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# Energy Management – Battery Storage & Charging Solutions Application Guide

TTI, Inc., – A Berkshire Hathaway Company



# The Specialist in Electronic Component Distribution

When it comes to IP&E and discrete components, TTI is your go-to resource with the broadest and deepest inventory and a reputation for quality and on-time delivery second to none.

## 3M Interconnect Solutions

### Abracon

### AirBorn Interconnects

### Amphenol

- Amphenol Advanced Sensors
- Amphenol Aerospace
- Amphenol Alden
- Amphenol All Sensors
- Amphenol Anytek
- Amphenol Canada
- Amphenol Communication Solutions
- Amphenol CONEC
- Amphenol Entertainment
- Amphenol FCI
- Amphenol Fiber Optics
- Amphenol Industrial
- Amphenol LTW
- Amphenol Nexus
- Amphenol PCD
- Amphenol PCD Shenzhen
- Amphenol Piher Sensing Systems
- Amphenol Positronic
- Amphenol RF
- Amphenol SGX Technology
- Amphenol Sine
- Amphenol Spectra Strip
- Amphenol SSI Technology
- Amphenol SV Microwave
- Amphenol TCS
- Amphenol Tuchel

### Aptiv

- APTIV FCI
- KUM

### Bourns

- J.W. Miller
- Keko-Varicon
- Komatsulite
- Transtek

### Chemi-Con

### Cornell Dubilier (CDE) (Knowles)

- Illinois Capacitor

### Delevan

### Dialight

### EATON

- Bussmann
- Coiltronics
- PowerStor
- Souriau-Sunbank
- Transportation and eMobility

### Glenair

### HARTING

### Harwin

### HellermannTyton

### Honeywell

### iNRCORE

- Gowanda
- Vanguard Electronics

### ITT Cannon

### KEMET (YAGEO Group)

- Arcotronics
- Evox Rifa
- Forest Electric (FELCO)
- NEC TOKIN

### Knowles

- Cornell Dubilier (CDE)
- Dielectric Labs (DLI)
- IMC

- Novacap

- Syfer

- Voltronics

### KOA Speer

### KYOCERA AVX

### KYOCERA Display

### Lelon

### Littelfuse

- C&K Components
- Carling Technologies
- Hamlin
- Hartland Controls
- IXYS
- Littelfuse Automotive
- Teccor
- US SENSOR

### MEAN WELL

### Molex

- AFFINITY MEDICAL
- BittWare
- Brad
- FCT
- Flamar
- GW Connect
- ISI
- Laird CVS
- Nistica
- OPLINK
- Philips Medisize
- Polymicro Technologies
- PROTEK
- SDP Telecom
- Sensorcon
- Soligie
- SST

Ask your TTI Sales Specialist about our Online Procurement programs – the quick and easy way to order components online using your terms account, see the status of your orders, upload your BOM and do it all with secure 24/7 access.

- Temp-Flex
  - TRITON
  - Woodhead
- Motherson**  
(formerly PKC Group)
- Murata**
- Murata Power Solutions (MPS)
- Nichicon**
- OHMITE**
- Arcol
- OMRON**
- OMRON Automation & Safety
  - OMRON Electronic Components
- Panasonic**
- PANJIT**
- Phoenix Contact**
- Preci-Dip**
- ROHM Semiconductor**
- Samtec**
- Sensata**
- Airpax
  - BEI Sensors
  - Crydom
  - Cynergy3
  - Gigavac
  - Kavlico
  - Sensor Solutions
- Spectrum Control**  
(formerly APITech)
- Switchcraft Conxall**
- TAIYO YUDEN**
- TDK**
- EPCOS
- TE Connectivity**
- Agastat
  - Alcoswitch
  - AMP
  - AST Sensors
  - Augat
  - Axicom
  - CII Technologies
  - Corcom
  - DEUTSCH
  - Elcon
  - ENTRELEC
  - ERNI
  - First Sensor
  - Hartman
  - HTS
  - Jaquet Sensors
  - Kemtron
  - Kilovac
  - Laird Antennas
  - Linx Technologies
  - Madison Cable
  - Measurement Specialties
  - Microdot
  - Nanonics
  - OEG
  - Potter & Brumfield
  - Products Unlimited
  - Raychem
  - Schrack
  - Seacon
- TT Electronics**
- BI Technologies
  - IRC
- OPTEK
  - Semelab
  - Welwyn
- Vishay**
- Angstrohm
  - Barry Industries
  - BCcomponents
  - Beyschlag
  - Cera-Mite
  - Dale
  - Draloric
  - Electro-Films
  - Huntington/Milwaukee
  - Roederstein
  - Semiconductors
  - Sfernice
  - Siliconix
  - Spectrol
  - Sprague
  - Tansitor
  - Techno
  - Thin Film
  - Vitramon
- VPG Foil Resistors**
- WIMA**
- YAGEO Group**
- KEMET
  - Nexensos
  - Pulse
  - Vitrohm

