

TerraTech

Integrated Intelligence in Motion

Technical Brochure

TerraTech Electrification Ecosystem leverages earth friendly technology to increase productivity and provide better and safer jobs.

Full Electric Motion System Architecture

Scalable. Modular. Configurable.

Software



Controls configurability of the machine.

Adaptive Electrification Management System



Central Controller simplifying power management, enabling automated features, and configures component modules.

*Includes Controller, Inverters, High Voltage Distribution, etc.

Traction Motor



Motor and gear assembly designed for **tracked vehicles**.

Electric Cylinder



Linear all electric actuation to replace hydraulic cylinders.

Drive Train Motor*



Electric motor for **wheeled vehicles**.

*Motor not shown in image. Available as needed based on machine architecture.

Battery



Battery and charging system for electric vehicles (Third party manufacturer).



Designed, Tested and Manufactured for the Construction Industry



What TerraTech Delivers



Scalable

One solution that fits across all your machine sizes and types. From compact, to 10 ton to 100 ton.



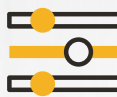
Serviceability

Optimized service through diagnostic software and swappable hardware



Modular

Designed for all machines. Constructed with standardized mechatronics approach for flexibility and variety in use across all your machines. Build standardization into your product line.



Configurable

Common Software and hardware that allows you to modify and update the machine to your needs. Quickly add functionality and enabled for future automation. Differentiate on your terms.

The Value TerraTech Brings to Manufacturers



Standardization

Make life predictable and avoid unpleasant surprises.

- Reduced planning time
- Consistent quality
- Lower lead times
- Reduced cost and overhead



Low Cost

Using common/standardized hardware and software platforms, keeps component and manufacturing costs low leading to lower total cost of ownership for end users and OEMs.



Usability/Reusability

Easy to use, integration between programming software, controllers, drives and actuation. Moog tools, libraries, API, Interconnected and reusable hardware and software. Accessibility to data, intelligence, machine analytics, reliability and performance data,



Systems Integration

TerraTech makes the complex simple. Spend less time in development and more time on added value tasks. Moog did all the hard system integration work for you; We make it simple to use.

Scalability Across Machine Types & Sizes

Scalable. Modular. Configurable.

