CONNECTING, PROTECTING AND POWERING THE WORLD

Solutions

ROBOTICS

- INDUSTRIAL
- SERVICE
- CONSUMER
- COLLABORATIVE

FEATURING

Motor Control

Battery Management

Ultra-Wideband (UWB)

Power Management

Wi-Fi

qorvo

CONNECTING,

PROTECTING

AND POWERING

THE WORLD

ROBOTICS EXAMPLES

High Level Design Considerations

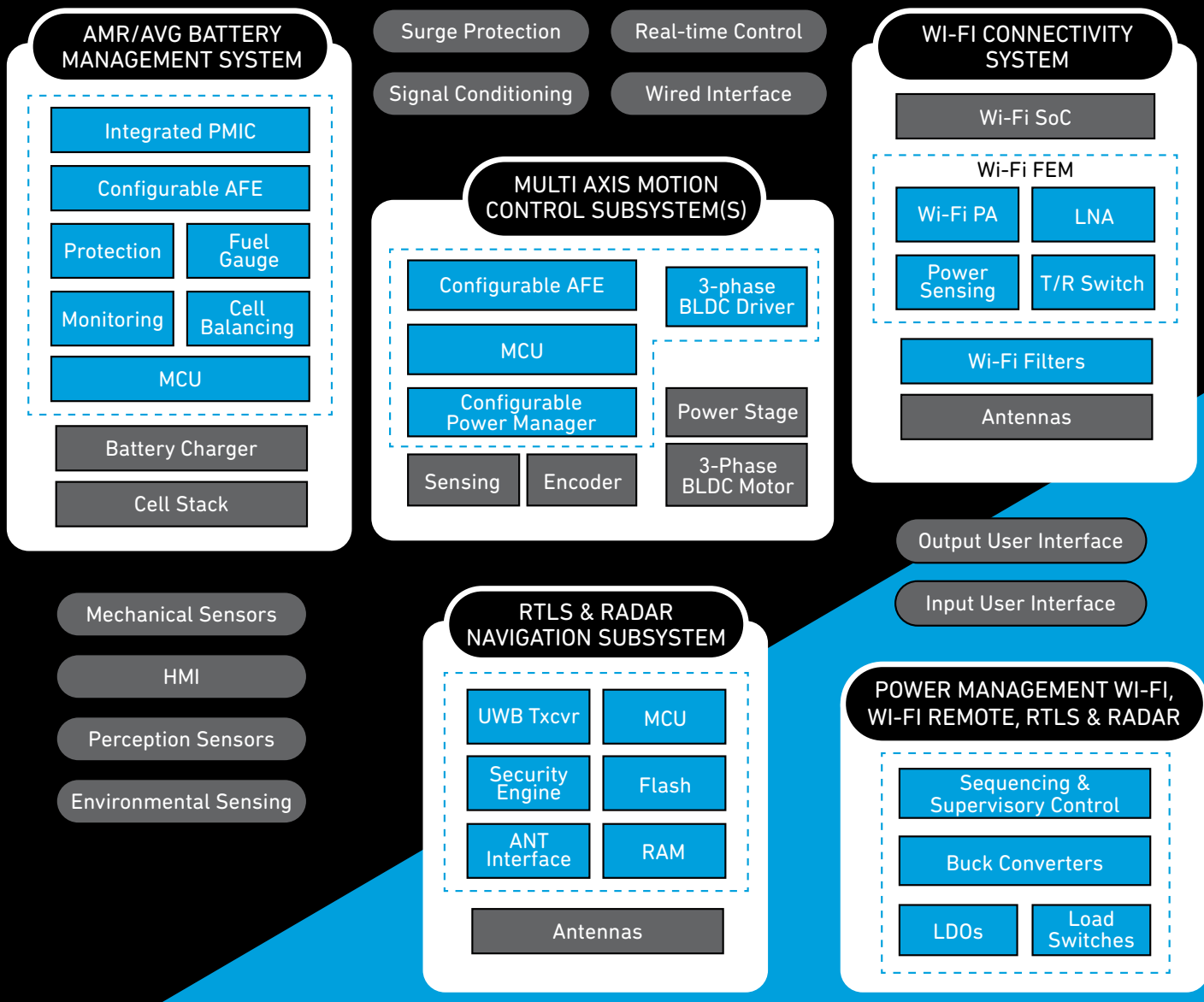
- **Safety:** Collaborative sensing • E-stop • Fault isolation
- **Energy:** Chemistry • Cooling • Efficiency budget
- **Motion:** Torque density • Feedback • Control loops
- **Power:** Rails • Isolation • Transient tolerance
- **Connectivity:** Deterministic links • Time sync • Indoor positioning

OFFERING UNIQUE CAPABILITIES

Achieved Through Smart Solutions

- **BLDC Drivers:** Improve efficiency and simplify design with integrated 3-phase control
- **Battery Management SoC:** Extends battery longevity, monitor health and enhance user safety
- **Wi-Fi 7 FEMs & Filters:** Optimize wireless links between robotic platforms and control systems
- **Integrated PMICs:** Streamline power architecture and reduce component count
- **Industrial UWB:** Enables precise localization and navigation in factory and warehouse environments

ROBOTICS BLOCK DIAGRAM



Look for blue blocks!

