

KEY FEATURES

- Inherently safer closed-loop adaptive charging expands battery performance envelope
- Active Safety Management runs hundreds of safety checks per charge cycle
- Reduces battery cost with cell multi-sourcing, enabled by improved cell to cell performance consistency
- Field proven – doubled battery lifespan in over 10 million smartphones
- QNS software-only implementation provides simple integration into Qualcomm® and Mediatek ARM-based Android mobile platforms without hardware changes
- Highest performance QNI Adaptive Pulse Modulation™ with hardware acceleration support on Qualcomm® Snapdragon™ 835 platform
- Optional Qnovo Analytics (QNA) provides safety and performance prediction for devices in the field



GENERAL DESCRIPTION

Through rigorous testing, Qnovo has shown that adaptive charging delivers substantial improvements in safety, performance and cost to battery-powered mobile devices:

ENHANCED SAFETY

Qnovo adaptive charging operates as a closed-loop control system with multiple layers of built-in safety checks. Qnovo algorithms are designed to mitigate safety-related degradation mechanisms, including lithium plating, excessive swelling, and rapid capacity loss. Hundreds of safety checks are performed each charge cycle, and unsafe deviations from expected behavior enable safe device shutdown.

EXTENDED PERFORMANCE

Qnovo adaptive charging extends lithium-ion capabilities across energy density, charge rate and cycle life. Over 1 million laboratory test cycles with more than 100 battery families demonstrate consistently superior results versus CCCV or step charging.

MULTI-SOURCE COST REDUCTION

Cell-to-cell performance variation across vendors often makes multi-sourcing impossible. Qnovo's closed-loop charging approach normalizes cell performance, allowing all cells to perform similarly, thus enabling multi-source cost reduction.

TWO LEVELS OF PERFORMANCE

QNS supports energy densities up to approximately 600 Wh/l, charge rates to 1C and 800 cycle lifespan. QNI excels at higher energy densities or charge rates, with 4.4V cells, or with cells that require advanced swelling control.



PRODUCT COMPARISON

| | QNS | QNI |
|---|---|--|
| Charging method | Adaptive charging | Adaptive Pulse Modulation™ |
| Battery model | Chemical degradation | |
| Cell characterization | One time per cell family and real-time during operation | |
| Temperature compensation | Intrinsic cell temperature | |
| Multi-sourcing: Reduces cell-cell performance variation | Yes | Yes, with improved performance |
| Safety monitoring interval | 5 to 30 seconds, platform dependent | < 1 second |
| Degradation mechanisms mitigated | Lithium plating SEI formation | Lithium plating, SEI formation electrolyte depletion, grain fracture, gas formation |
| Swell reduction | Yes | Yes, with improved performance |
| Performance | ~ 600 Wh/l, 1C, 800 cycles | 700+ Wh/l, 2C+, 800+ cycles |
| Supported ARM-based platforms | Qualcomm, Mediatek | Qualcomm PMI8998 |

SYSTEMS ARCHITECTURE

QNS or QNI software runs as a user-space service within the operating system. Supported cell profiles are pre-characterized and compiled into a Qnovo binary file. The Qnovo software communicates with the fuel gauge and charger drivers to control the battery charging process.

QNI is based on patented Adaptive Pulse Modulation, which utilizes charge pulses to both charge the battery and extract frequency information from the cell in real-time. QNI depends on an additional hardware element, the Qnovo pulse engine, embedded in the Qualcomm Snapdragon 835 PMI8998 PMIC. The pulse engine enables QNI advanced diagnostics and allows QNI software to deliver Qnovo's highest performance charging with enhanced safety.

