



# ELECTRIFICATION TECHNOLOGIES

How MWF is contributing to the electrification of transportation

## TRACTION & MOTION

Electric traction, steering and braking systems for EVs

## CONTROLLERS

Electronic Control Unit and Battery Management System for EVs





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**Electric traction** for tractors

**Auxiliary traction** for implements

**Electric brake and steering** for tractors and implements

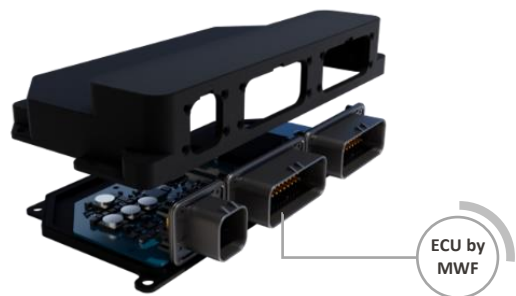
# AG ELECTRIFICATION

**Electric farms:** the electrification of agriculture is a very particular niche in this new industry.

The electrification of tractors and agricultural implements can be approached in many ways. Unlike road vehicles, which strongly depend on batteries and must travel long distances without charging, AG vehicles are suitable for other architectures, making this market very flexible and promising. One of these possibilities is to use ethanol for running an electric generator to charge the batteries; this solution can be embedded into the vehicle. Ethanol has a much smaller carbon footprint compared to fossil fuels, since a lot of carbon is absorbed by the original plantation. Moreover, many ethanol industries can directly provide this fuel for its vehicles.

In addition to the environmental benefits, electric agricultural vehicles can reduce the operational cost and provide more precise and safe systems. Electrically actuated mechanisms,

compared to hydraulic ones, are lighter and can be controlled directly by an Electronic Control Unit (ECU), which brings various benefits, such as: complete vehicle integration, advanced connectivity with actuators and sensors, health monitoring, possibility of precise motion control for implements, brakes, steering and velocity, etc.



Because of these control-related characteristics, electrically actuated systems can operate exactly at the desired setpoint, in contrast to systems powered by combustion engines, which are constantly subject to power oscillations.





Heavy-duty commercial vehicles

High-power Cruiser MPV

## No emissions, no fossil fuel

Many companies are trying to reduce their CO2 emissions by adopting electrified transportation solutions. In the top 5 heavy-duty truck markets, more than 1.6M trucks are sold every year. The largest truck manufacturers agreed to start transition to electrified powertrains back in 2020.

**Safety however is a key factor** that imposes severe constraints on adopting new technologies in vehicular systems. Electric powertrains are brand new technologies; they bring challenges of a more technological platform along with higher demands for safety in every vehicle subsystem.

There are many possibilities for the main source of energy in electric trucks. The most common are FCEV (fuel cell electric vehicle); PHEV (plug-in hybrid electric vehicle); BEV (battery electric vehicle); HEV (hybrid electric vehicle); and MHEV (mild hybrid electric vehicle).

An interesting fact is that the **electric motors, inverters and specific-purpose ECUs are always part of any of these systems**. Depending on the technological choice, the powertrain electronics is expanded to embody battery management systems and advanced health monitoring systems, both for fuel cells and batteries. MWF provides every enabling technology needed to enhance an electrical powertrain and put it on the road.



## They have arrived, but there is a catch

Although the electric motorcycle market has grown tremendously in the last few years, the production is way behind demand in Brazil. The main player in the Brazilian market imports their product from China and rebrands it locally. The lead-time for the final customer can go as long as one year. In addition, spare parts are difficult to find due to the lack of regular supply.

This production issue can be solved by actually manufacturing the motorcycles in Brazil, taking advantage of the existing supply chain for combustion. The main components that differ an electric from a combustion motorcycle are the electric motor, the inverter, the battery and the ECU (i.e. the powertrain); the other components are basically the same. MWF develops and produces the required components for a motorcycle powertrain, while the other parts are already available locally.



