

## BEU8635-24

Balancing for 24-Cell Battery  
Cell Voltage Monitoring and Telemetry

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### Description

The Aeroflex 8635-24 is a Lithium-Ion cell balancing system. It controls the balancing of one battery consisting of a series stack of Lithium-Ion cells to ensure that each cell is precisely charged to its proper level of energy and to monitor each cell's operational voltage.

The cell balancing circuitry uses a set of bilateral DC-DC converters which tie each cell of a battery to a common share bus. Cell charge is distributed among the multiple cells so that the charge of each cell is automatically matched to the average charge of the other cells.



### Features

- Cell Balancing to within  $\pm 5.0\text{mV}$
- Cell Voltage Monitoring Accuracy  $\pm 10.0\text{mV}$  ( $\pm 20.0\text{mV}$  Space Mission Life)
- Total Battery Voltage Monitoring Accuracy  $\pm 0.3\%$  of Full Scale
- Supports 24 Lithium-Ion battery cells in series
- Battery Drain Current at Balance 15mA maximum
- Discrete output lines for critical signaling with user definable thresholds:
  - Overvoltage Protection 4.40V typ
  - Cell Voltage High 4.20V typ
  - Cell Voltage Low 3.20V typ
- MIL-STD-1553B telemetry for data logging and monitoring

### Safety

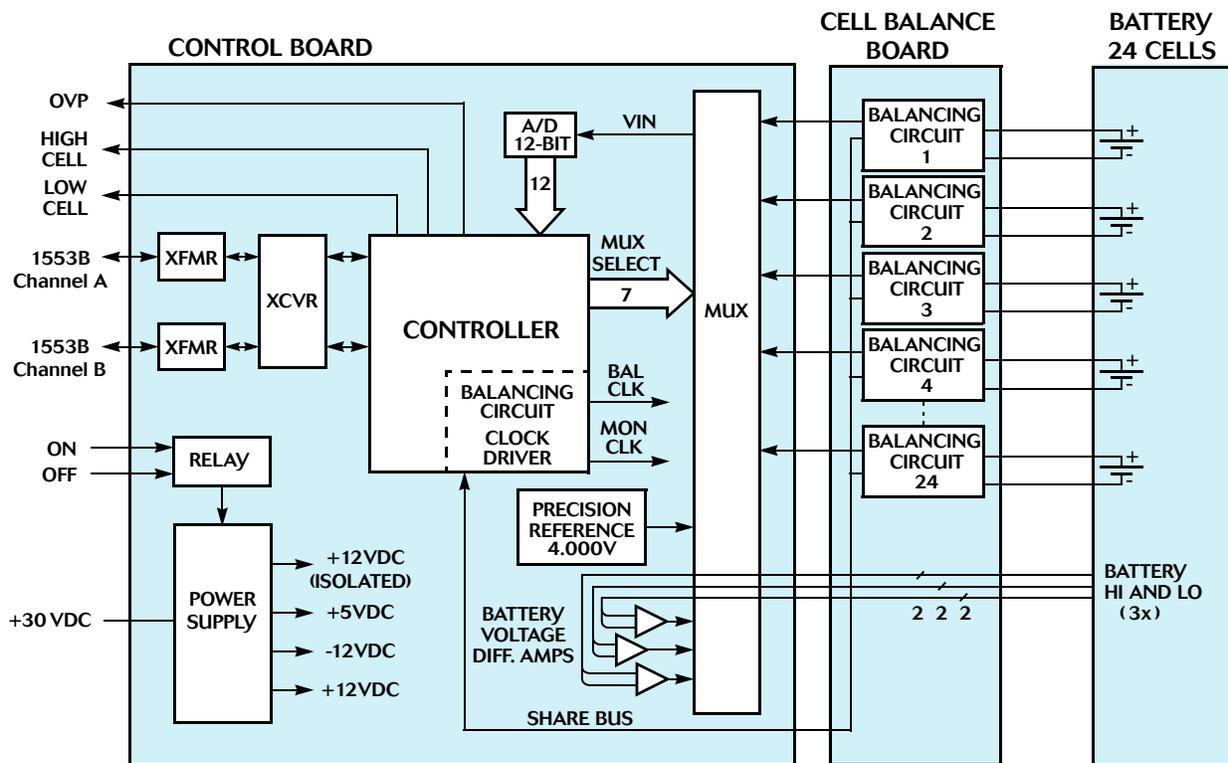
The safety of Lithium-Ion battery technology requires that extreme care be taken in the provisions made for cell charging and cell monitoring.