Qorvo content shown in blue blocks

BRIDGING GAPS WITH INNOVATIVE SOLUTIONS

For Today's Challenges

Highly compact and flexible PMICs

Up to 13 voltage rails supporting a wide range of voltage and current requirements

Robust BLDC control at a low cost

Space saving integration of MCU, gate drivers and power management

Precise UWB positioning

±5 cm ranging allows geofencing and autonomous navigation in warehouses

Integrated Wi-Fi FEMs & Filters

Delivers low latency, robust, interference-free wireless performance for stable operation

Industrial-grade BMS safety

Fast fault protection (OV/UV/OCP/OTP), cell balancing and accurate SOC/SOH are essential to meeting safety requirements for robotic fleets

Solutions Built for Autonomous Systems

Flexible BMS for varying power levels

Single chip BMS solutions support 10s-20s applications across a wide range of cell chemistries

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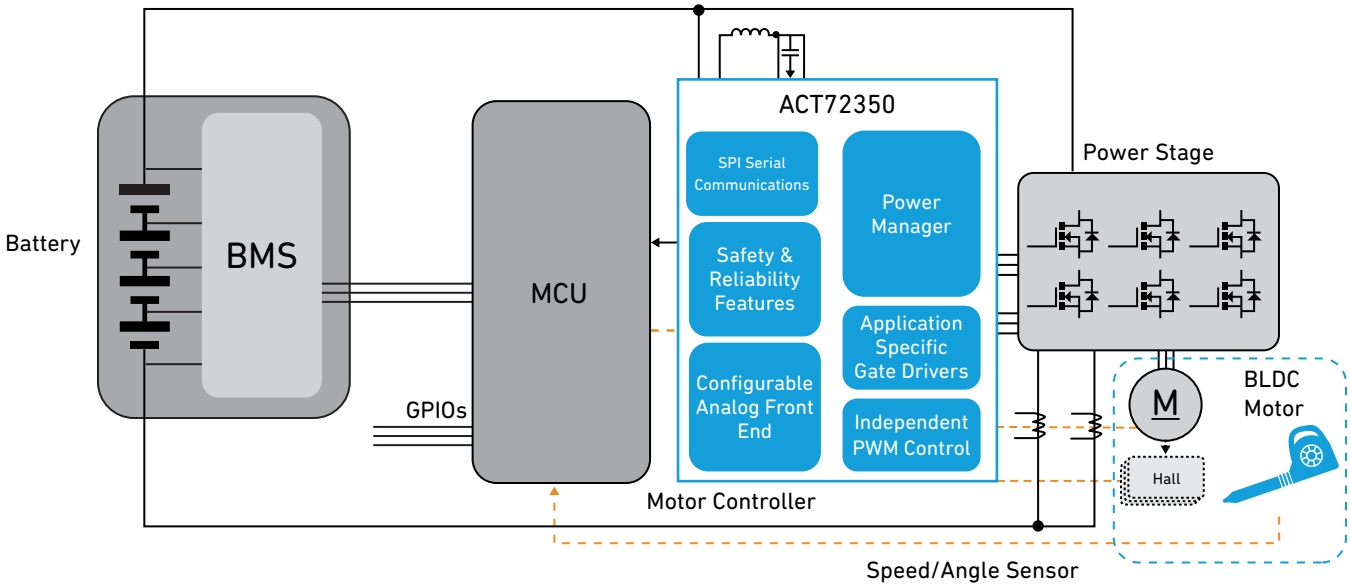
MOTOR CONTROL

Motor Driver

160V 3-phase BLDC Motor Driver with Integrated Power Manager and Configurable AFE

- 25V to 160V input range powers applications from 36V service robots to 100V industrial AGVs
- Buck DC-DC and on-chip LDOs power internal rails and the existing MCU, eliminating extra regulators
- Three half-bridge drivers (3 x 160V HS, 3 x 20V LS, 2 A source/sink) reliably drive high-torque BLDCs
- Cycle-by-cycle protection, VDS sensing and programmable OCP shut down motor fast on stalls or shorts, protecting packs and MOSFETs
- Configurable AFE with 3 diff + 4 single PGAs and 3-phase sample-and-hold gives precise current feedback