## THE E-MOTORCYCLE POWERTRAIN BY MWF

MWF ECU (Electronic Control Unit for motorcycles)



MWF hollow-shaft PMSM for in-wheel applications



MWF inverter for PMSM speed control



# FUNCTIONAL SAFETY

## CERTIFICATION KITS

- FuSa collaterals
- Item definition
- Simulation models
- Code standard/tests
- Reliability metrics
- Many more...




## ISO 26262








extremely low failure rates

New designs use our many hours of validated processing modules and controllers' design. The guideline for new projects borrows a redundant architecture with hardware and software measures implemented to achieve the rate of as low as **one dangerous failure in 1140 years!**

**PMSMC**  
Permanent Magnet Synchronous Motor Control - Version 1.0



▼ Package Contents

-  **UsersGuide**  
User's Guide and Release Notes
-  **Examples**  
Inverter, PMSM dynamics, Driver/Controller, Driveline (vehicular systems application).
-  **PMSM**  
Dynamics of PMS Motors using power flow approach for the interaction between electromagnetics and mechanics.
-  **Sensors**  
Voltage, current, velocity, position, and field intensity modeled at a lower level than usual for control systems.
-  **Design**  
Utilities do the design of DSP and digital controls.
-  **Hardware**  
MCU, inverter, and controller considering quantization, computation delay, and discrete-time characteristics.
-  **UnderDevelopment**  
Placeholder for unfinished modeling still under alpha version.

▼ Information

Models for control systems design and vehicular systems design using PMSM motors and inverters designed and produced by MWF Mechatronics.

**Version 1.0**

Three-phase PMSM models, High Voltage DC source, inverter, space-vector PWM, Clarke and Park transformations, and examples dynamic analysis and control.

## Applicability

- AUTOMOTIVE** ISO-26262
- INDUSTRY IN GENERAL** IEC-61508
- AIRBORNE ELECTRONICS** DO-254
- AIRBORNE SOFTWARE** DO-178C
- AGRICULTURE** ISO-25119
- MEDICAL** IEC-62304



## IEC 61508 non-tolerable risks

In the safety life cycle, the design of the mechanical part of the actuator and electromagnetics are employed in an integrated way. This mitigates intricate requirements imposed to electrical, electronic, and programable safety functions. It enables a **safe-by-design system**.

VCU



## CONTROL SYSTEMS DESIGN SUITE

We offer modeling and simulation tools completely integrated to rugged hardware. The complete model-based development cycle can be covered by the QFIRE Studio (modeling and simulation); QFIRE Controllers (real-time rugged controllers); Asturian (HiL simulation platform); and a ready-to-go production process for high reliability electronic controllers.

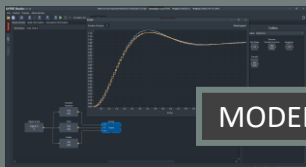


**Brake controller** deployed for heavy-duty vehicular application

## QFIRE ECOSYSTEM



REAL-TIME ANALYSIS



MODELING & SIMULATION



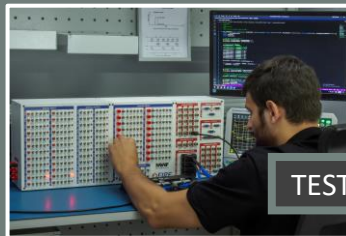
HIL SIMULATION



HARDWARE

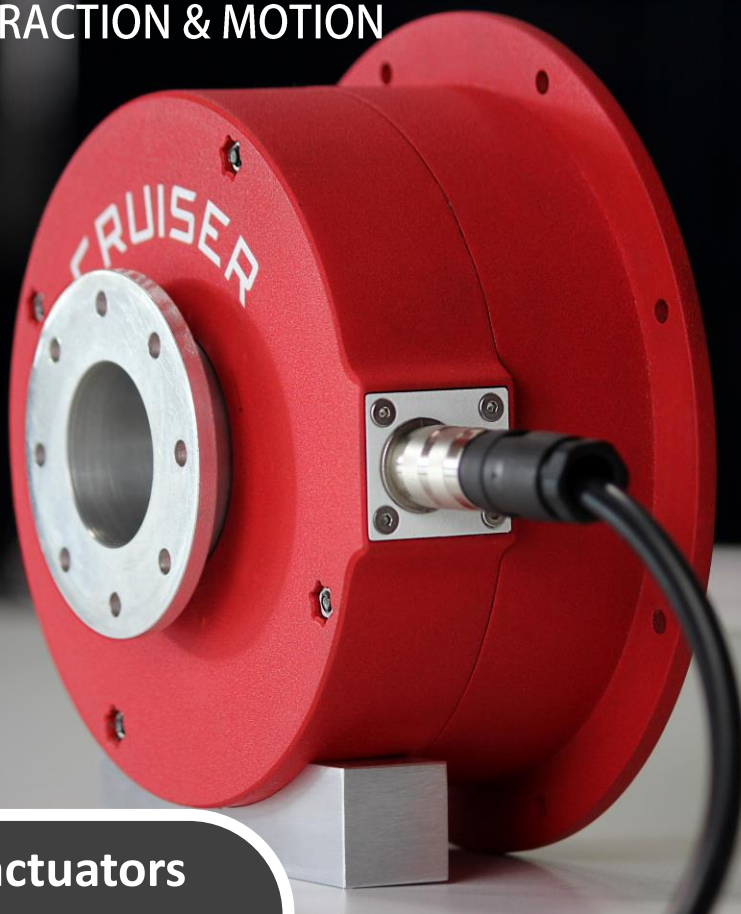


PRODUCTION



TESTING





## Electric actuators for all purposes

The Cruiser line of actuators developed by MWF comprehends all vehicular applications, from traction to precise motion control. This is only possible because we also develop our own inverters and its respective control systems. The most common applications in electric vehicles are: main or auxiliary traction, steering and braking; all critical.



**Cruiser MPV**  
for traction



## In-house development and production

Our motors are completely developed in-house, including the electromagnetic, thermal, mechanical, and manufacturing projects. After they are finished, the production line is prepared in our facilities according to demand. Not only the assembly processes, which require many dedicated equipment, are performed, but the actual manufacturing of most of the parts, e.g. stator and rotor cores, shaft and frame.



**Gama MLI**  
inverter



# CAPABILITIES

## Mass production of standard and custom items

The products developed by MWF can be either standard or custom, according to client's specification; either way, these products are often mass produced at MWF. Firstly, the production processes must be created and implemented, which is also frequently done internally; then, the production is started and operated. This is possible by virtue of MWF's specific infrastructure, equipment and operation expertise. Finally, the products are tested and evaluated in order to assure the desired performance and safety



Rugged ECU enclosures for vehicular application

## 47k m<sup>2</sup> area

MWF counts on a large area for its facilities and future expansions, in addition to the offices downtown. The company headquarters are located in **Campos**, state of Rio de Janeiro, in the middle southeast **Brazil**.



“WE BUILT A CULTURE THAT PUTS THE PERSONAL ASPIRATIONS OF OUR TEAM MEMBERS IN SYNERGY WITH THE COMPANY’S OBJECTIVES”

Alexandre Leite | Head of R&D at MWF



## Talented people engaged in meaningful activities

Developing cutting edge technology demands a prepared team and hard work. At MWF there is a strong culture of excellence and learning; our people are constantly perusing solid engineering grounds, which lives may depend on. In transportation particularly, most of the our products, such as braking systems, are life-critical; they cannot fail, and we take that seriously.





# MWF

## ELECTRIFICATION TECHNOLOGIES

MWF Engineering Magazine on  
Electrification Technologies, ed. 23.01