Precision measurements of each of the individual cell voltages in the battery stack and precise charge balancing to each individual cell are critical.

The Aeroflex 8635-24 provides the necessary precision of control and monitoring to ensure that safety.

Discrete logic outputs are provided for critical signaling, enabling the user to initiate load shedding and/or to halt charging.

Low operating losses enable continuous operation. Continuous balancing provides maximum protection against any one cell becoming overcharged.



**Block Diagram**

## 8635-24 Operating Details

### Battery Cell Balancing

Provides 24 individual continuous balancing circuits.

### Maximum Cell Balancing Current Limit

Each cell is provided with a 1 Amp fuse for overload interrupt in the event of a shorted cell to protect the remaining cell balance functionality.

### Cell Balancing Accuracy

When connected to a battery, the 8635-24 provides balancing currents into each of the battery's cells. The directions and the magnitudes of the individual currents are proportional to the deviations of the cell voltages from the average cell voltage. The transfer ratio of voltage to current is 1.0 Ohm nominal and is satisfied for cell voltages of up to 4.2V.

### Battery Cell Current Drawn in Off State

In the off state, the differential mode battery cell current drawn by each cell balancing circuit is less than 50µA.

### Battery Cell Voltage Monitoring

Measures cell voltages for up to 24-cells.

### 4V and 0V References for Calibration

Provides 4V and 0V references for cell voltage telemetry calibration.

### Battery and Cell Protection

Incorporates overvoltage protection (OVP) circuits. These circuits monitor all of the battery cell voltages and only register the highest of all cell voltages monitored. When a cell voltage threshold of 4.40V is reached, the protection circuit output changes state and latches within 50mS.

### Battery Cell Overvoltage Latch Output

The status of the OVP latch is provided by telemetry as specified in Tables II, III & IV and also as a discrete output.

### Recovery from Cell Overvoltage Indication

The OVP latch is reset by a 1553B reset command or by recycling the input power.

### Highest Battery Cell Voltage Telemetry

Provides highest battery cell voltage telemetry as specified in Tables I & IV.

### Lowest Battery Cell Voltage Telemetry

Provides lowest battery cell voltage telemetry as specified in Tables I & IV.

### Test Points

Provides test points for total battery voltage, low cell indicator and high cell indicator. Access to the total battery voltage is provided to permit pre-charging before connection to the battery.

## MIL-STD-1553B Telemetry & Commands

Analog or bi-level telemetry can be requested from the controller and reported over the dual redundant 1553B interface with the RT addresses configurable at the J1 connector.

### Analog Telemetry

Each analog telemetry item can be requested individually on sub-addresses 18, 19 or 22.

First a 1553B receive command with one data word as defined in Table I, which specifies the telemetry item being requested, must be issued. After a minimum delay of 1.2ms, the data can be retrieved by sending a 1553B transmit command for one data word on the same sub-address on which the request was initiated.

The 12-bit data reply is left justified in the 16-bit 1553B data word with the four LSBs set to "0".

