The MA190 module is a scalable and configurable cell pack based on GS Yuasa’s LSE190 Generation III lithium ion cell. With a nameplate capacity of 190Ah, the LSE190 cell has significant spaceflight heritage supporting both human rated LEO missions as well as commercial GEO satellites.

MA190 modules may each contain between 6 and 12 LSE190 cells. The cells in a module may be electrically connected in a simple series arrangement, yielding a module rated for 190Ah. Alternatively, two or three cells may be connected first in parallel and then in series yielding 380Ah or 570Ah modules.

**LSE190 Cell Safety Tests (JSC 20793)**

- Over-charge
- Over-discharge (forced reversal)
- External short circuit (2 & 5 milliohm)
- Crush (fresh & seasoned cells)
- Heat to vent
- Three orientation drop
- Vent and burst pressure

**MA190 Module Qualification Tests**

- Sine vibration
- Random Vibration
- Shock
- Thermal vacuum

**MA190 Module Configuration Numbering**
Vehicle battery systems consist of one or more MA190 modules connected in series and/or parallel. The table below provides nominal mass, dimensions and key electrical performance attributes for select module configurations. Please contact GS Yuasa Lithium Power for information on other configurations.

<table>
<thead>
<tr>
<th>Module Configulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module Config.</td>
</tr>
<tr>
<td>MA190-106 1p6s</td>
</tr>
<tr>
<td>MA190-107 1p7s</td>
</tr>
<tr>
<td>MA190-108 1p8s</td>
</tr>
<tr>
<td>MA190-109 1p9s</td>
</tr>
<tr>
<td>MA190-110 1p10s</td>
</tr>
<tr>
<td>MA190-111 1p11s</td>
</tr>
<tr>
<td>MA190-112 1p12s</td>
</tr>
<tr>
<td>MA190-206 2p3s</td>
</tr>
<tr>
<td>MA190-208 2p4s</td>
</tr>
<tr>
<td>MA190-210 2p5s</td>
</tr>
<tr>
<td>MA190-212 2p6s</td>
</tr>
<tr>
<td>MA190-306 3p2s</td>
</tr>
<tr>
<td>MA190-309 3p3s</td>
</tr>
<tr>
<td>MA190-312 3p4s</td>
</tr>
</tbody>
</table>

Notes:
1. at acceptance, C/2 discharge, 4.10V to 2.75V
2. includes cell pack, bus bars, bypass switches, wire harness, heaters
3. 18 year GEO mission, 80% actual DOD max, no bypassed cells
4. based on 4.20V per cell EOM condition
5. EOM, based on 18 year GEO mission at rated power
6. 15 year LEO mission, 30% DOD (Ah nameplate), no bypassed cells
7. based on 4.05V per cell EOM condition
8. End of year 15
MA190 Battery Systems

Key Attributes of Notional Configurations

The charts below provide battery system mass and operating voltage range as a function of required LEO or GEO eclipse power. Battery systems described are comprised of one or more MA190 module(s) connected in series to form a single battery. A vehicle battery system may consist of one or more batteries.

In these examples, the LEO mission is 15 years and the GEO mission is 18 years. Higher eclipse power may be supported for shorter design lives. These charts assume no cells are bypassed. Please contact GS Yuasa Lithium Power (GYLP) for consideration of your specific requirements.

United States Department of Defense: For classified missions, GYLP is able to provide software tools to assist with battery system configuration and predictive life and performance modeling.
### Generation III Energy Type LSE Cell Test Data

#### LEO Cycle 25% DOD of Nameplate
- Capacity (Ah)
- Voltage

#### LEO Cycle 40% DOD of Nameplate
- Capacity (Ah)
- Voltage

#### GEO Cycle 80% DOD of Nameplate
- Capacity (Ah)
- Voltage

#### Semi-accelerated GEO Cycle ~70% Max DOD of Nameplate
- Voltage

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**Eclipse:** 1 cycle/day, 10°C, 4.0 EoCV
**Solstice:** 69 days, 25°C, 4.0V

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