## Advanced Engineering • • • Testing Solutions



## EV & Hybrid - R&D Powertrain Test Cell Integration

## ....luuluu/mityu/mityuluuluuluuluuluuluuluuluuluul







### Mustang Advanced Engineering is an industry leader in the design, manufacture and installation of advanced test cell solutions.



MAE is a test cell system integrator capable of supplying turnkey, fully functional, integrated test cell solutions. MAE draws on more than 35 years of test cell integration experience to provide customers the perfect test cell for their requirements. MAE has developed its TESTCell<sup>™</sup> product line which leverages existing designs and subsystems with new designs and integrating the latest technology to meet customer requirements efficiently.

MAE was an early adopter of the EV test cell market, integrating the first General Motors EV1 electric powertrain test cell in the 1990's. MAE has delivered many solutions to NASA, military, and commercial entities for fixed wing aircraft, rotary wing aircraft, VTOL, and eVTOL applications. MAE is poised to serve the Electric & Hybrid Aerospace market. The EV and Hybrid Test Cell is composed of various building block test cell items as well as custom test article specific items.

- Power analyzer measurement systems
- High speed data acquisition system (>1,000 Hz to GHz)
- Test stand automation and data acquisition system (<1,000 Hz)</li>
- HV (300 1,500 VDC) DC PS; battery simulators/ emulators
- LV (12 48 VDC) DC PS; MCU and vehicle accessory voltage supply
- Test article fixturing; fixed, adjustable and rotatable
- Dynamometers and controls ; AC, DC, eddy current, etc.

- Various interfaces (CAN, CAN FD, ARINC 429, ARINC 825/CAN, Mil-STD-1553) to BMS, FCMS, MCU, and DC/DC Converter
- Coolant conditioning systems for liquid and gaseous coolant medium
- Facility chiller and/or coolant systems to supply coolant to the coolant conditioning systems
- Actuator and controls for the test article and subsystems
- Test article/test cell climate controller interfaces
- Hydrogen fuel supply systems

### **Coolant Conditioning Systems**

- Cooling capacity of 1 kW 250 kW
- Single or multiple loop conditioning systems
- Configurable with heating and/or cooling of coolant medium
- Coolant medium control modes: pressure, flow & temperature
- Coolant medium measurement: flow, pressure, temperature, particulate matter
- Fluid filters with dirty filter sensor, easy hose disconnects, ball valves at interconnected points, sensors plumbed for calibration support
- Computer controlled with interface to TESTCell<sup>™</sup> automation system.
- Modular design for easy placement and movement.
- Multiple coolant mediums supported
  - ✓ Water
  - ✓ Water/glycol
  - Water/ethylene glycol
  - Lubricant oils (heavy)
  - Oil & transmission fluids
  - Fuel



www.MustangAE.com

# Single range, and dual range high voltage power supplies provide battery emulation from 300 - 1,200 VDC, power up to 1.9 MW.

### **Battery Simulator Packages**



	400 - 800 VDC Single Range*						
	DC Output Power		Current @ 400 VDC	Current @ 800 VDC			
Model*	HP	kW	Amps	Amps			
MAE-BS-9400-80	107	80	198	99			
MAE-BS-9400-130	174	130	311	155			
MAE-BS-9400-160	214	160	399	200			
MAE-BS-9400-320	429	320	779	390			
MAE-BS-9400-470	630	470	1,169	584			
MAE-BS-9400-630	845	630	1,558	779			
MAE-BS-9400-780	1,045	780	1,948	974			
MAE-BS-9400-940	1,260	940	2,337	1,169			
MAE-BS-9400-1100	1,475	1,100	2,727	1,363			
MAE-BS-9400-1250	1,675	1,250	3,116	1,558			
MAE-BS-9400-1410	1,890	1,410	3,506	1,753			
MAE-BS-9400-1560	2,091	1,560	3,895	1,948			
MAE-BS-9400-1720	2,305	1,720	4,285	2,142			
MAE-BS-9400-1870	2,507	1,870	4,675	2,337			

Other Ranges are Available, contact MAE sales at 1.330.963.5400 or sales@ MustangAE.com

	300 - 600 / 600 - 1,200 VDC Dual Range*							
	DC Output Power		Current @ 300 VDC	Current @ 600 VDC	Current @ 1,200 VDC			
Model*	HP	kW	Amps	Amps	Amps			
/IAE-BS-9500-110	147	110	377	188	94			
/IAE-BS-9500-180	241	180	591	295	148			
/IAE-BS-9500-240	321	240	779	390	195			
AE-BS-9500-470	630	470	1,558	779	390			
/IAE-BS-9500-710	951	710	2,337	1,169	584			
AE-BS-9500-940	1,260	940	3,116	1,558	779			
AE-BS-9500-1170	1,568	1,170	3,895	1,948	974			
AE-BS-9500-1410	1.890	1.410	4.675	2.337	1.169			

\*Other Ranges are Available, contact MAE sales at 1.330.963.5400 or sales@MustangAE.com