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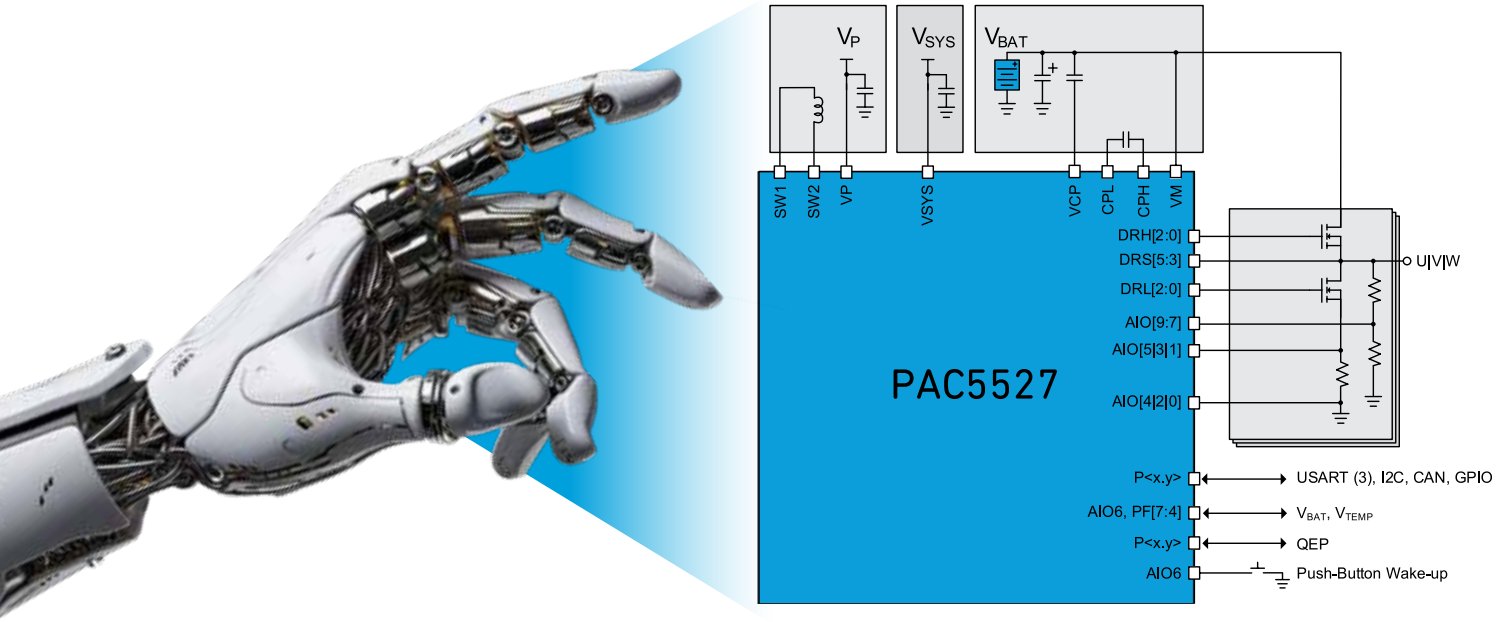
MOTOR CONTROL

Motor Controller & Driver

48V BLDC Motor Controller and Driver with Charge Pump and Configurable Analog Front End

- 150 MHz Arm® Cortex®-M4F MCU (128 kB Flash/32 kB SRAM) for fast FOC and diagnostics
- Reduces up to 18 discrete external components with 48V charge pump
- Eliminates extra DC/DC & LDOs with integrated multimode power manager
- Includes configurable analog front end (CAFE) for precise signal conditioning
- Cycle-by-cycle current limit, programmable OCP and fault protection enhance safety and reliability



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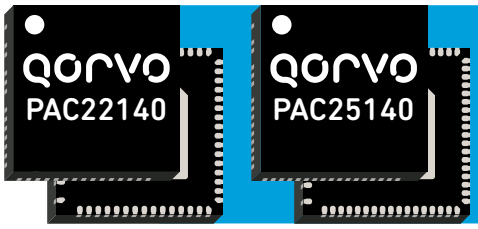
BATTERY MANAGEMENT