**Table I – Analog Telemetry**

| Item | Telemetry Title         | Telemetry Reply Scale | 1 <sup>st</sup> Data Word of 1553B Receive Command (Hex) |
|------|-------------------------|-----------------------|--|
| 1    | 4V Reference            | -0.40V to 4.89V       | 0800   |
| 2    | 0V Reference            | -0.40V to 4.89V       | 0803   |
| 3    | Total Battery Voltage 1 | 0V to 122.88V         | 0805   |
| 4    | Total Battery Voltage 2 | 0V to 122.88V         | 0806   |
| 5    | Total Battery Voltage 3 | 0V to 122.88V         | 0809   |
| 6    | Share Bus Voltage       | 0V to 5.12V           | 080A   |
| 7    | Cell 1 Voltage          | 0V to 5.12V           | 0811   |
| 8    | Cell 2 Voltage          | 0V to 5.12V           | 0812   |
| 9    | Cell 3 Voltage          | 0V to 5.12V           | 0814   |
| 10   | Cell 4 Voltage          | 0V to 5.12V           | 0817   |
| 11   | Cell 5 Voltage          | 0V to 5.12V           | 0818   |
| 12   | Cell 6 Voltage          | 0V to 5.12V           | 081B   |
| 13   | Cell 7 Voltage          | 0V to 5.12V           | 081D   |
| 14   | Cell 8 Voltage          | 0V to 5.12V           | 081E   |
| 15   | Cell 9 Voltage          | 0V to 5.12V           | 0821   |
| 16   | Cell 10 Voltage         | 0V to 5.12V           | 0822   |
| 17   | Cell 11 Voltage         | 0V to 5.12V           | 0824   |
| 18   | Cell 12 Voltage         | 0V to 5.12V           | 0827   |
| 19   | Cell 13 Voltage         | 0V to 5.12V           | 0828   |
| 20   | Cell 14 Voltage         | 0V to 5.12V           | 082B   |
| 21   | Cell 15 Voltage         | 0V to 5.12V           | 082D   |
| 22   | Cell 16 Voltage         | 0V to 5.12V           | 082E   |
| 23   | Cell 17 Voltage         | 0V to 5.12V           | 0830   |
| 24   | Cell 18 Voltage         | 0V to 5.12V           | 0833   |
| 25   | Cell 19 Voltage         | 0V to 5.12V           | 0835   |
| 26   | Cell 20 Voltage         | 0V to 5.12V           | 0836   |
| 27   | Cell 21 Voltage         | 0V to 5.12V           | 0839   |
| 28   | Cell 22 Voltage         | 0V to 5.12V           | 083A   |
| 29   | Cell 23 Voltage         | 0V to 5.12V           | 083C   |
| 30   | Cell 24 Voltage         | 0V to 5.12V           | 083F   |
| 31   | Lowest Cell Voltage     | 0V to 5.12V           | 0871   |
| 32   | Highest Cell Voltage    | 0V to 5.12V           | 0872   |

### Bi-Level Telemetry

Bi-level telemetry can be requested on sub-addresses 18, 19 or 22.

First a 1553B receive command with one data word as defined in Table II, which specifies the telemetry item being requested, must be issued. After a minimum delay of 1.2ms, the data can be retrieved by sending a 1553B transmit command for one data word on the same sub-address on which the request was initiated.

**Table II – Bi-level Telemetry**

| Item | Telemetry Title          | Status  | Reply Bit | 1 <sup>st</sup> Data Word of 1553B Receive Command (Hex) |
|------|--------------------------|---------|-----------|--|
| 1    | Overvoltage Latch Status | 1 = Set | D13       | 0C80   |

### 32-Word Telemetry

To reduce data bus bandwidth usage, the 8635-24 supports a 32-word telemetry request on sub-address 20 as defined in Table III.

First a 1553B receive command with one data word of AAAA(Hex) must be issued. After a minimum delay of 1.2ms, the data can be retrieved by sending a 1553B transmit command for 32 data words on sub-address 20.

Reply word 31 is a modulo-16 message count. This counter increments by one for each valid telemetry request.

The 12-bit analog data reply is left justified in the 16-bit 1553B data word with the four LSBs set to "0"..

