



MR2

HARDWARE-IN-THE-LOOP

First Plug & Play
HARDWARE-IN-THE-LOOP System
in the world



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MR2 HARDWARE-IN-THE-LOOP

A HIL DEDICATED TO MOTOR DRIVE CONTROLLER

Precise. Fast. Economical.

First plug & play HIL in the world

User-friendly, Precise, and Economical



【Features】

Hardware in the loop (HIL) is a real-time simulation platform where the physical electronic controller is able to interact with the simulated part, like: power stages, motor, encoder...etc.

【Application】

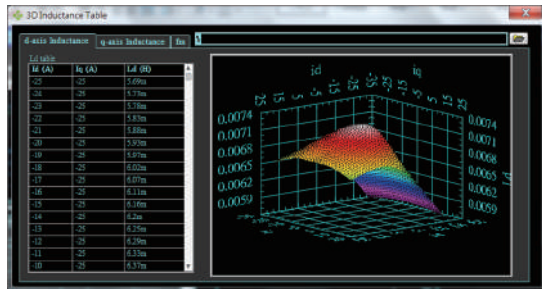
MR2 is dedicated to motor drive controller. The 3-phase 2-level DC to AC inverter, various electric machines, load torques are built-in. Users can easily connect their control board to MR2 and do all controller performance test.

【Functions】

- Various motor can be selected
- The parameters of power grid and rectifier can be changed
- 3 Level NPC/T Type topology(MR2 PRO)
- Motor emulation can be very close to real characteristic (Maxwell ECE Table is feasible)
- Various rotary encoder types can be selected (e.g. pulses, resolver, 1V)
- Real-time system state monitoring
- Fit to any controller (user-defined scaling)
- Mimic application condition by flexible load torque editor
- 6 phase motor application(MR2 PRO)

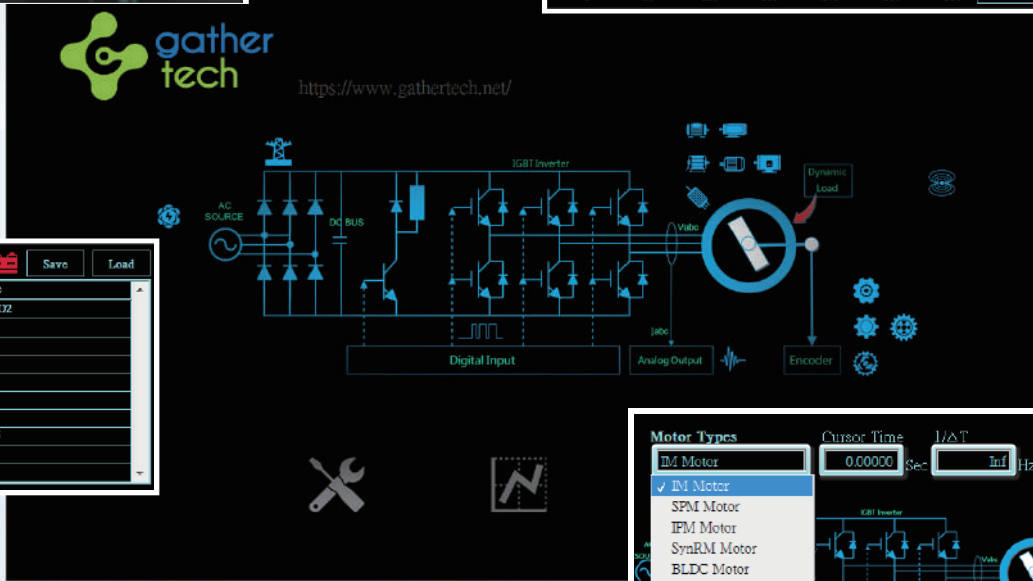
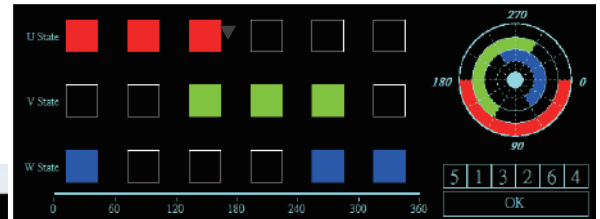
MR2 HIL : Easy to Get Started