	Battery Simulator/Dynamometer Drive Systems							
	DC Output Power		AC Dyne Power		AC Dyne Max Speed	AC Dyne Max Torque		
Model*	HP	kW	HP	kW	rpm	N-m		
MAE-BS/DD-110/100	147	110	134	100	25,000	100		
MAE-BS/DD-180/200	241	180	268	200	22,000	150		
MAE-BS/DD-240/250	321	240	335	250	20,000	300		
MAE-BS/DD-470/500	630	470	670	500	12,000	1,000		
MAE-BS/DD-710/750	951	710	1,005	750	10,000	1,800		
MAE-BS/DD-940/1,000	1,260	940	1,340	1,000	8,000	2,500		
MAE-BS/DD-1,170/1,250	1,568	1,170	1,675	1,250	6,000	4,000		
MAE-BS/DD-1,410/1,500	1,890	1,410	2,010	1,500	5,000	5,000		

\*Other Ranges are Available, contact MAE sales at 1.330.963.5400 or sales@MustangAE.com



I

Ν

## MAE draws on more than 35 years of test cell integration experience to provide customers the perfect test cell for their requirements.

### **High-Speed Data Acquisition**

High-speed sampling rates (< 1 MHz, higher rates for antenna signal analyzers) Sensors:

- Accelerometers
- Microphones
- Cameras & vision
- Laser distance detection
- Antenna monitoring
- Strain gauges

#### Analysis PC

- Spectral analysis
- FFT





### **Low Voltage Power Supplies**

Low Voltage (LV) power supplies (12- 32 VDC) are used to power the MCU and/or auxiliary systems in a vehicle:

- DC/DC converter management systems
- Auxiliary battery management systems
- LV variable power supplies integrated with DC PS (HV)
  - 12 VDC (150 400 W)
  - 24 VDC (150 400 W)





### www.MustangAE.com

# MAE has the right resources and products to assist in the engineering, development and validation of your hybrid and electric vehicle systems.

### **Automation Controller**



The Automation Controller is the PLC based supervisor of the test stand. The Automation Controller will be programmed to monitor safety conditions of the test stand and perform control loops of various types on the test stand subsystem controllers. The Automation Controller collects test stand and subsystem data (<1,000 Hz) and displays it to the operator and makes limit determinations. The operator PC commands set-point control to the Automation Controller which carries out the control of the set-points. The control feedback signals, torgue and speed from the test stand and test article, are also routed to the Automation Controller. The Automation Controller monitors and controls subsystems such as test stand gearbox oil system(s). test article coolant conditioning system(s) and test stand rotational system(s). The Automation Controller has many other test stand feedback sensors to monitor the operational wellness of the test stand for display to the operator.



### **Power Analyzers**

High-speed sampling up to 5 MHz for electrical and mechanical power and efficiency measurements

Wave forms:

- Oscilloscope
- Spectral analysis
- Efficiency maps



# MAE has delivered R & D test stands to NASA, the US military, and companies such as Honda, Harley-Davidson, Bombardier, CAT, Toro,





## Tilt Rotor Electric Power Unit Test Stand



#### Products, Engineering, Experience = Solutions

Mustang Advanced Engineering has the right resources and products to assist in the engineering, development and validation of your hybrid vehicle systems. As a leading supplier of testing and simulation solutions for the development of powertrains and powertrain components, MAE has been involved in the development of advanced HEV testing and simulation test systems from the very beginning. Since then, MAE has continued to develop industry leading hardware and software for testing applications ranging from AC Engine Dynamometers, Electric Motor Test Systems, Inverter Test Systems, Battery Simulation Systems, Full Powertrain Test Systems, and Complete End of Line Multi-Function Test Stands for production testing and validation.

### Rotary Wing Test Stands

#### **Electric Scooter Test Stand**



Toll Free: 1.330.963.5400





## Fearless Innovation



## About MAE

Mustang Advanced Engineering is a leading provider of comprehensive testing solutions for the development and testing of motors, batteries, fuel cells, and powertrain systems for fixed wing aircraft, rotary wing aircraft, VTOL, and eVTOL vehicles. Founded in 1975, Mustang has long been a trusted source of expertise in measurement and testing technologies for the global industrial market. World-class product offerings, custom design support and technical assistance, backed by a dedicated factory service team, has positioned MAE among the global leaders in providing advanced testing solutions.

As a global leader in the design, manufacturing, and integration of advanced testing and measurement systems, MAE has delivered and continually supports literally thousands of test systems to virtually every corner of the globe.

Our mission is to achieve the highest possible level of customer satisfaction by providing innovative technical solutions and product designs and by striving to achieve perfection in product quality, delivery and service. At MAE, our customers are our highest priority - we do everything in our power to satisfy our customers. Our entire organization understands that the customer comes first and nothing else is more important.

To learn more about how MAE can help solve your most demanding testing challenges contact one of our sales engineers or visit www.mustangae.com.



#### U.S. Corporate Headquarters Mustang Advanced Engineering

2300 Pinnacle Parkway Twinsburg, OH 44087 Phone: (330) 963-5400 Fax: (330) 425-3310 Email: sales@mustangae.com

www.MustangAE.com