**Table III – 32-Word Telemetry**

| Item | Telemetry Title          | Telemetry Type | Reply Word | Reply Bits |
|------|--------------------------|----------------|------------|------------|
| 1    | 4V Reference             | Analog         | 1          | D(15:4)    |
| 2    | Total Battery Voltage 1  | Analog         | 2          | D(15:4)    |
| 3    | Total Battery Voltage 2  | Analog         | 3          | D(15:4)    |
| 4    | Total Battery Voltage 3  | Analog         | 4          | D(15:4)    |
| 5    | Share Bus Voltage        | Analog         | 5          | D(15:4)    |
| 6    | Reserved                 | -              | 6          | -          |
| 7    | Cell 1 Voltage           | Analog         | 7          | D(15:4)    |
| 8    | Cell 2 Voltage           | Analog         | 8          | D(15:4)    |
| 9    | Cell 3 Voltage           | Analog         | 9          | D(15:4)    |
| 10   | Cell 4 Voltage           | Analog         | 10         | D(15:4)    |
| 11   | Cell 5 Voltage           | Analog         | 11         | D(15:4)    |
| 12   | Cell 6 Voltage           | Analog         | 12         | D(15:4)    |
| 13   | Cell 7 Voltage           | Analog         | 13         | D(15:4)    |
| 14   | Cell 8 Voltage           | Analog         | 14         | D(15:4)    |
| 15   | Cell 9 Voltage           | Analog         | 15         | D(15:4)    |
| 16   | Cell 10 Voltage          | Analog         | 16         | D(15:4)    |
| 17   | Cell 11 Voltage          | Analog         | 17         | D(15:4)    |
| 18   | Cell 12 Voltage          | Analog         | 18         | D(15:4)    |
| 19   | Cell 13 Voltage          | Analog         | 19         | D(15:4)    |
| 20   | Cell 14 Voltage          | Analog         | 20         | D(15:4)    |
| 21   | Cell 15 Voltage          | Analog         | 21         | D(15:4)    |
| 22   | Cell 16 Voltage          | Analog         | 22         | D(15:4)    |
| 23   | Cell 17 Voltage          | Analog         | 23         | D(15:4)    |
| 24   | Cell 18 Voltage          | Analog         | 24         | D(15:4)    |
| 25   | Cell 19 Voltage          | Analog         | 25         | D(15:4)    |
| 26   | Cell 20 Voltage          | Analog         | 26         | D(15:4)    |
| 27   | Cell 21 Voltage          | Analog         | 27         | D(15:4)    |
| 28   | Cell 22 Voltage          | Analog         | 28         | D(15:4)    |
| 29   | Cell 23 Voltage          | Analog         | 29         | D(15:4)    |
| 30   | Cell 24 Voltage          | Analog         | 30         | D(15:4)    |
| 31   | Message Count            | Analog         | 31         | D(15:0)    |
| 32   | Overvoltage Latch Status | Bi-level       | 32         | D13        |

### 8-Word Telemetry

To reduce data bus bandwidth usage, the 8635-24 supports an 8-word telemetry request on sub-address 24 as defined in Table IV.

First a 1553B receive command with one data word of 5555(Hex) must be issued. After a minimum delay of 1.2ms, the data can be retrieved by sending a 1553B transmit command for 8 data words on sub-address 24.

Reply word 8 is a modulo-16 message count. This counter increments by one for each valid telemetry request.

The 12-bit analog data reply is left justified in the 16-bit 1553B data word with the four LSBs set to "0".

**Table IV – 8-Word Telemetry**

| Item | Telemetry Title          | Telemetry Type | Reply Word | Reply Bits |
|------|--------------------------|----------------|------------|------------|
| 1    | Overvoltage Latch Status | Bi-Level       | 1          | D13        |
| 2    | Reserved                 | -              | 2          | -          |
| 3    | Reserved                 | -              | 3          | -          |
| 4    | Reserved                 | -              | 4          | -          |
| 5    | 0V Reference             | Analog         | 5          | D(15:4)    |
| 6    | Lowest Cell Voltage      | Analog         | 6          | D(15:4)    |
| 7    | Highest Cell Voltage     | Analog         | 7          | D(15:4)    |
| 8    | Message Count            | Analog         | 8          | D(15:0)    |

## Additional Commands

### Data Load Command

1553B receive commands consist of 2 data words to the sub-address specified in Table V. Only the first data word is used.

**Table V – Commands**

| Item | Function Title  | Sub-Address | 1 <sup>st</sup> Data Word of 1553B Receive Command (Hex) |
|------|-----------------|-------------|--|
| 1    | Reserved        | 13          | -  |
| 2    | Reserved        | 14          | -  |
| 3    | Reset OVP Latch | 15          | 0400   |

### Telemetry Frame Sync Command

1553B broadcast command on sub-address 17 (any data word) commands the 8635-24 to refresh its RT address.

### Remote Terminal State Command

1553B transmit command on sub-address 21 for one data word. The reply word will be 4000(Hex), to indicate that the unit is ready to accept another command or 5000(Hex), to

indicate that the unit is busy and cannot accept another command.

### 1553B Data Wrap Around

Sub-address 30 is dedicated to data wrap around as specified in MIL-STD-1553B.

### Supported Mode Codes

The 8635-24 supports the 1553B Mode Codes in Table VI.