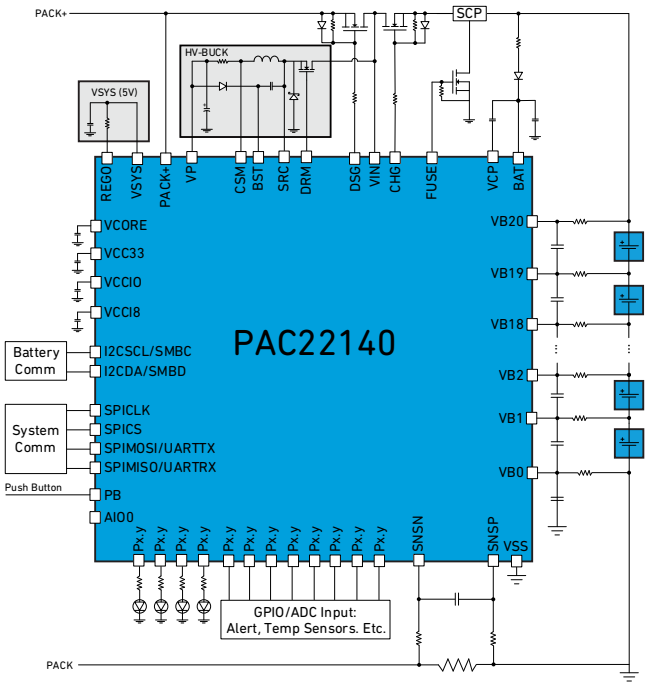
System on Chip



Up to 20s Intelligent Battery Management SoC with Arm Cortex MCU, Integrated PMIC and BMS AFE, including cell balancing

- Fully programmable industry-standard Arm
  - PAC22140 50 MHz Arm-M0 32 kB Flash/8 kB SRAM
  - PAC25140 150 MHz Arm-M4F 128 kB/32 kB SRAM
- Three ADCs for monitoring key parameters
  - 16-bit SD ADC for current sense with differential PGA
  - 16-bit SD ADC for voltage sense and cell balancing
  - 10/12-bit SAR ADC for additional voltage/temperature sense
- Complete power solution
  - 145V DC/DC buck
  - 5V 225mA
  - 3.3V 90mA
  - MCU V_{core}

Single IC required for complete BMS solution



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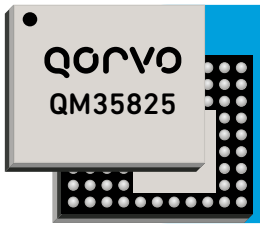
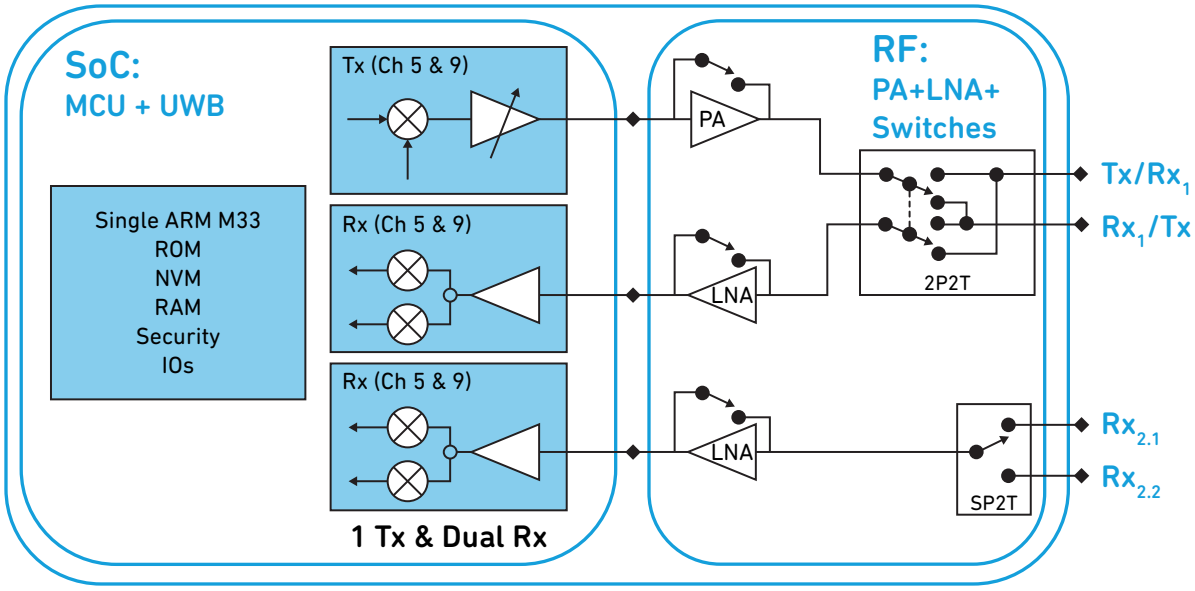
ULTRA-WIDEBAND