Simply connect, setup, and run



▲ Maxwell ECE Table

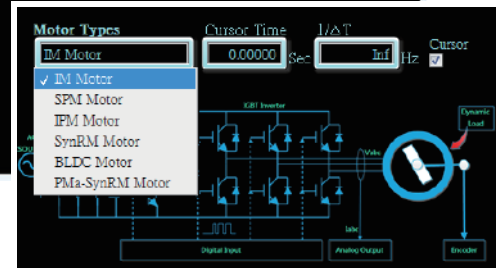
▼ Hall-effect sensor installation setting



Battery Type: Lithium Ion

Pr. Names	Unit	Value
Positive electrode materials	pe.	LiCoO2
Negative electrode materials	pe.	LiC6
Number of cells (in series)	pe.	12
Number of cells (in parallel)	pe.	12
Capacity of cell	Ah	2.7
Initial state-of-charge	%	95
Minimum state-of-charge	%	1
Internal resistance of cell	Ohm	0.005

▲ Battery power source setting



▲ Motor type selection

AB PPR: 1024, C Gain: 1, A Gain: 1, D Gain: 1, B Gain: 1

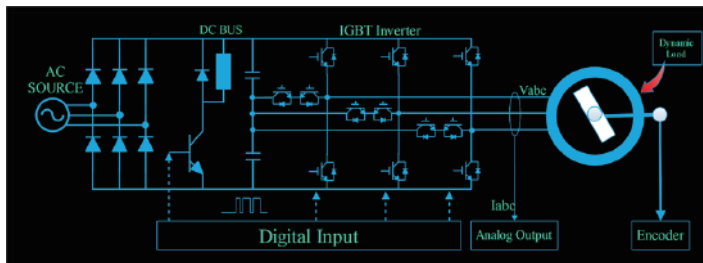
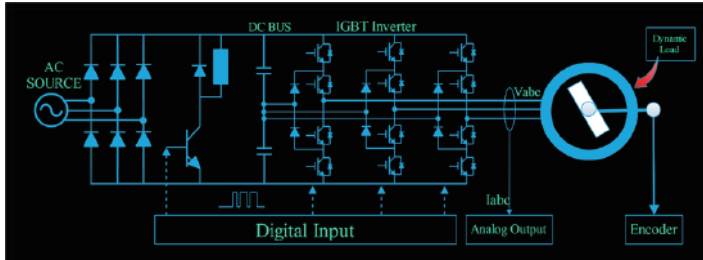
▲ 1 Vpp Sin/Cos encoder setting

Easy Procedure for First-time User :

- Select the motor type to be emulated, e.g. Squirrel-cage Induction Motor, IPMSM, synRM etc.
- Set up parameters of the motor which is selected.
- Select the type of power source, e.g. Three-phase grid power source, Ideal DC source, Battery power source etc.
- Select the signal type of feedback signals, e.g. ABZ incremental encoder signal, UVW Hall-effect sensor signals, Resolver signals, Serial interface encoder, Analog encoder with 1 Vpp Sin/Cos etc.
- Set up the scaling of the feedback signals to controller, e.g. Three-phase currents feedback, DC bus voltage feedback etc.