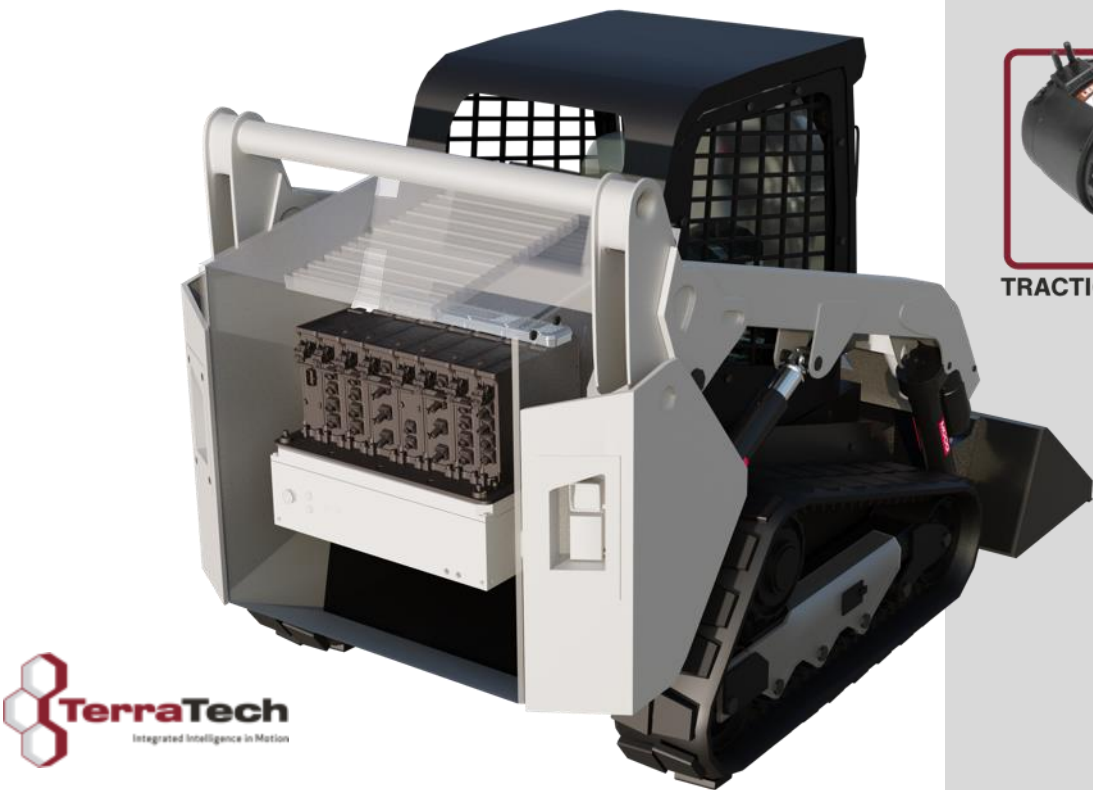


Gen 4 Simplification and Component Reduction

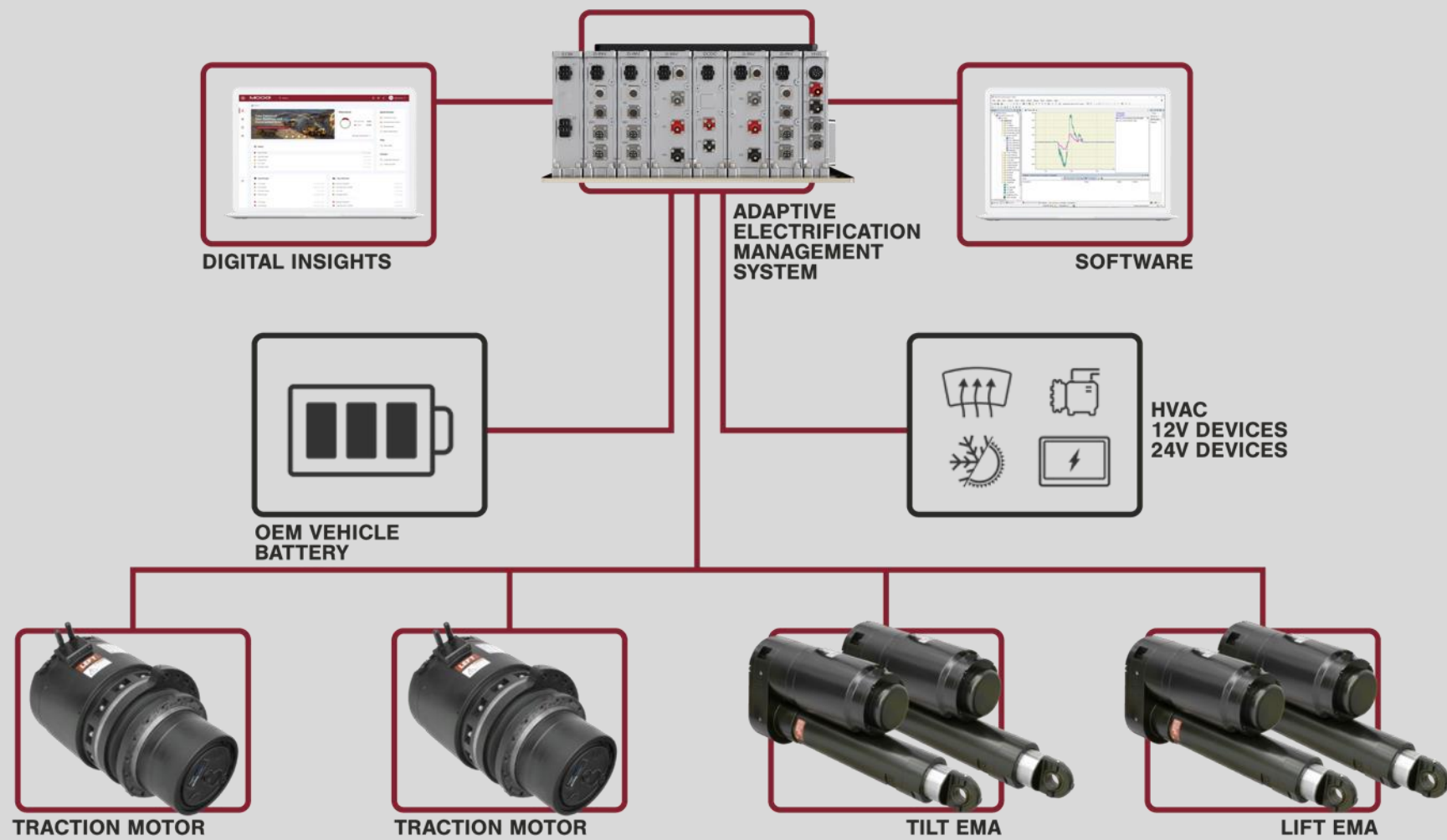
Integrated Intelligence in Motion

The TerraTech Ecosystem is a revolutionary solution that enables the accelerated adoption of zero-emission vehicles.

This a cutting-edge solution that combines advanced technology, cost-effectiveness, customization, and adaptability to meet the evolving needs of the construction industry.



All Electric Track Loader System Architecture



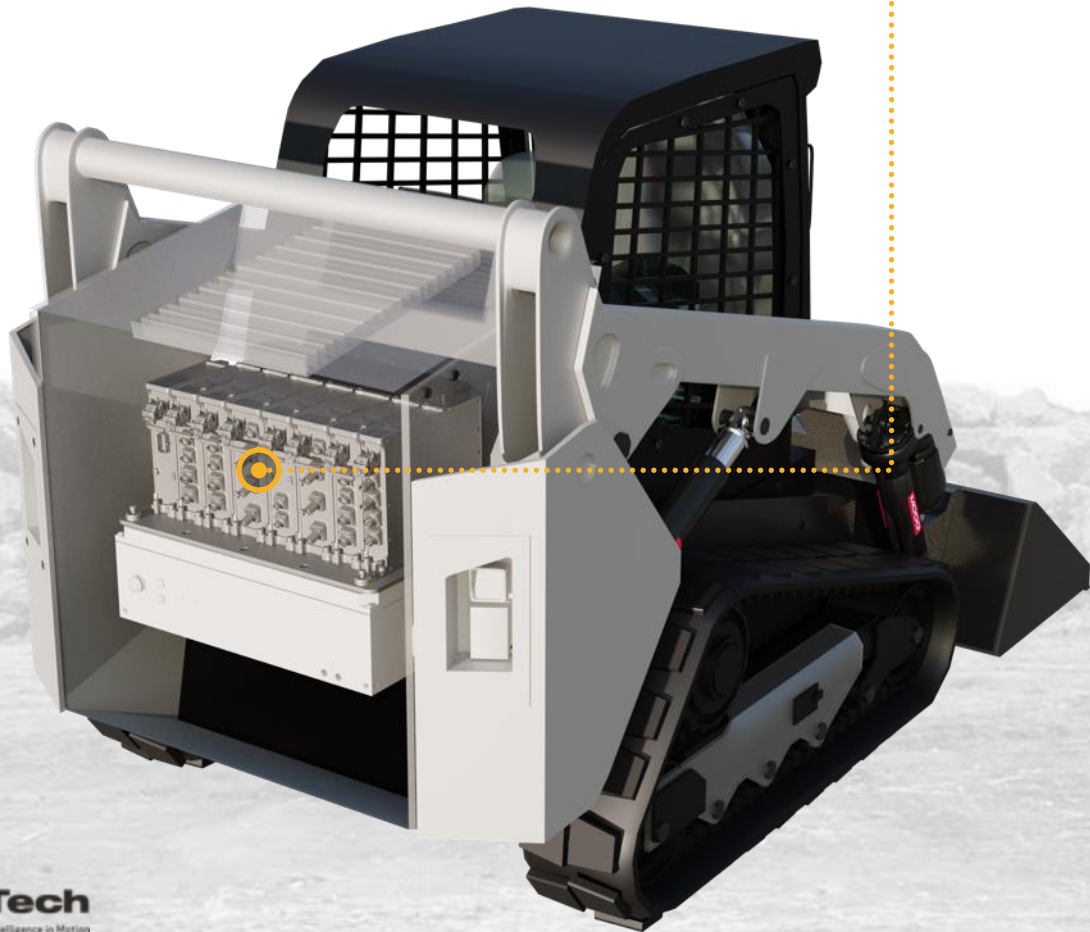
Moog Construction provided

Customer provided

Adaptive Electrification Management System



The Adaptive Electrification Management System by Moog Construction simplifies the power management and control of functions on electric vehicles. It integrates key components, reduces complexity and cost, and can be easily updated. It manages power, enables automated features, and configures component modules for specific applications.