**Table VI – 1553B Mode Codes**

| Mode Code Name                | Mode Code Number |
|-------------------------------|------------------|
| Transmit Status Word          | 2                |
| Transmitter Shutdown          | 4                |
| Override Transmitter Shutdown | 5                |
| Reset Remote Terminal         | 8                |

### 1553B Status Flag Bits

The 8635-24 supports the following 1553B status flag bits:

1. Message Error bit
2. Broadcast Message Received bit

All other status bits are set to "0".

**Connector P1**  
**26 Pin Subminiature-D Plug**  
**Cell Sense**

| Pin # | Function Name | Pin # | Function Name |
|-------|---------------|-------|---------------|
| 23    | CELL_12+      | 17    | CELL_24+      |
| 9     | CELL_11+      | 7     | CELL_23+      |
| 3     | CELL_10+      | 14    | CELL_22+      |
| 19    | CELL_9+       | 1     | CELL_21+      |
| 10    | CELL_8+       | 20    | CELL_20+      |
| 13    | CELL_7+       | 12    | CELL_19+      |
| 16    | CELL_6+       | 18    | CELL_18+      |
| 26    | CELL_5+       | 8     | CELL_17+      |
| 5     | CELL_4+       | 4     | CELL_16+      |
| 2     | CELL_3+       | 21    | CELL_15+      |
| 15    | CELL_2+       | 22    | CELL_14+      |
| 24    | CELL_1+       | 6     | CELL_13+      |
| 11    | CELL_1-       | 25    | CELL_13-      |

**Connector J2 for Control Board**  
**Triaxial**  
**1553B Bus A**

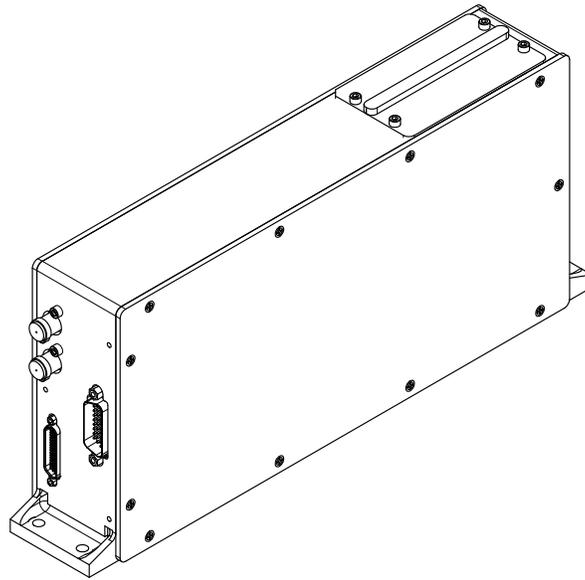
|            |
|------------|
| CHA_DATA_H |
| CHA_DATA_L |
| SHIELD     |