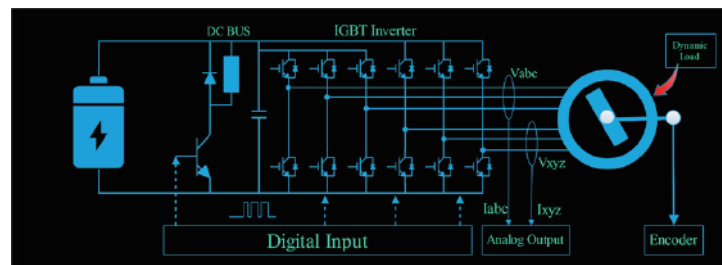
Real-time Simulation System Upgrading

MR2 PRO provide multiple interface and application



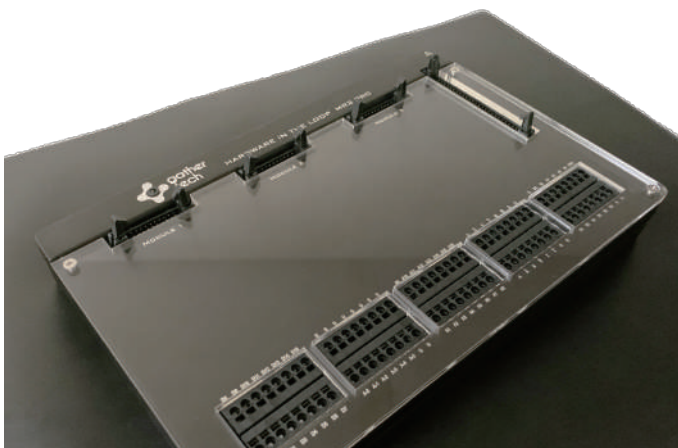
◆ 3 Level Architecture

3 level NPC and T Type topology are new architecture in MR2 PRO. To complete a precise and rapid verification, it is designed to retain MR2 features, capturing PWM signal and the motor model simulation time step can be in 100 nSec.



◆ 6 Phase Motor

As identifying market needs and trends, we build in 6 phase motor model to MR2 PRO. This new function assist users in automotive field quickly test and develop.



◆ Expansion Interface

In addition to the original 8 analog output channels(1MS/s), MR2 PRO has 16 channels of customized analog output (100k S/s) and three expansion module slots. It is not only capable of extending application more convenient, also give user a corresponding processing of multiple signals output in peripheral circuit.

Practical functions & Extension Modules

To meet the requirements of different applications or control system configuration, MR2 provides a series of extension modules for signal emulation.



Encoder:

- ABZ incremental encoder emulation module
- UVW Hall-effect sensor emulation module
- Resolver emulation module
- PWM output encoder emulation module
- 1 Vpp Sin/ Cos signals encoder emulation module
- Serial interface encoder emulation module:
Tamagawa(17bit, 23bit) · PEPPERL+ FUCHS(SSI)
- BISS Interface Encoder

Load torque:

- Load torque module

Power source:

- Power quality emulation module
- Battery power source module

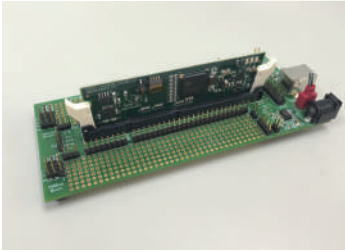
Communication:

- Communication module / RS485, 115200 bps
(W/R all parameters)
- Communication module / CAN Bus

RT connector:

- NI RT Connector with USB
- RT connector with CAN bus
- External modeling module / COM port

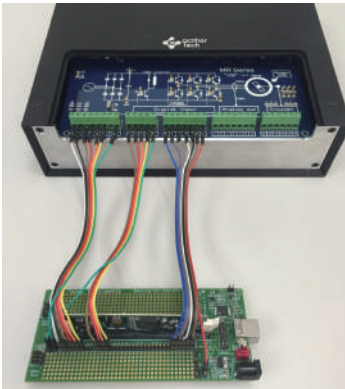
Operation Manual



Step1:

Prepare the motor drive controller. It can be a real control PCB or just a evaluation starter kit provided by MCU providers.

1



Step2:

Connect the input/output ports of the controller to MR2. In general, the input signals to MR2 includes gate-driving signals (PWM), braking resistor enabling signal; the output signals from MR2 includes motor currents, encoder signals, DC bus voltage signal etc.

2



Step3:

Power on the controller and MR2, and open the operational software of MR2.

3



Step4:

Setup the environment.

4



Step5:

Test your controller in a very safe, repeatable, and efficient real-time emulation environment with MR2.