## Battery Storage & Charging Solutions Application

The market for energy storage systems (EES) is one of the fastest growing markets in Asia, driven by the transformation of the energy mix to become carbon neutral. Factors such as growing renewable energy like solar or wind, government policies and the request of uninterrupted and reliable power supply drive the development of new, more efficient energy management and storage solutions.

Whether you are looking for new solutions in terms of power connectors for batteries, switching loads by high voltage contractors or relays up to a broad range of passive and discrete components – with TTI as your specialized distributor, you have a partner for designing and producing the complete range of such applications.

From the classical inverter to the energy and battery management system, the residential battery system and finally to close the application cycle – down to the EV-wallbox – check out our featured products – they all support these trends and requirements – or simply call your local TTI contact for more information.

### Energy Management

- Inverter systems
- Energy controller
- Energy monitoring
- Smart home interfaces

### Battery Systems

- Battery management systems
- Residential energy storage
- Battery packs
- UPS systems

### Charging

- Mobile application charger
- Industrial charger
- EV home charger (wall box)



# Connectors

			
<p>Mini Clamp II</p>	<p>Anytek Terminal Blocks</p>	<p>Minitek MicroSpaceXS™</p>	<p>PowerStak®</p>
<ul style="list-style-type: none"> <li>• Simple installation process</li> <li>• Labour saving IDC termination process</li> <li>• Ease of assembly for system building</li> </ul>	<ul style="list-style-type: none"> <li>• Rising clamp system</li> <li>• Screw pluggable system</li> <li>• Spring pluggable system</li> </ul>	<ul style="list-style-type: none"> <li>• LV214 Severity-3 and USCAR-T2V2 compatible</li> <li>• Terminal positioning assurance (TPA)</li> <li>• Primary and secondary contact retention</li> </ul>	<ul style="list-style-type: none"> <li>• High current carrying capacity with miniaturized shape</li> <li>• Up to 20A per power blade</li> <li>• 2 to 10 power blades on 2.0mm pitch</li> </ul>
			
			
<p>PwrBlade+™ Connectors</p>	<p>Power Solutions</p>	<p>USB4 Type C Connectors</p>	<p>Modular Jack RJ45 Connector Solutions</p>
<ul style="list-style-type: none"> <li>• High power contact option (up to 75A/contact; 30°C temperature: rise in still air) for cost-effective power delivery in 1U &amp; 2U power supplies or power distribution applications</li> </ul>	<ul style="list-style-type: none"> <li>• Broad range of power connectors, power cable assemblies &amp; power distribution (bus bar) products</li> <li>• Focused on ultra-low contact resistance</li> </ul>	<ul style="list-style-type: none"> <li>• High-speed transmission up to 40Gb/s</li> <li>• Excellent copper alloy material for terminals design</li> <li>• Extended 5A current rating for USB power delivery</li> </ul>	<ul style="list-style-type: none"> <li>• Various shielding options and LEDs</li> <li>• Wide operating temperature: -55 to +85°C</li> <li>• 750 mating &amp; unmating cycles</li> </ul>
			