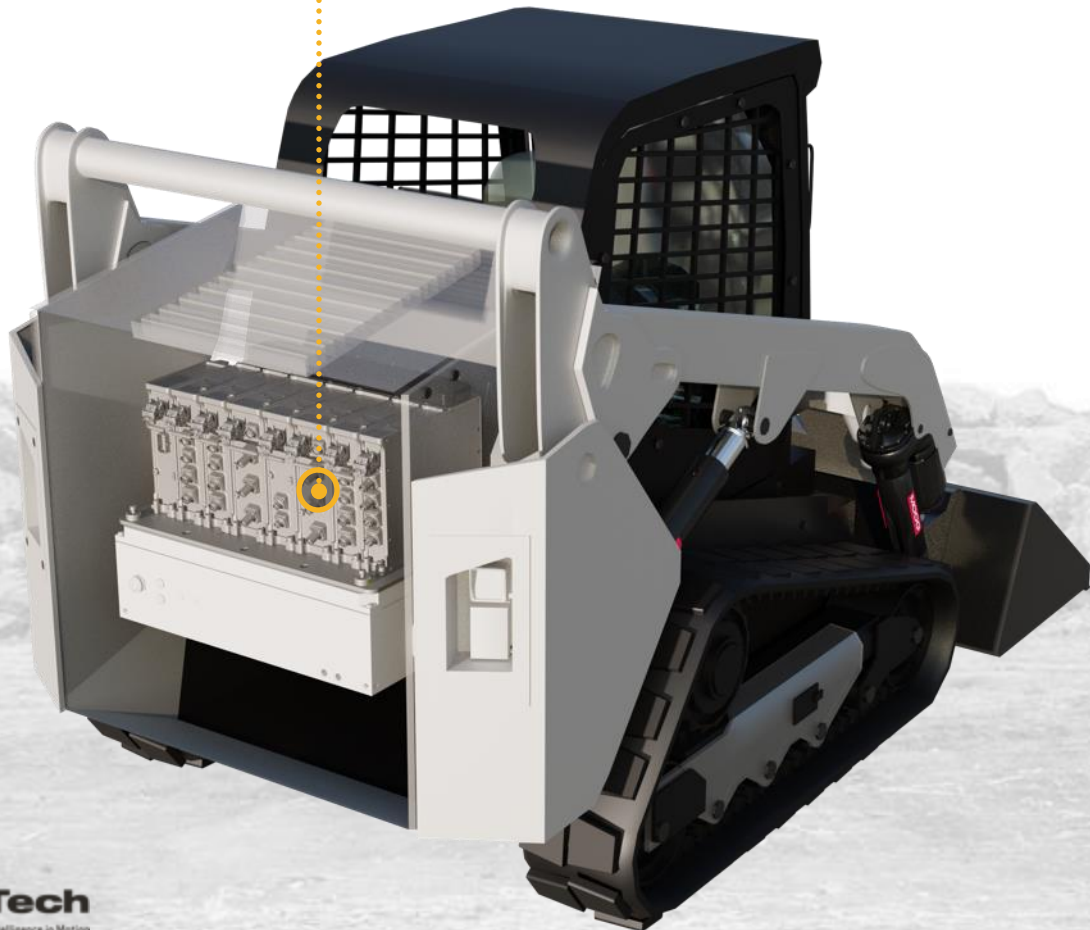
Features

Patented common high voltage busbar & coolant modules	<ul style="list-style-type: none">• Reduces cable connections• Increases reliability• Increases efficiency• Reduces component count
Bookcase Architecture	<ul style="list-style-type: none">• Minimizes integration time, including pluggable connections• Minimizes costly downtime• Minimizes cost of repair
Designed to meet the highest global standards and regulations	<ul style="list-style-type: none">• EMC: ISO 13766, Electrical Safety: ISO 14990, Environmental: ISO 16750• Tested and verified as a complete system solution, CE, CSA
Optimized voltage ranges	<ul style="list-style-type: none">• ISO 21498: Udc nom Unlimited• 400: 270Vdc-480Vdc & 800: 400Vdc-800Vdc• Optimizes system costs• Optimizes system/solution size (compact)
Integrated functionality safety (as optional variant)	Integrated functional safety to Performance Level D in accordance with ISO 13849

Single Axis Inverter Module



An electronic component used to invert a high voltage dc supply to a variable amplitude and frequency, AC output. The AC output is used to control the torque and speed of a single 3-phase motor.



Features

Common DC Bus interface	Distributes high voltage power among modules, while Reducing electrical cables and connectors
Common liquid coolant connection	Increases component life while reducing number of Liquid cooling lines
Combined motor brake and motor feedback interface	Reduces the number of electrical cables, connectors, and electric modules
Pluggable connections	Optimized integration and ease of use
Advanced Diagnostic Tools\Fault Detection	Optimized service capabilities
Integrated functional safety	Increased vehicle/human safety

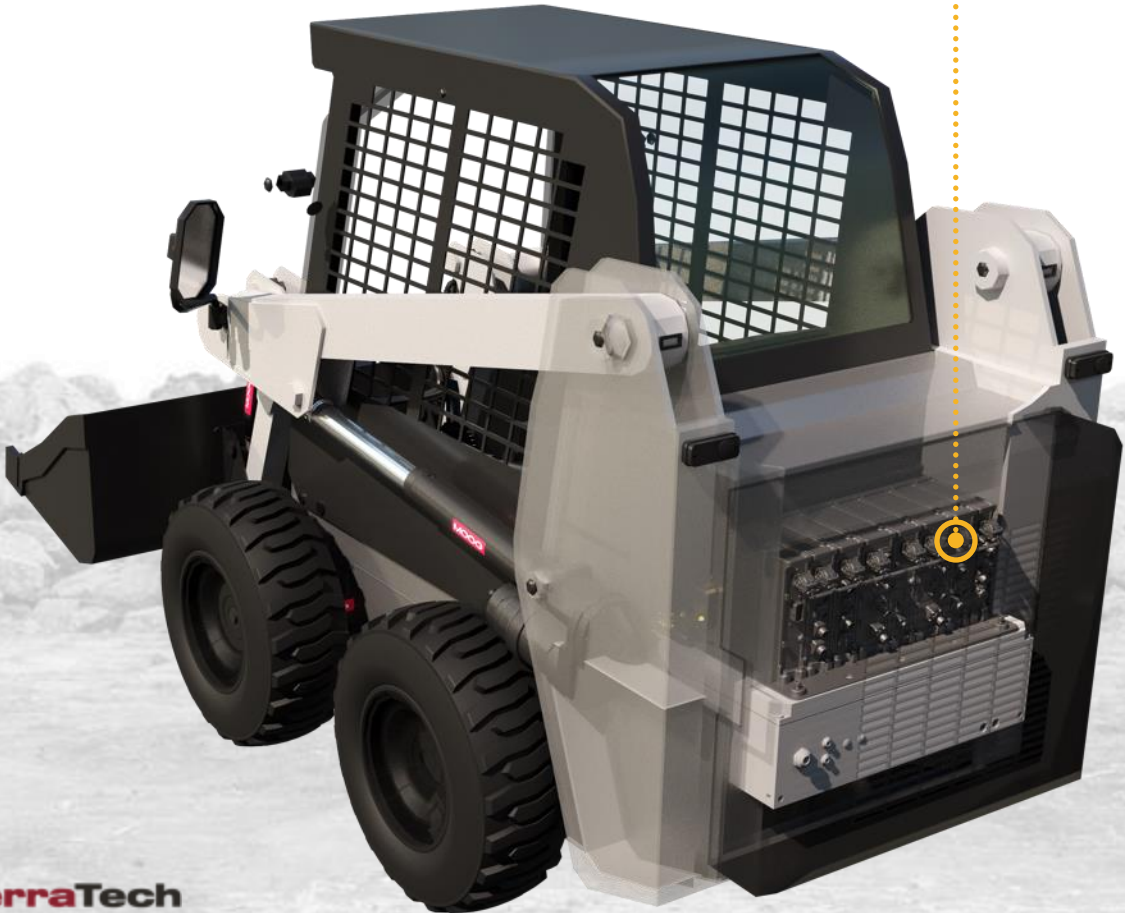
Technical Data

Input Voltage Range	400: 270Vdc-480Vdc 800: 400Vdc – 800Vdc
Output Current	128Arms\256Apk
Ambient Temperature Range	-40°C to +85°C
Ingress Protection	IP67, IP6K9K
Weight	<10kg
Vibration & Shock	5.91g & 50g
Dimensions	L:358mm W:77mm H:293mm
Compliance	ISO 13766, ISO 14990, ISO 16750, ISO 13489, CE

Dual Axis Inverter Module



An electronic component used to invert a high voltage dc supply to a variable amplitude and frequency, AC output. The AC output is used to control the torque and speed of two independent 3-phase motors.



Features

Dual Axes	Provides power to two lower control axes for a compact solution
Common DC Bus interface	Distributes high voltage power among modules, while reducing electrical cables and connectors
Common liquid coolant connection	Reduces number of Liquid cooling lines, while increasing component life
Combined motor brake and motor feedback interface	Reduces the number of electrical cables, connectors, and electric modules
Brake Bypass functionality	Supports the use of a dynamic brake to remove energy from the system
Advanced Diagnostic Tools\Fault Detection	Optimized service capabilities
Integrated functional safety	Increased vehicle/human safety
Pluggable connections	Optimized integration and ease of use

Technical Data

Input Voltage Range	400: 270Vdc-480Vdc 800: 400Vdc – 800Vdc
Output Current	2x 32Arms\96Apk
Ambient Temperature Range	-40°C to +85°C
Ingress Protection	IP67, IP6K9K
Weight	<10kg
Vibration & Shock	5.91g & 50g
Dimensions	L:358mm W:77mm H:293mm
Compliance	ISO 13766, ISO 14990, ISO 16750, ISO 13489, CE

DCDC Converter Module



An electronic component used to convert a high voltage dc supply to a lower 14V or 28V DC output. The DC output is used to power a vehicle’s low voltage system.



Features

Common DC Bus interface	Reduces the number of electrical cables and connectors
Common liquid coolant connection	Reduces number of Liquid cooling lines, while increasing component life
Fieldbus control & monitoring	Supports status monitoring and output voltage control via fieldbus
Output reverse polarity protection	Allows the system to withstand a reversed battery connection
Pluggable connections	Optimized integration and ease of use
ASIL compliant	Increased human/vehicle safety

Technical Data

Input Voltage Range	400: 270 VDC-480 VDC 800: 400 VDC – 800VDC
Output	14 VDC/130 A 28 VDC/ ??
Ambient Temperature Range	-40°C to +85°C
Ingress Protection	IP67, IP6K9K
Weight	<7kg
Vibration & Shock	5.91g & 50g
Dimensions	L:358mm W:77mm H:293mm
Compliance	ISO 13766, ISO 14990, ISO 16750, CE

Electric Control Module



An electronic component used to control and manage the solution modules.



Features

MOOG Hosted CODESYS Programmable Software*	Allows component configuration and machine differentiation
Fieldbus: CANOpen, J1939	Common vehicle communication protocols
Interfaces: Ethernet, USB, WIFI & Bluetooth, LTE	Diverse vehicle connectivity and communication
General Purpose IO & High Current Outputs	versatility and ability to handle a wide range of input and output operations
Dedicated IO	On board charging and dynamic brake control

*CODESYS® is a registered trademark of 3S0Smart Software Solutions GmbH.

Technical Data

Quiescent current	<1mA
Ambient Temperature Range	-40°C to +70°C
Ingress Protection	IP67, IP6K9K
Weight	<5kg
Vibration & Shock	5.91g & 50g
Dimensions	L:262mm W:72mm H:293mm
Compliance	ISO 13766, ISO 14990, ISO 16750, ISO 13489, CE

High Voltage Distribution Module



An electronic component used to safely distribute high voltage to various auxiliary devices on the vehicle. Excess regenerative energy is also managed within the module.



Features

Common DC Bus interface	Connects all the system modules without needing cables and connectors
Cooling	Reduces number of Liquid cooling lines, while increasing component life
High voltage distribution	Distributes high voltage DC power
Integrated branch fuses	On-board branch fuse protection
Integrated dynamic brake circuit	Removes energy from the system and reduces the number of cables and connections
Configurable options	Insulation monitoring, EMI filtering, battery connections - increases fault detection, ensures reliable electrical signals, can connect to 3 rd party high voltage batteries