5

Application: Motor Drive Development

*Delta Electronics use MR2 HIL to develop and test
CH2000 motor drive*



- ◆ The connection of MR2 Hardware-in-the-loop and the CH2000 motor drive provided by Delta Electronic Inc.



- ◆ The most common test: Torque-Speed test

Conducting your motor drive controller development with MR2 is extremely easy. Users can adjust all emulation environment by parameter settings. No system modelling is required. The most commonly used functions for motor drive test have been built-in, e.g. Rotor locked, Phase loss, Encoder signal loss etc.

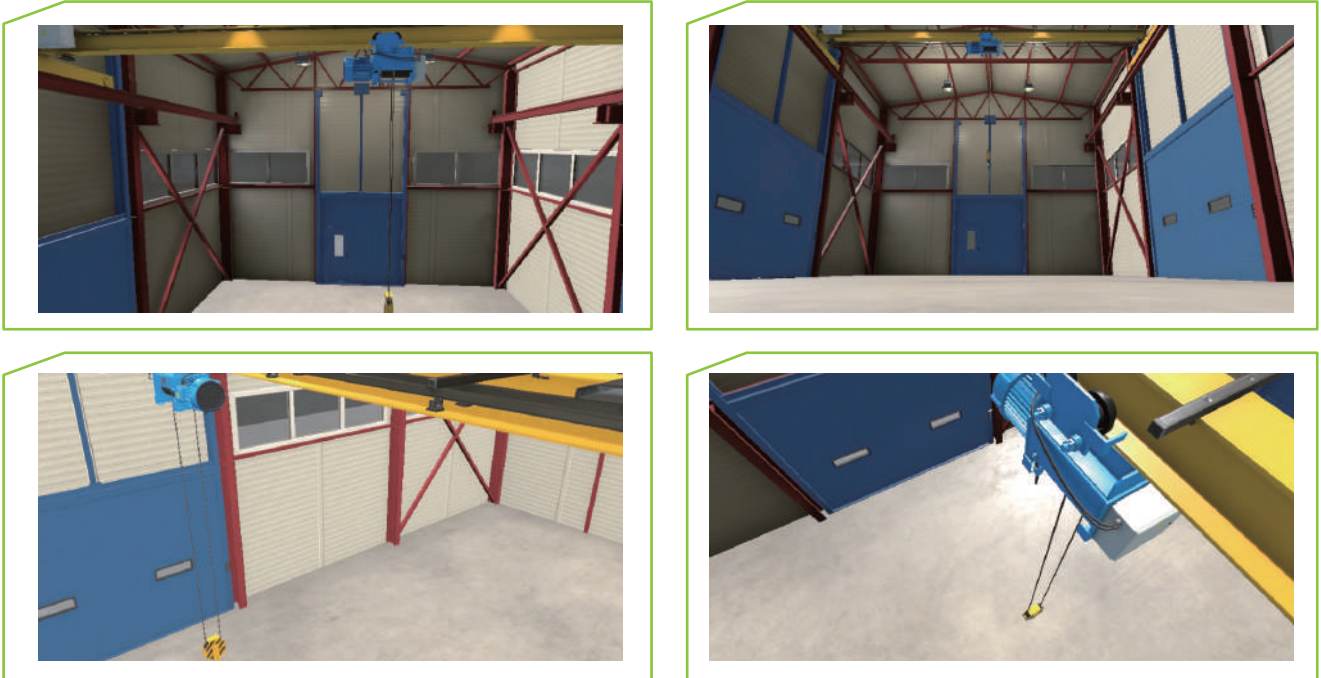


- ◆ Controller operation and motor status monitoring

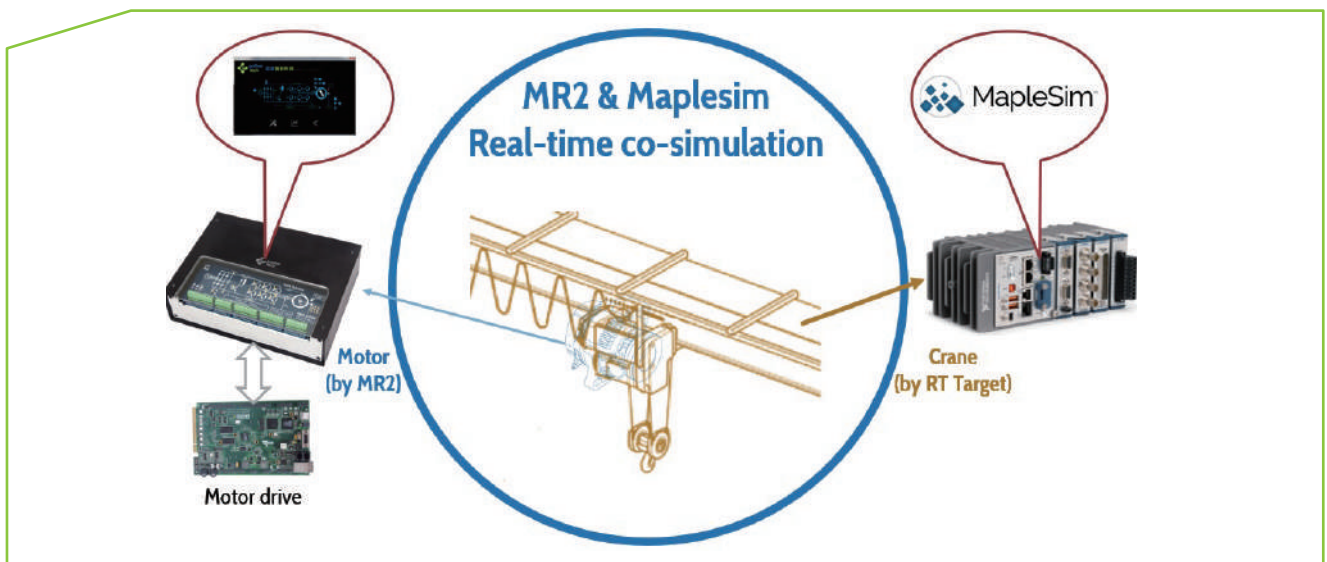
Application: Cran Controller Development