			<p>• <b>A P T I V</b> •</p>
<p>BarKlip® Series</p>	<p>Surlok Plus</p>	<p>Ecomate® Rugged Metal Connectors</p>	<p>High Voltage RCS</p>
<ul style="list-style-type: none"> <li>• 10 points of contact for high reliability</li> <li>• Low halogen housing</li> <li>• Wide operating temperature: -40 to +150°C</li> </ul>	<ul style="list-style-type: none"> <li>• 1000V DC, up to 300A, IP67/IP69K</li> <li>• Unshielded and wire to device</li> <li>• 6 to 95mm<sup>2</sup> cable sizes</li> </ul>	<ul style="list-style-type: none"> <li>• Suitable for indoor and outdoor applications</li> <li>• EMI/RMI shielding capabilities with appropriate backshell</li> <li>• Operating temperature: -40 to +105°C</li> </ul>	<ul style="list-style-type: none"> <li>• High voltage RCS1100: 1000V</li> <li>• High voltage RSC800: 850V</li> <li>• High current carrying capacity: 375A at 85°C with 95mm<sup>2</sup> wire sections; 230A at 70°C with 50mm<sup>2</sup> wire sections</li> </ul>
			

# Connectors

<p><b>HARWIN</b></p>	<p><b>HARWIN</b></p>	<p><b>KYOCERA AVX</b></p>	<p><b>molex</b></p>
<p>High-Reliability M300 Power Connectors</p>	<p>Kona 8.5mm Pitch High-Reliability Power Connectors</p>	<p>Ethertronic Antenna Solutions</p>	<p>Fit Family Power Connectors</p>
<ul style="list-style-type: none"> <li>• High performance contacts in a compact housing</li> <li>• 3mm pitch housing featuring 10A contacts for 18 to 22 AWG cable &amp; board connectors</li> </ul>	<ul style="list-style-type: none"> <li>• 60A and 3,000V per contact</li> <li>• Beryllium copper &amp; gold plated 6-finger contact design to maintain electrical continuity</li> </ul>	<ul style="list-style-type: none"> <li>• Internal antennas: off-board &amp; on-board solutions</li> <li>• External antennas: indoor &amp; outdoor solutions</li> <li>• Active solutions: RF band switching &amp; active steering</li> </ul>	<ul style="list-style-type: none"> <li>• Fully isolated terminals</li> <li>• Positive locking housings</li> <li>• Polarization and keying to reduce possibility of misalignment</li> </ul>
			
<p><b>molex</b></p>	<p><b>molex</b></p>	<p><b>molex</b></p>	<p><b>molex</b></p>
<p>PowerPlane Busbar Connectors</p>	<p>Busbar Solutions</p>	<p>CLIK-Mate Wire-to-Board Connectors</p>	<p>EXTreme Ten60Power High-Current Connectors</p>
<ul style="list-style-type: none"> <li>• Multiple points of contact</li> <li>• Low-voltage drop</li> <li>• Current: 80 to 300A</li> <li>• Various termination styles</li> </ul>	<ul style="list-style-type: none"> <li>• Improved heat dissipation</li> <li>• Low characteristic impedance</li> <li>• Powder coat solutions</li> <li>• Tin, nickel &amp; silver plating</li> </ul>	<ul style="list-style-type: none"> <li>• Wide variety of circuit sizes, mounting styles</li> <li>• Dual positive inner lock offers greater mating assurance</li> <li>• Compact 1.50mm pitch</li> </ul>	<ul style="list-style-type: none"> <li>• Low-profile design: 10mm height</li> <li>• Available in 1 through 9 circuit split-blade power modules</li> <li>• Split-Blade power modules (1 through 9 circuits)</li> </ul>
			