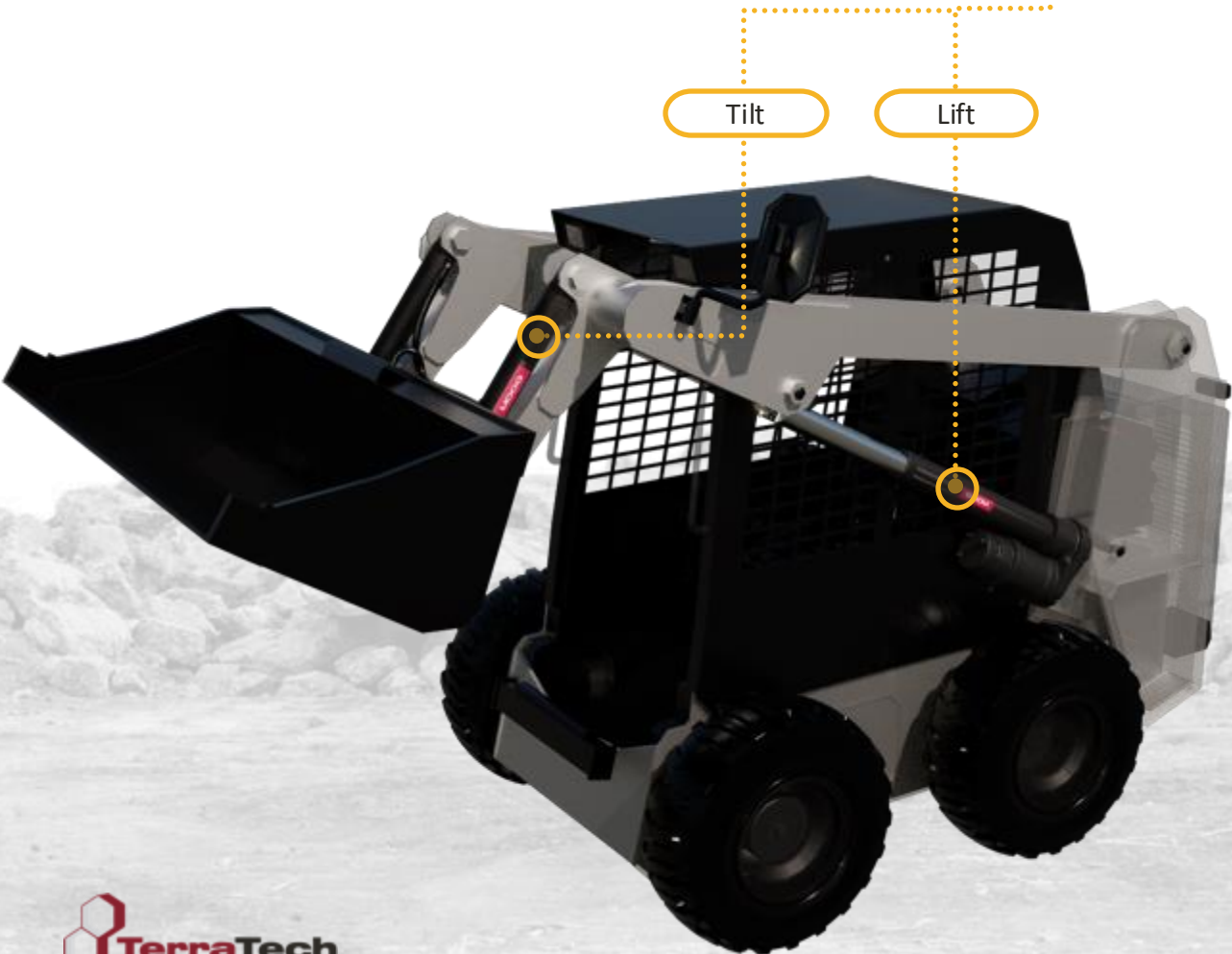
Technical Data

Input Voltage Range	270Vdc– 800Vdc
Ambient Temperature Range	-40°C to +85°C
Ingress Protection	IP67, IP6K9K
Weight	<10kg
Vibration & Shock	5.91g & 50g
Dimensions	L:358mm W:77mm H:293mm
Compliance	ISO 13766, ISO 14990, ISO 16750

Electric Cylinder



Electric cylinders, also known as Electromechanical Actuators (EMAs), convert the rotary motion of the servo motor into linear motion. The servo motor receives 3-phase power from the servo drive to provide high forces and high-speed control that matches or exceeds hydraulic cylinder performance without the mess of hydraulics.



Features	
Flexible Configurations	Ability to modify standard series to meet performance requirements.
Variable Stroke Lengths	Capable of meeting the pin-to-pin requirements of the machine and motion envelope requirements.
Sensors	Resolver or absolute multiturn encoder provides actuator speed and position. Thermistor monitors internal motor temperature.
Load Holding Brake	Integrated load holding brakes provide load holding capabilities of vertical loads for safety and energy saving purposes.
Equal Extend and Retract Force	Peak forces are the same during both extension and retraction, unlike in a single rod hydraulic cylinder.
Efficient Design	High efficiency decreases total energy usage and leads to longer battery life.
Designed for Cost	A simplified design lowering production cost