**Connector J3 for Control Board**  
**Triaxial**  
**1553B Bus B**

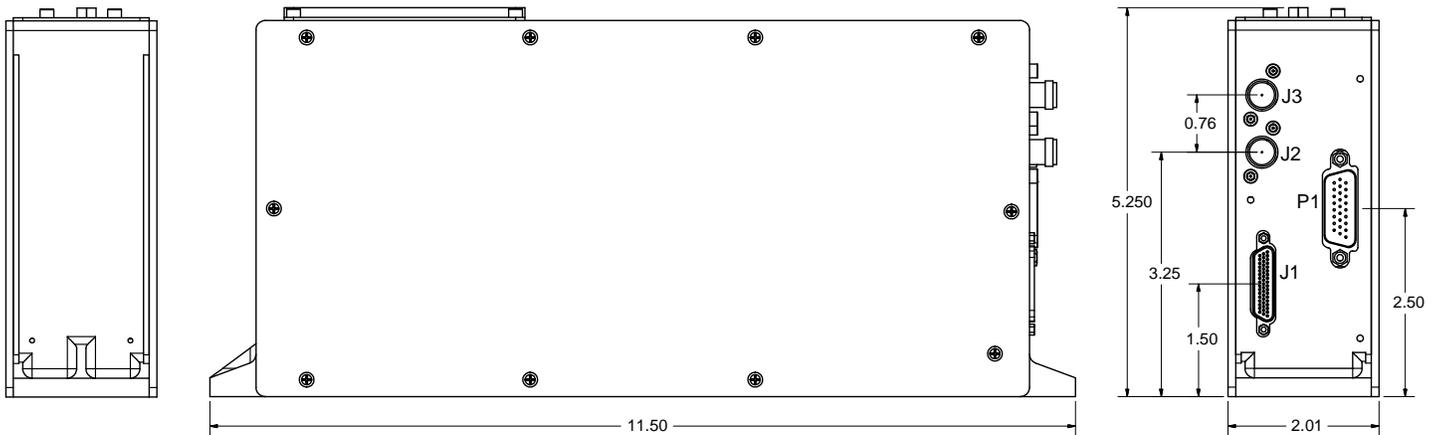
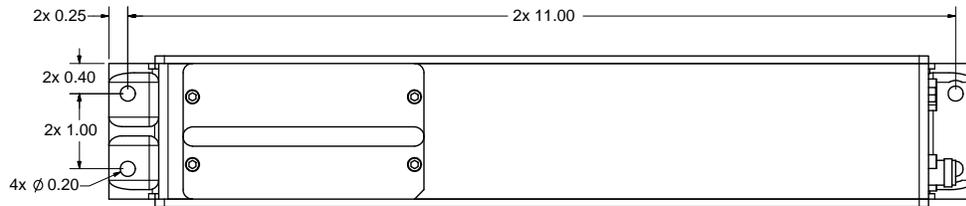
|            |
|------------|
| CHB_DATA_H |
| CHB_DATA_L |
| SHIELD     |

**Connector J1 for Control Board**  
**51 Pin Micro-D Receptacle**  
**Control & Test Points**

| Pin # | Function      | Pin # | Function     | Pin # | Function     |
|-------|---------------|-------|--------------|-------|--------------|
| 1     | 30V_RTN       | 18    | V_BAT_3      | 35    | V_BAT_2      |
| 2     | NC_ISOLATION  | 19    | NC_ISOLATION | 36    | NC_ISOLATION |
| 3     | NC_ISOLATION  | 20    | +30V_POWER   | 37    | NC_ISOLATION |
| 4     | NC_ISOLATION  | 21    | +30V_POWER   | 38    | NC_ISOLATION |
| 5     | 30V_RTN       | 22    | NC_ISOLATION | 39    | SPARE        |
| 6     | NC_ISOLATION  | 23    | NC_ISOLATION | 40    | CHASSIS GND  |
| 7     | CHASSIS GND   | 24    | CHASSIS GND  | 41    | CELL_CHG_24  |
| 8     | CELL_CHG_12   | 25    | LOW_CELL     | 42    | SPARE        |
| 9     | SPARE         | 26    | RESERVED     | 43    | BEU_ON_CMD_1 |
| 10    | BEU_OFF_CMD_2 | 27    | BAL_ON_1     | 44    | BEU_ON_CMD_2 |
| 11    | BEU_OFF_CMD_1 | 28    | BAL_ON_2     | 45    | HIGH_CELL    |
| 12    | RTA_2         | 29    | RTA_0        | 46    | RTA_4        |
| 13    | RTA_GND       | 30    | RTA_GND      | 47    | RTA_GND      |
| 14    | RTA_GND       | 31    | RTA_GND      | 48    | RTA_GND      |
| 15    | RTA_1         | 32    | RTA_3        | 49    | RTPTY        |
| 16    | OV_PROT       | 33    | V_BAT_TP     | 50    | V_BAT_RTN1   |
| 17    | V_BAT_RTN3    | 34    | V_BAT_RTN2   | 51    | V_BAT_1      |



**3-D View**



**Outline**

## Standard Configuration

### Power Dissipation

9.0 Watts from 30V Supply

1.5 Watts from battery

### Operating Base Plate Temperature

BEU8635-24-S -34°C to +71°C

BEU8635-24 0°C to +70°C

### Storage Temperature

-34°C to +71°C

### Dimensions

11.5" L x 2.01" W x 5.25" H

### Weight

3.5 lbs (1.59 kg)

## Ordering Information

| MODEL NUMBER | SCREENING                    |
|--------------|------------------------------|
| BEU8635-24-S | High Reliability Space Grade |
| BEU8635-24   | Commercial Flow              |

### EXPORT CONTROL:

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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused