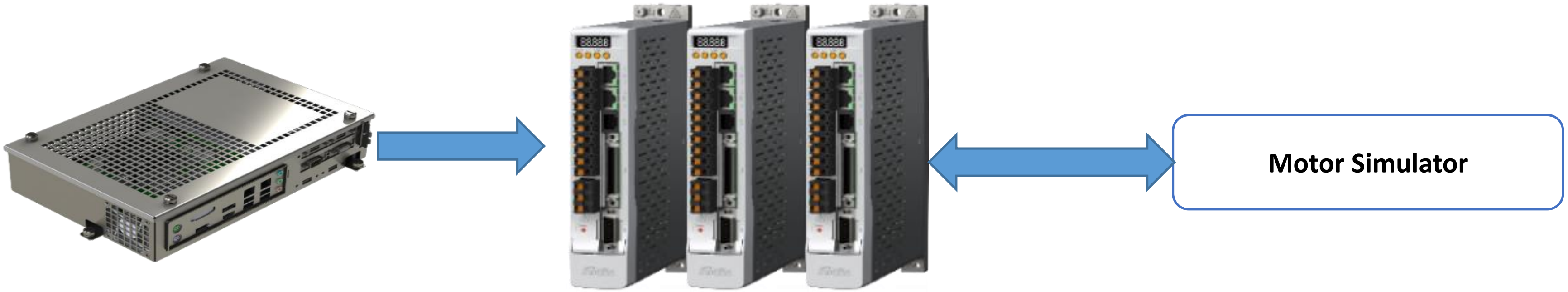
Web based servo sim



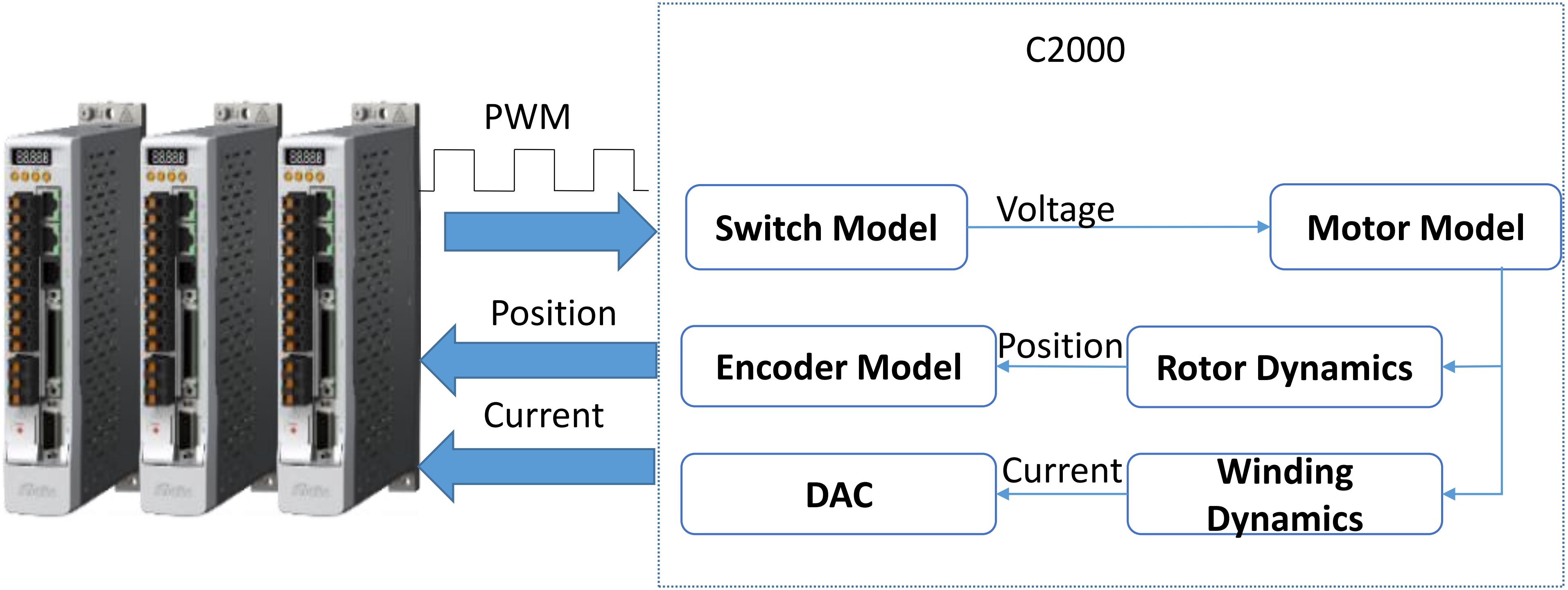
Student Project – Motor HIL

Create a synchronous motor simulator that can replace physical motors when testing servo drive hardware.

The simulator will run on a Texas Instruments (TI) C2000 based microcontroller.



Motor HIL System overview



Motor HIL System - Simulink

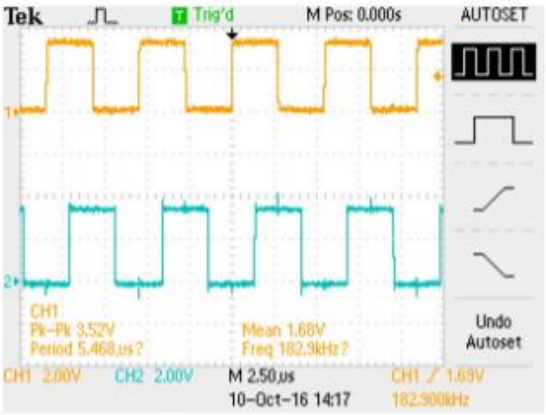
The custom motor simulator was written entirely in Simulink.

Embedded coder was used to generate C code from Simulink and call the TI toolchain to compile and deploy onto the target.

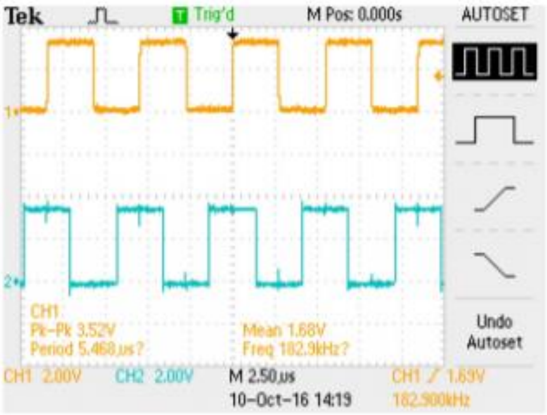
TI target support package used to configure and control hardware.

Motor HIL System - Results

Encoder signals CW and CCW rotation 5rad/s



CH1
Pk-Pk 3.52V
Period 5.468μs?
Mean 1.68V
Freq 182.9kHz?
CH1 2.00V CH2 2.00V M 2.50μs
10-Oct-16 14:17
CH1 ⁄ 1.69V
182.900kHz



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10-Oct-16 14:19
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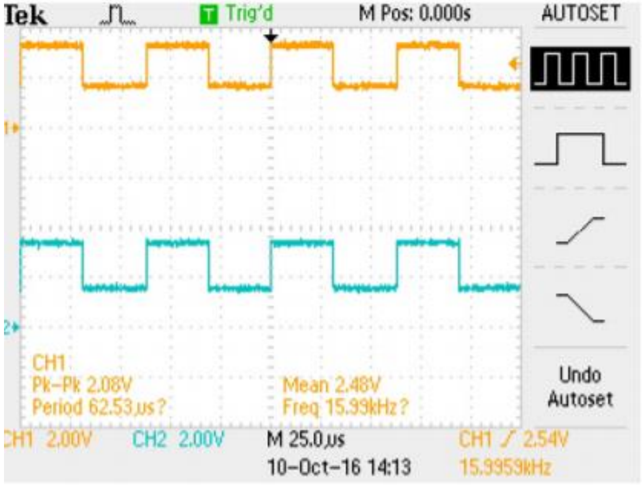
Duty cycle measurement



CH1
Pk-Pk 2.08V
Period 62.53μs?
Mean 2.48V
Freq 15.99kHz?
CH1 2.00V CH2 2.00V M 25.0μs
10-Oct-16 14:13
CH1 ⁄ 2.54V
15.9959kHz

Source: Li, D., Li, W., Wei, Y., Zhang, L. (2016).
Servo Drive Hardware in the Loop Test System

Conclusion

Automatic code generation automates translation step removing potential source of errors.

SIL allows errors to be captured earlier.

Enables greater focus on algorithms as opposed to implementation concerns.

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Motion Control Solutions