Co-simulation MR2 & MapleSim

◆ Software screen of the real-time co-simulation system



◆ Schematic diagram of the real-time co-simulation system

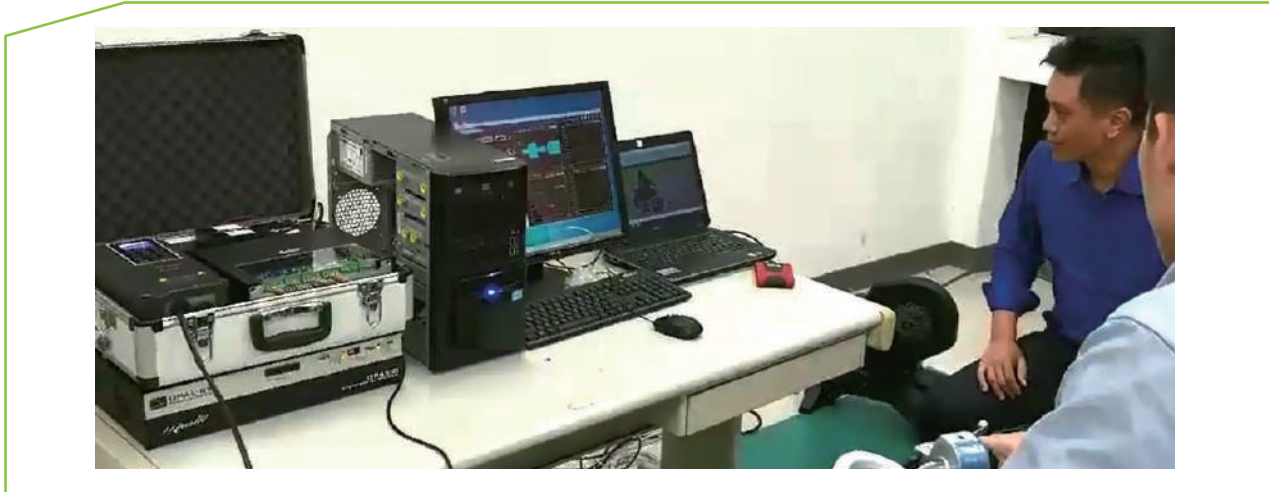


The application of MR2 can be extended to any motor-driven equipment or system. Such that a whole system real-time emulation is ready for controller test, including motor drive controller and host controller. The relatively fast dynamic of the motor is emulated by MR2 and the relatively slow dynamic of the physical system can be modeled by other useful tool, like: MapleSim provided by MapleSoft. The physical system model can be executed in many real-time targets, like: NI-cRIO, NI-PXI, Opal-RT etc. These two emulation system are connected by digital communication to complete the whole system real-time emulation.

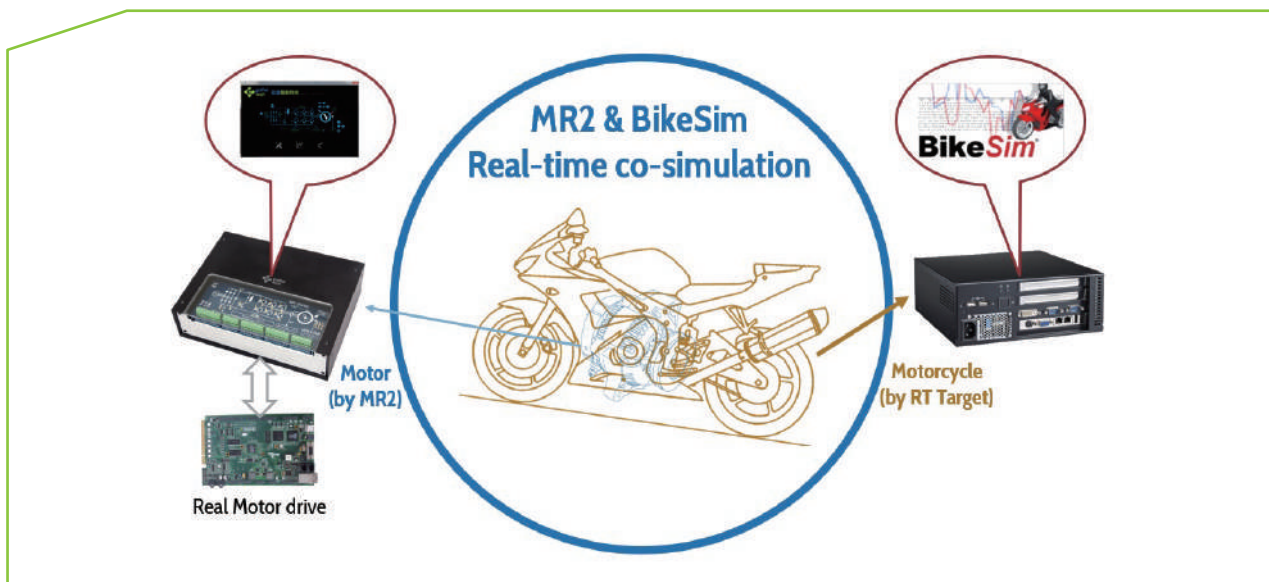
Application: (Motor Control Unit: MCU)Development

Co-simulation of MR2 & BikeSim

- ◆ Test site photo of the virtual test bench for MCU of electric scooter



- ◆ Schematic diagram of the real-time co-simulation system



For different application, the physical system can be replaced easily to different motor-driven system. In this case, the physical model of electric scooter is modeled by BikeSim, and executed in a real-time target. This real-time emulated scooter is connected with MR2. A virtual test bench of an electric scooter is ready for controller test. Please search for "Real time emulation of an electric motorcycle" on Youtube for the video of this application. (<http://youtu.be/veGC6i1hn-M>)




WHO have been using MR2?

* All product names, trademarks are the property of their respective owners. Use of these property does not imply endorsement.



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