<p><b>molex</b></p>	<p><b>molex</b></p>	<p><b>PHOENIX CONTACT</b></p>	<p><b>PHOENIX CONTACT</b></p>
<p>FCT D-Sub Connectors</p>	<p>IoT Antennas</p>	<p>ES-FT-BPC-B/S Battery Connectors</p>	<p>Lever-actuated PCB terminal blocks</p>
<ul style="list-style-type: none"> <li>• Plastic &amp; metal backshells</li> <li>• Machined contacts</li> <li>• Waterproof IP67 options available</li> <li>• Effective solutions for a variety of applications</li> </ul>	<ul style="list-style-type: none"> <li>• Poly-flexible, double-sided adhesive tape on antenna</li> <li>• High antenna radiation performance</li> <li>• Ground plane independent design</li> </ul>	<ul style="list-style-type: none"> <li>• Future-oriented connection technology: voltages up to 1,500V</li> <li>• Flexible in use: connections are possible on the front or the rear of the battery module</li> </ul>	<ul style="list-style-type: none"> <li>• Colour-coded actuating lever</li> <li>• Tool-free lever principle</li> <li>• Distinct lever positions give a reliable feedback for opened or closed</li> </ul>
			

# Connectors

	 <small>AUTHORIZED DISTRIBUTOR</small>	 <small>AUTHORIZED DISTRIBUTOR</small>	 <small>AUTHORIZED DISTRIBUTOR</small>
<p><b>PV Connectors</b></p>	<p><b>AMP-LATCH Ribbon Cable Interconnects</b></p>	<p><b>Industrial Ethernet Solution</b></p>	<p><b>Micro-MaTch Connector Family</b></p>
<ul style="list-style-type: none"> <li>• Unique SUNCLIX connection technology</li> <li>• Weatherproof insulation materials and high-quality contacts with minimized contact resistances</li> </ul>	<ul style="list-style-type: none"> <li>• Mass termination capabilities</li> <li>• No need to strip or prepare wire</li> <li>• Variety of centre lines and options</li> </ul>	<ul style="list-style-type: none"> <li>• Extensive temperature range between -40 to +85°C</li> <li>• Minimum product life requirement of 10 years</li> <li>• 260°C PIP soldering reflow capability</li> </ul>	<ul style="list-style-type: none"> <li>• Tin plated contact design</li> <li>• One of the smallest systems available at 1.27mm</li> <li>• UL-recognized</li> </ul>
			
 <small>AUTHORIZED DISTRIBUTOR</small>	 <small>AUTHORIZED DISTRIBUTOR</small>	 <small>AUTHORIZED DISTRIBUTOR</small>	 <small>AUTHORIZED DISTRIBUTOR</small>
<p><b>Dynamic Series</b></p>	<p><b>Heavy Duty Connectors with Dynamic Inserts</b></p>	<p><b>Circular Plastic Connectors</b></p>	<p><b>Snap-Lug Quick Disconnect Power Connectors</b></p>
<ul style="list-style-type: none"> <li>• Vibration resistant</li> <li>• Housings are keyed preventing mis-mating &amp; misalignment</li> <li>• Positive audible locking sound</li> </ul>	<ul style="list-style-type: none"> <li>• Designed for harsh environments</li> <li>• Improved operational efficiency</li> <li>• Reliable &amp; high density contact</li> </ul>	<ul style="list-style-type: none"> <li>• Lightweight, all-plastic and metal-shell connectors</li> <li>• UL 94V-0 rated and made of stabilized, heat resistant, self-extinguishing thermoplastic material</li> </ul>	<ul style="list-style-type: none"> <li>• Enable connections in confined spaces with a reliable snap-on, quick disconnect connector, without the need for a torque wrench</li> </ul>
			
 <small>AUTHORIZED DISTRIBUTOR</small>	 <small>AUTHORIZED DISTRIBUTOR</small>	 <small>AUTHORIZED DISTRIBUTOR</small>	
<p><b>Dynamic Mini Series</b></p>	<p><b>IPT</b></p>	<p><b>Antenna Solutions &amp; Technologies</b></p>	
<ul style="list-style-type: none"> <li>• Higher reliability due to second lock design</li> <li>• Space saving on board due to low profile</li> <li>• Faster system assembly due to SMT reflow capability</li> </ul>	<ul style="list-style-type: none"> <li>• 850V DC, 1, 2 &amp; 3-way versions</li> <li>• Shielded and wire to device</li> <li>• 16, 25, 35 and 50mm<sup>2</sup> versions available</li> </ul>	<ul style="list-style-type: none"> <li>• Broad range of antenna types include standard antennas &amp; custom antennas</li> <li>• Bluetooth, WLAN, Cellular and ZigBee</li> </ul>	
			

# Power Supplies & Sensors

<p><b>Amphenol®</b></p>	<p><b>Honeywell</b></p>	<p><b>Honeywell</b></p>	<p><b>KEMET</b> a YAGEO company</p>
<p>TR Series Thermal Runaway Detection Modules</p>	<p>CSCA-A Series Open Loop Device</p>	<p>Battery Safety Pressure Sensors</p>	<p>FG-RO5-3A Current Sensors</p>
<ul style="list-style-type: none"> <li>• H2 Sensor module</li> <li>• Analogue, CAN, I2C, SPI communication options</li> <li>• &gt;20 year design life</li> </ul>	<ul style="list-style-type: none"> <li>• Open Loop Hall technology</li> <li>• Ranges up to +/- 900A</li> <li>• Fast response time</li> </ul>	<ul style="list-style-type: none"> <li>• High accuracy</li> <li>• Low temperature drift</li> <li>• Advance warning for thermal runaway</li> </ul>	<ul style="list-style-type: none"> <li>• AC &amp; DC leak current sensor</li> <li>• Digital output fault detection</li> <li>• Complies to mode 2 of IEC62752</li> <li>• Mode 3 replacement compatible</li> </ul>
			
<p><b>KEMET</b> a YAGEO company</p>	<p><b>Littelfuse®</b></p>	<p><b>TE</b> CONNECTIVITY AUTHORIZED DISTRIBUTOR</p>	
<p>C/CT Series AC Current Sensors</p>	<p>USP16673 Thermistor Probes</p>	<p>Energy Meter DRS-100-3P-MOD-01</p>	
<ul style="list-style-type: none"> <li>• Snap on, compact slimline design</li> <li>• Flat temperature characteristics</li> <li>• UL94 V-0 flame retardant rated case</li> </ul>	<ul style="list-style-type: none"> <li>• Tight tolerance</li> <li>• Ultra thin</li> <li>• 90°C maximum operating temperature</li> </ul>	<ul style="list-style-type: none"> <li>• MID D Certified</li> <li>• Direct connect to 100A</li> <li>• Easy to program &amp; Din Rail mount</li> <li>• Accurate and cost effective</li> </ul>	
			

# Relays & Switches

 NOW PART OF 			
<b>ZMW Series</b> Mini size snap-acting Switches	<b>DCNLEV50</b>	<b>G7EB</b> PCB AC-Power Relays	<b>G9KA</b> PCB-Power Relays
<ul style="list-style-type: none"> <li>• Mini size snap-acting switches ideal when space is limited</li> <li>• Reliable snap-acting mechanism with long stroke setting</li> </ul>	<ul style="list-style-type: none"> <li>• High current (50A) &amp; high voltage (900V) contactor for charging applications</li> <li>• Epoxy resin ensures hermetic sealing</li> <li>• IP67K sealed</li> </ul>	<ul style="list-style-type: none"> <li>• High power &amp; high temperature type power relay with 480VAC 100A current</li> </ul>	<ul style="list-style-type: none"> <li>• High power &amp; high temperature type power relay with 800VAC 200A current</li> </ul>
			
		 <small>AUTHORIZED DISTRIBUTOR</small>	 <small>AUTHORIZED DISTRIBUTOR</small>
<b>ESB33 Push Switches</b>	<b>HVC</b> Contactor for DC Switching	<b>High Power Relays</b> <b>K1K 1000V/1.000A</b>	<b>IHVA Series</b> <b>DC Contactors</b>
<ul style="list-style-type: none"> <li>• Low profile, h=6.0mm</li> <li>• SMD type (embossed taping available)</li> <li>• 2-pole 2-throws are available</li> </ul>	<ul style="list-style-type: none"> <li>• Up to 1200VDC</li> <li>• Up to 500A</li> <li>• Bipolar design</li> <li>• Single &amp; Dual coil design available</li> </ul>	<ul style="list-style-type: none"> <li>• High performance in a compact, lightweight, hermetically sealed contactor</li> <li>• Designed for up to 1000V/1000A in harsh environment</li> </ul>	<ul style="list-style-type: none"> <li>• Non polarity for contact current</li> <li>• Aux contact available</li> <li>• Coil voltage 12/24/48VDC, ~ 5W</li> </ul>
			
 <small>AUTHORIZED DISTRIBUTOR</small>	 <small>AUTHORIZED DISTRIBUTOR</small>		
<b>AV Series</b> <b>Vandal Resistant Switches</b>	<b>HV Rotary Switches</b>		
<ul style="list-style-type: none"> <li>• 250VAC &amp; 5A push button switch</li> </ul>	<ul style="list-style-type: none"> <li>• Mechanical switch which can handle switching currents up to 550A and a voltage of 1000VDC</li> </ul>		
			

# Passives

 <p>Powering Business Worldwide</p>	 <p>a YAGEO company</p>	 <p>a YAGEO company</p>	 <p>PRECISION SCIENTIFIC</p>
<p>XLM Supercapacitors</p>	<p>KC Link Ceramic Capacitors</p>	<p>ALS Electrolytic Capacitors</p>	<p>Hi Voltage and Safety MLCCs</p>
<ul style="list-style-type: none"> <li>• Long lifetime (operating lifespan of up to 20 years)</li> <li>• Maintenance free (no monitoring or user controls required)</li> </ul>	<ul style="list-style-type: none"> <li>• EIA 1812, 2220, and 3640 case size</li> <li>• AEC-Q200 automotive qualified</li> <li>• Flexible termination option available</li> </ul>	<ul style="list-style-type: none"> <li>• Compact size with high CV</li> <li>• Long life, up to 20,000 hours</li> <li>• High ripple current</li> </ul>	<ul style="list-style-type: none"> <li>• Safety capacitors with 305Vac rating</li> <li>• Safety capacitors with 1kVdc rating</li> </ul>
			
		 <p>INNOVATOR IN ELECTRONICS</p>	 <p>INNOVATOR IN ELECTRONICS</p>
<p>FFLR / FFVE Power Film Capacitors</p>	<p>Supercapacitors Family</p>	<p>KCA Metal Termination Capacitors</p>	<p>Safety Capacitors</p>
<ul style="list-style-type: none"> <li>• Self healing technology</li> <li>• FFLR – Voltage range: 600V to 3800V, capacitance range: 105uF to 3000uF</li> <li>• Aluminium cylindrical case filled with polyurethane resin</li> </ul>	<ul style="list-style-type: none"> <li>• Superior reliability, AVX passes 4000 hours life tests with results still within specification</li> </ul>	<ul style="list-style-type: none"> <li>• Capacitance from 100pF to 10nF</li> <li>• Operating temperature range: -55°C to +125°C</li> </ul>	<ul style="list-style-type: none"> <li>• High impulse tolerance product can help reduce the size of the board</li> </ul>
			
			
<p>AC Output Filter Capacitors</p>	<p>EDLC ENYCAP Supercapacitors</p>	<p>High Capacitance MLCCs</p>	<p>Isomov Hybrid Protectors</p>
<ul style="list-style-type: none"> <li>• Optimized AC voltage performance</li> <li>• High ripple current capability</li> <li>• THB: 60°C/95%RH/Vrac/1000h</li> </ul>	<ul style="list-style-type: none"> <li>• Rated capacitance: 5F to 100F</li> <li>• Rated voltage (65°C, 85°C): 3V, 2,6V</li> <li>• Useful life: 2.000h at 85°C</li> </ul>	<ul style="list-style-type: none"> <li>• High capacitance and high voltage at once</li> <li>• Size: 0805 to 1812</li> <li>• TC: X7R (-55°C ~ 125°C)</li> </ul>	<ul style="list-style-type: none"> <li>• Space saving solution (GDT +MOV)</li> <li>• Reduced down time and service cost</li> <li>• Enhanced surge ratings</li> </ul>
			