Sectional View of an Electric Cylinder



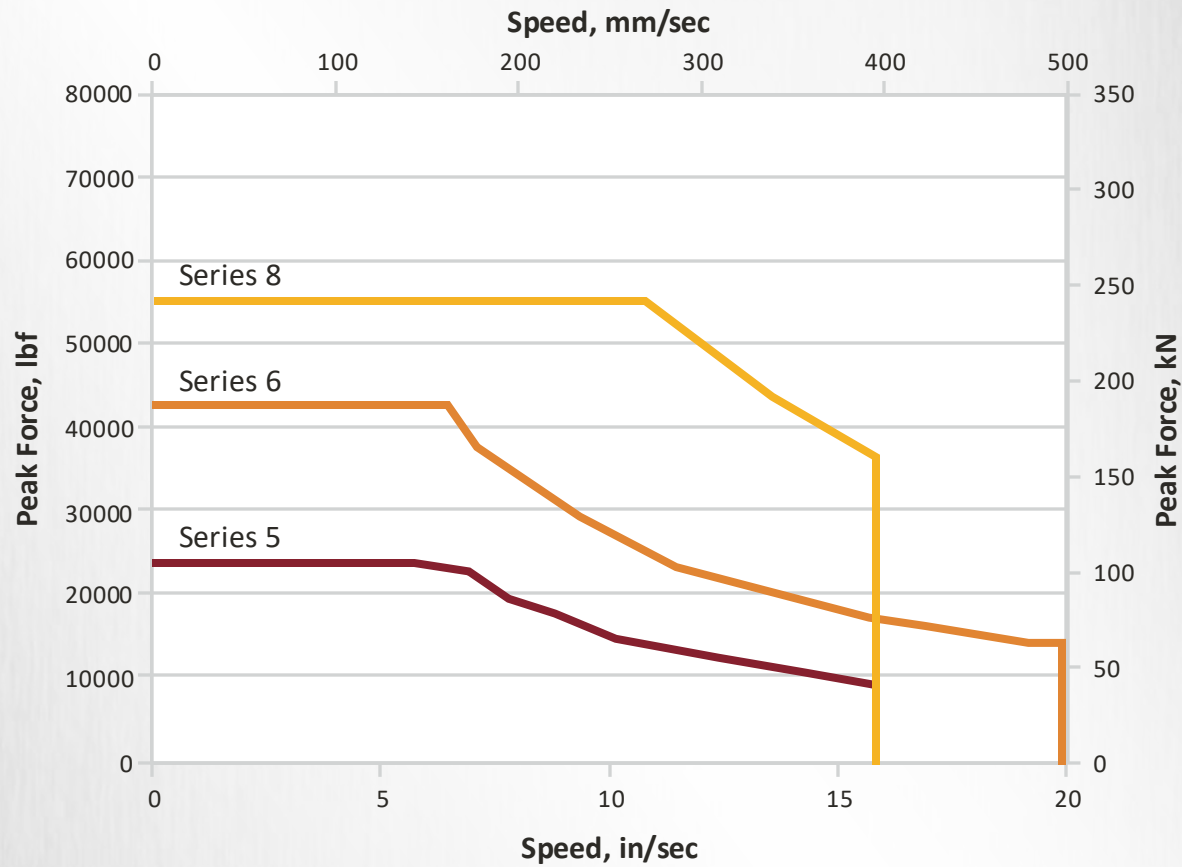
Electric Cylinder



General Performance Capabilities			
Specifications	Series 5	Series 6	Series 8
Peak Force (Extend & Retract)	106 kN (23,830 lbf)	190 kN (55,980 lbf)	249 kN (55,980 lbf)
No Load Speed mm/s (in/s)	400 (16)	500 (20)	400 (16)
A Length mm (in)	515 + Stroke (20.3 + Stroke)	508 + Stroke (20 + Stroke)	732 + Stroke (28.8 + Stroke)
B Length mm (in)	354 mm (13.9)	388 mm (15.3)	544 mm (21.4)
C Length mm (in)	162 mm (6.4)	210 mm (8.3)	270 mm (10.6)
Operating Voltage	400V - 800V		
Shock and Vibration	50g, 6g		
Environmental Ratings	IP66 & IP67 (Protected against hose down and temporary immersion) -40°C to +85°C (Ambient temperature)		



Speed Force Curve



Traction Drive Assembly

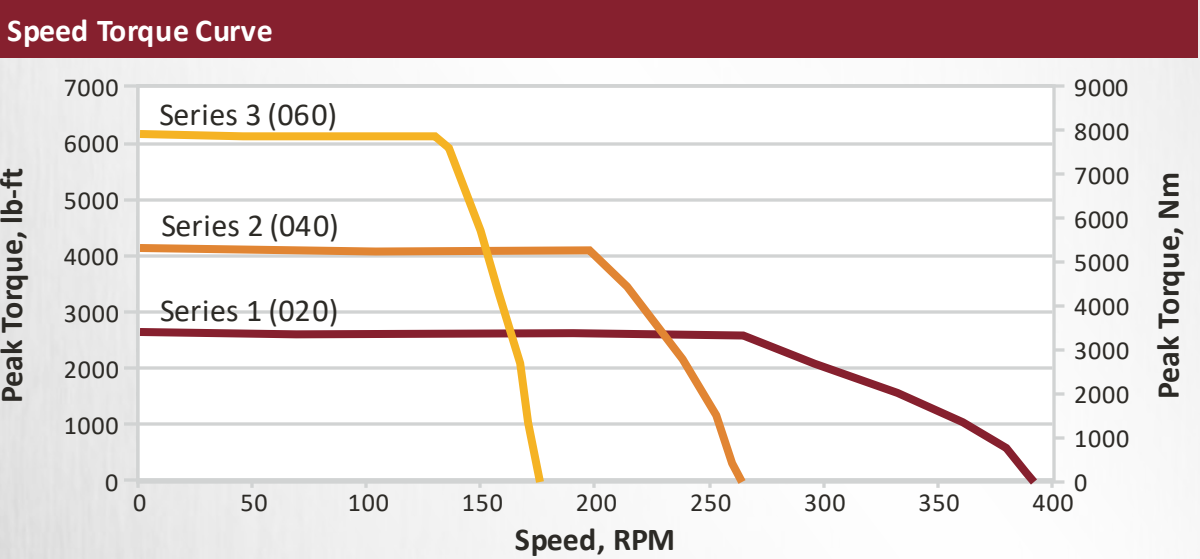


Features	
Flexible Configurations	Ability to modify standard series to meet performance requirements.
Sensors	Resolver or absolute multiturn encoder provides actuator speed and position. Thermistor monitors internal motor temperature.
Load Holding Brake	Integrated load holding brakes provide load holding capabilities.
Thermal Protection	Thermistor monitors internal motor temperature to prevent overheating.
Liquid Cooled	Liquid cooling increases the life and longevity of the traction motor.

- 1 Motor
- 2 Internal Brake
- 3 Gearbox
- 4 3 Phase Power Connectors
- 5 Coolant Ports



General Performance Capabilities			
Specifications	Series 1	Series 2	Series 3
Peak Torque	3,566 Nm (2,630 lb-ft)	5,586 Nm (4,120 lb-ft)	8,379 Nm (6,180 lb-ft)
Max No Load Speed	390 RPM	260 RPM	175 RPM
D - Flange	285 mm (11.2)	285 mm (11.2)	285 mm (11.2)
L1 – Total Length mm (in)	478 mm (18.8)	529 mm (20.8)	579 mm (22.8)
L2 – Brake & Gearbox Length mm (in)	228 mm (9.0)	228 mm (9.0)	228 mm (9.0)
Operating Voltage	400V - 800V		
Shock and Vibration	50g, 6g		
Environmental Ratings	IP66 & IP67 (Protected against hose down and temporary immersion) -40°C to +85°C (Ambient temperature)		

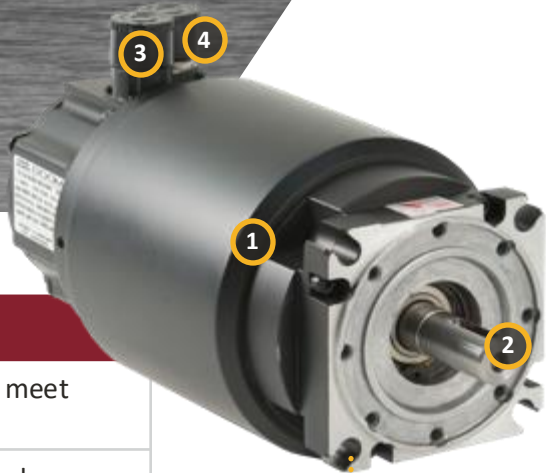


Drive Train Motor



Features

Flexible Configurations	Ability to modify standard series to meet performance requirements.
Sensors	Resolver or absolute multiturn encoder provides actuator speed and position. Thermistor monitors internal motor temperature.
Load Holding Brake	Integrated load holding brakes provide load holding capabilities.
Thermal Protection	Thermistor monitors internal motor temperature to prevent overheating.
Liquid Cooled	Liquid cooling increases the life and longevity of the traction motor.