# Passives

			
<p>Shunt Resistors</p>	<p>High Energy Pulse Resistors</p>	<p>PSX Power Fuses</p>	<p>Thermal Sensing Solutions</p>
<ul style="list-style-type: none"> <li>• 0.5mΩ to 20mΩ</li> <li>• 1W (0805 inch) to 5W (2512 inch)</li> <li>• Current ratings up to 100A</li> </ul>	<ul style="list-style-type: none"> <li>• Non-inductive</li> <li>• 25kV pulse voltage (HPC 3, 4, 5)</li> <li>• Power rating up to 5W</li> </ul>	<ul style="list-style-type: none"> <li>• Low watt loss (energy efficiency for BESS applications)</li> <li>• Compact NH 1XL &amp; 3XL sizes</li> <li>• Class aR performance according to IEC 60269-4</li> </ul>	<ul style="list-style-type: none"> <li>• Custom probe assemblies</li> <li>• High precision thermistors</li> <li>• Custom R-T curves</li> </ul>
			
			
<p>Thin Film Resistors</p>	<p>Low ESR Aluminium Capacitors</p>	<p>EMC Filters</p>	<p>Metal Element Inverse Shunts</p>
<ul style="list-style-type: none"> <li>• Wide resistance range</li> <li>• 10Ω to 1MΩ (E-96)</li> <li>• Low current noise, excellent linearity</li> </ul>	<ul style="list-style-type: none"> <li>• Low ESR (down to 12mΩ)</li> <li>• High ripple current (up to 3820mA)</li> <li>• Temperature range: -40°C to +105°C</li> </ul>	<ul style="list-style-type: none"> <li>• 1, 2, 3 &amp; 4 line filters</li> <li>• Highest performance by optimized design</li> <li>• Line reactors, output chokes and output filters</li> <li>• Broad range of standard products</li> </ul>	<ul style="list-style-type: none"> <li>• Inverse 1020 &amp; 1225 SMD shunt, 0.1 to 3m Ohms, down to 1%</li> <li>• Ultra-low ohmic values support high energy efficiency in the end product</li> </ul>
			
			
<p>GBS Vitreous Resistors</p>	<p>Aluminium Housed Power Resistors</p>		
<ul style="list-style-type: none"> <li>• High power rating up to 1000W</li> <li>• Excellent pulse load capability</li> <li>• Low ohmic values &lt;1 Ohm</li> </ul>	<ul style="list-style-type: none"> <li>• High power rating: 75W to 500W</li> <li>• Wirewound resistors, high power, aluminium housed, heatsink type</li> <li>• Resistance range: .1Ω to 51KΩ</li> </ul>		
			

# Discrete Semiconductors

			
<b>TBU-DB-Q Series High-Speed Protectors</b>	<b>CD-MMBL110S SMD Bridge Rectifiers</b>	<b>CDSOT23-T24CAN CANbus Protectors</b>	<b>556 - LED PMI Series</b>
<ul style="list-style-type: none"> <li>• Superior circuit protection</li> <li>• Overcurrent protection</li> <li>• Blocks surges up to rated voltage limit</li> <li>• High-speed performance</li> <li>• Small SMT package</li> </ul>	<ul style="list-style-type: none"> <li>• 1000V/1A rating</li> <li>• Low profile DFN3538 package (3.5 x 3.8 x 1.15mm)</li> <li>• High thermal dissipation</li> </ul>	<ul style="list-style-type: none"> <li>• Single device for two I/O lines</li> <li>• Low capacitance for high-speed CANbus</li> <li>• AEC-Q101 compliant</li> </ul>	<ul style="list-style-type: none"> <li>• Available in a large range of DC &amp; AC voltages</li> <li>• Flat or domed lens, to fit any kind of application</li> <li>• Daylight viewable version</li> <li>• Constant intensity version</li> </ul>
			