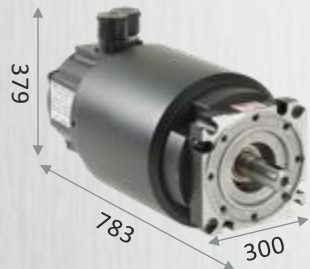
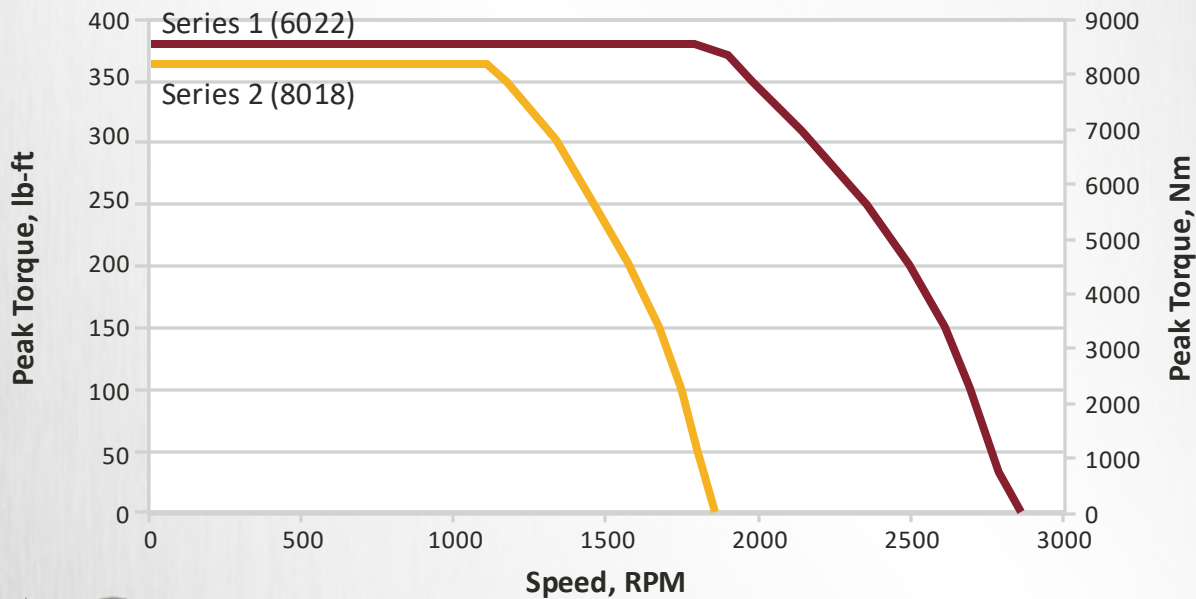
- 1 Stator
- 2 Rotor Shaft
- 3 3 Phase Power Connection
- 4 Coolant Ports



General Performance Capabilities

Specifications	Series 1	Series 2
Peak Torque	515 Nm (380 lb-ft)	735 Nm (542 lb-ft)
Max No Load Speed	2850 RPM	1850 RPM
A Length mm (in)	732 mm (28.8)	783 mm (30.8)
B Length mm (in)	379 mm (14.9)	379 mm (14.9)
C Length mm (in)	300 mm (11.8)	300 mm (11.8)
Operating Voltage	400V - 800V	
Shock and Vibration	50g, 6g	
Environmental Ratings	IP66 & IP67 (Protected against hose down and temporary immersion) -40°C to +85°C (Ambient temperature)	

Speed Torque Curve



EVCN With Common Digital and Software Platform for All Your Machines



Digital Insights

Software

Telematics

Productivity

Vehicle Management

System Development

Software Development

Machine Monitoring



Software Development Environment



Software Support and Co-Creation of Applications

Moog offers extensive application engineering and support and will consult OEM's to support customer projects. Moog has extensive experience and can support the entire system level software development. We help co-create programs that help differentiate and help meet the requirements of the construction and other off-highway vehicles.

CODESYS Integrated Development Environment allows for development of User Interface screen and control logic within the same project.

Completely integrated editor for user interfaces: programming of application software as well as graphical projection of the operation/diagnosis interface in a single tool.

The CODESYS Development System is the market-leading integrated development environment (IDE) in accordance with IEC 61131-3 for programmable embedded devices in industrial automation applications.

CODESYS allows the developer to choose between multiple programming languages, including graphical languages.

CODESYS® is a registered trademark of 3S Smart Software Solutions GmbH.

Software System Development

The following programming languages can be used to program the application software:

- CODESYS 2.3 / 3.5 / 3.5 SIL2

Figure 1 | CODESYS IDE: Device Tree and Display Editor

MOOG has developed fit-for-purpose screens that relate to the direct operation of the machine as well as comprehensive diagnostics overviews to ease troubleshooting.

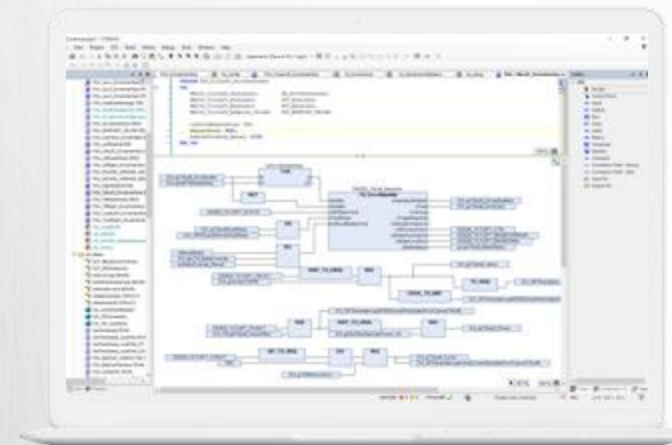
Using graphical programming languages allows easy overview of functionality and capability of code and eases software maintenance and diagnostics.



Figure 2 | Control Interface Developed in Continuous Function Chart

MOOG has developed and fully tested Library / Toolbox functions specifically for Mobile Machinery for fast development of machine control.