			
<b>AQ24CANA CAN Protections</b>	<b>IX4351NE SiC MOSFETs &amp; IGBT Drivers</b>	<b>LSIC1MO120G0080 – 800V SiC N-Ch MOSFETs</b>	<b>VCNL4200 - Proximity &amp; Ambient Light Sensors</b>
<ul style="list-style-type: none"> <li>• Low clamping voltage</li> <li>• Low leakage current</li> <li>• ESD, ISO 10605, 330pF 330Ω, ±27kV contact, ±30kV air</li> <li>• AEC-Q101 qualified</li> </ul>	<ul style="list-style-type: none"> <li>• Separate 9A peak source &amp; sink outputs</li> <li>• Operating voltage range: -10V to +25V</li> </ul>	<ul style="list-style-type: none"> <li>• Optimized for high-frequency, high-efficiency applications</li> <li>• Extremely low gate charge and output capacitance</li> <li>• Low gate resistance for high-frequency switching</li> </ul>	<ul style="list-style-type: none"> <li>• SMD 8.0 x 3.0 x 1.8mm</li> <li>• IRED, ALS, PS, IC integrated</li> <li>• Filtron technology</li> <li>• Dark lens design</li> <li>• Output type: I2C bus (ALS/PS)</li> </ul>
			
			
<b>SIA477EDJT 12V P-CH MOSFETs</b>	<b>SIC32201 Integrated OR-ing Switches</b>	<b>XMC7K24CA XClamp™ TVS Diodes</b>	
<ul style="list-style-type: none"> <li>• PowerPAK® SC-70 package</li> <li>• Small footprint area</li> <li>• Low on-resistance</li> <li>• RDS(on) rating at VGS = -1.8V</li> <li>• Built in ESD protection</li> </ul>	<ul style="list-style-type: none"> <li>• Integrated 0.45mΩ n-channel current sense MOSFET</li> <li>• Lossless current sense without shunt resistor</li> <li>• Integrated current sensing and reporting circuits</li> </ul>	<ul style="list-style-type: none"> <li>• XClampR™ extremely low clamping voltage</li> <li>• <math>I_{PPM} = 180A</math> with a 10/1000μs waveform</li> <li>• Low leakage current</li> <li>• AEC-Q101 qualified</li> </ul>	
			

# Rugged. Reliable. Future Ready

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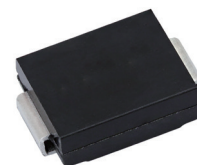
Vishay offers a broad portfolio of solutions for Battery Management Systems including MOSFETs, diodes, shunt resistors as well as temperature sensors. Vishay's component solutions deliver long lasting performance, high transient resistivity, and ultra-high stability.



SMD high power and high voltage resistors for pre-charge and discharge



NTC thermistors for cell and coolant temperature detection



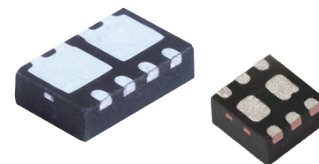
PAR® TVS diodes for transient protection



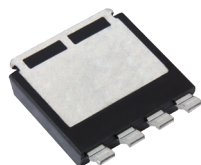
Power Metal Strip® battery shunt resistors with very low ohmic values



High power, long side termination thick film resistors for balancing



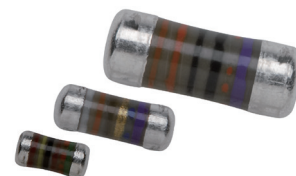
P-channel MOSFETs with ultra low  $R_{DS(on)}$  and small packages



Power MOSFETs in PowerPAK® 8x8L with low thermal resistance for battery switch



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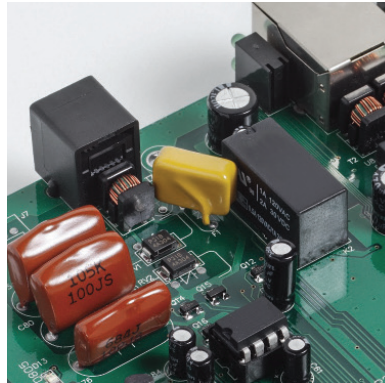
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