1. Interface and control of various models of Batteries and Onboard Chargers
2. Motion Kinematics and Actuator protection schemes
3. Servo Drive interfaces
4. Traction control and power management
5. Thermal management



Software Development Kit

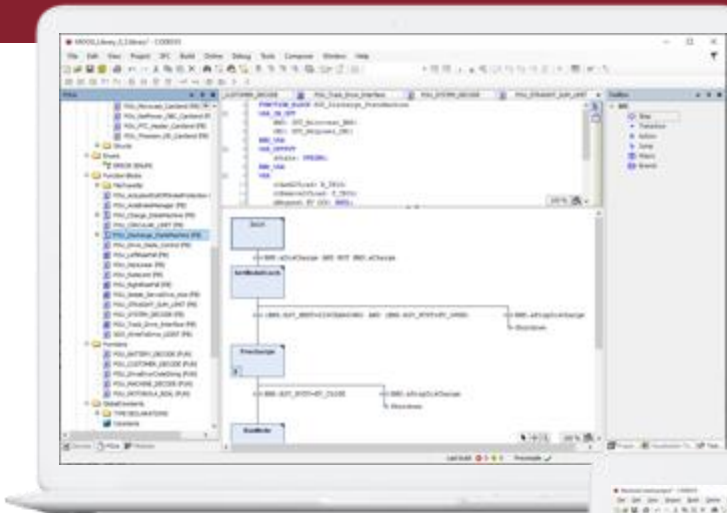


Figure 3 | State Machine in Sequential Function Change

The software developer is free to mix-and-match **between** the available programming languages and choosing the type than best fits the task a hand.

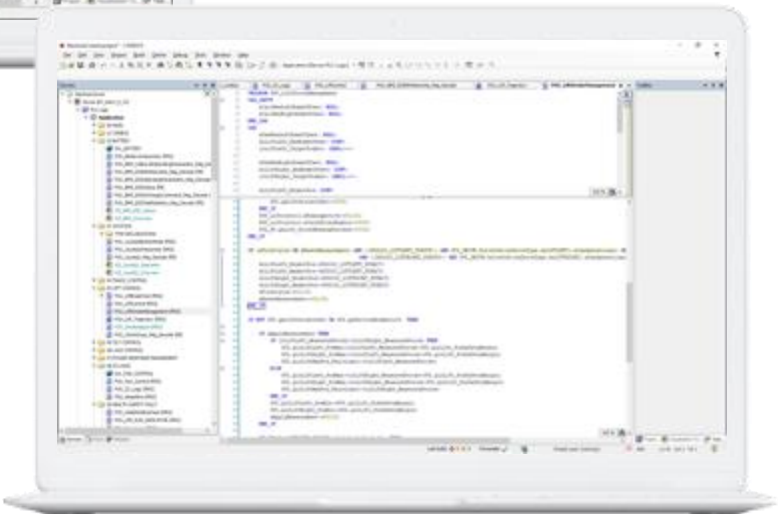


Figure 4 | Textual Programming in Structured Text

For the experienced programmer that is used to writing software in C-language.

Machine Monitoring Software

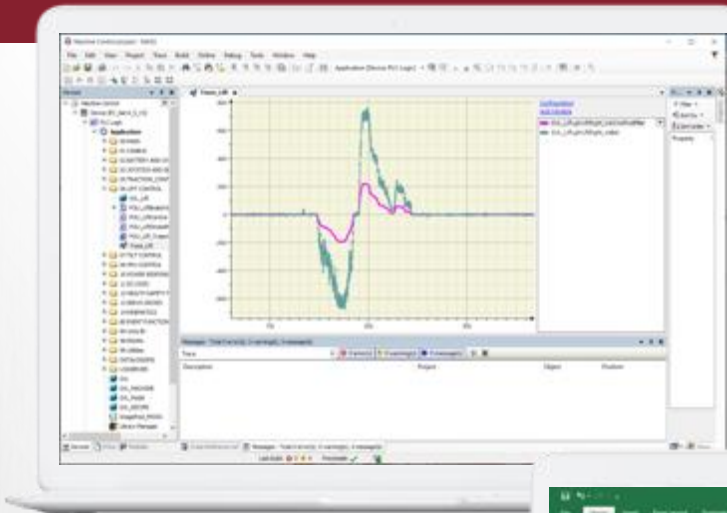


Figure 5 | Tracing of Machine Data

For advanced diagnostics it is possible to capture high resolution data.

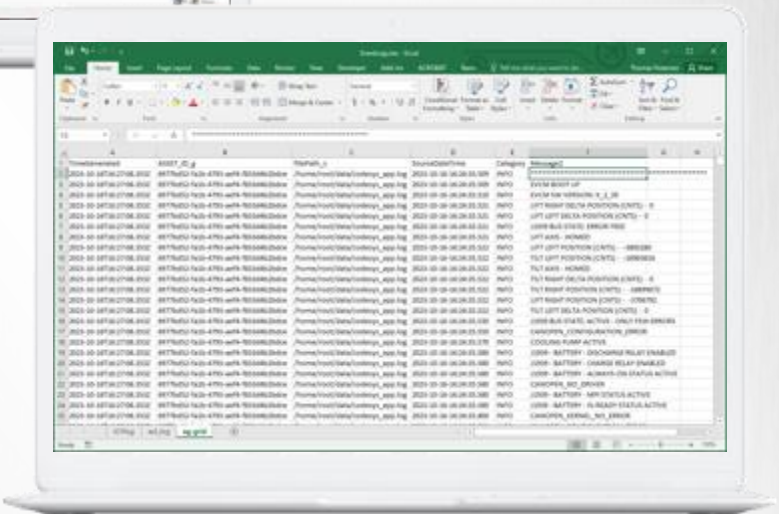
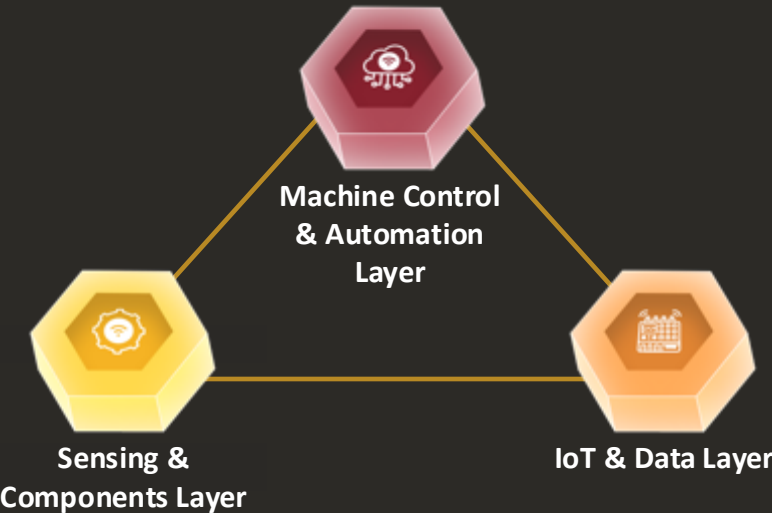


Figure 6 | Machine Event Logging During Power Up and Operation of the Machine

Event and Data logging available on machine or over the air through IoT for easy machine diagnostics.

HMI and display and graphics integrated into Wheel Loader.



Integrated Intelligence in Motion



MOOG
CONSTRUCTION