Low-Power SoC: Industrial Applications



UWB Low-power, 6.5 & 8.0 GHz SoC
Compliant with IEEE 802.15.4z™-2024

- ± 5 cm / ± 2° ranging accuracy keeps robots in-bounds and autonomously operating
- Sub-ms ranging + 104 dB link stay solid through trees and sheds for safe routing
- Four-antenna 3-D AoA keeps heading precise through tight turns
- -98 dBm Rx and low-power Cortex-M33 stretch battery; on-chip math, no extra MCU
- SESIP3 boot, STS, AES/RSA block spoofing and tampering on high-value gear
- Built-in UWB radar wakes on approach and spots obstacles, no extra sensors needed



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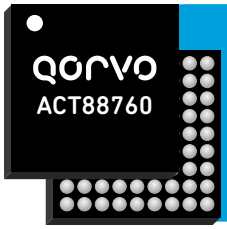
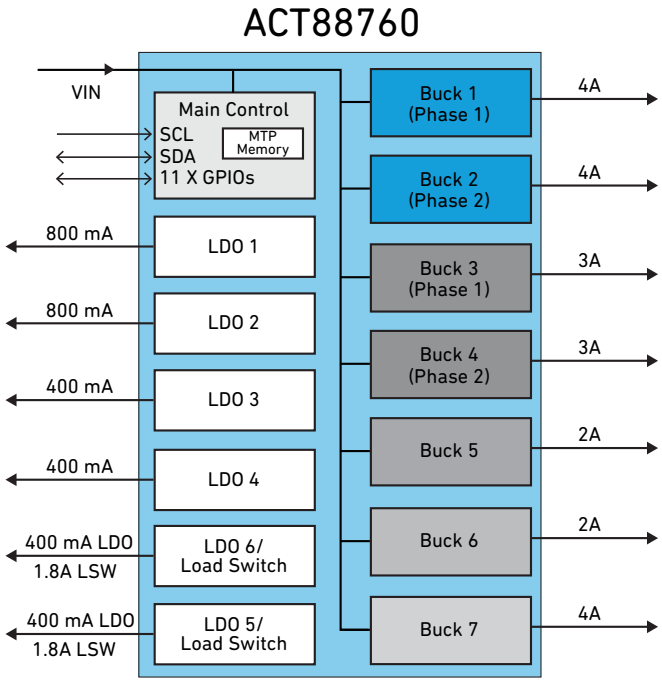
POWER MANAGEMENT

High-Rail-Count PMIC



Dual-phase Bucks, High PSSR LDOs, 13 Voltage Rail PMIC

- ACT88760 supports up to 13 voltage rails
- Wide input operating range : 2.6V-5.8V
- High integration leads to small form factor ~3.85x3.85mm
- 3x 4A (5A peak), 2x 3A (4A peak) & 3x 2A (3A peak) buck regulators
- 6x LDOs/load switch with LDO5, 6 having load switch (LSW) or LDO configuration options
- Low quiescent current (IQ<15µA for bucks & IQ~20µA for LDOs) LPM (low power mode) operation
- All bucks only need 3 external components (each) to operate



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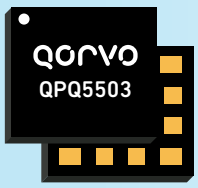
WI-FI

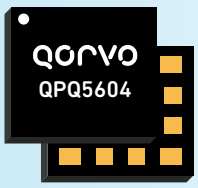
Filter Modules

Band Filters
2.4G Bandedge Filter
Wi-Fi/LTE Co-existence Filter

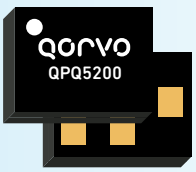
- BAW modules push higher power through more Wi-Fi 7 channels than designs with no or legacy filtering
- QPQ5503/QPQ5604 isolate 5 GHz and 6 GHz sub-bands for clean, high-throughput backhaul in tri-band nodes
- QPQ5200 lets 2.4/5 GHz PAs hit regulatory power limits while staying inside OOB masks
- QPQ5230 delivers deep rejection to block adjacent-cell interference in converged devices
- Validated on Qualcomm, MediaTek and Broadcom Wi-Fi 7 designs for fast time-to-market



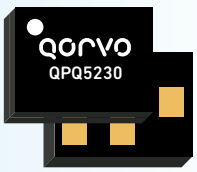
QPQ5503
1816 size
UNII 1-3



QPQ5604
1816 size
UNII 5-8



QPQ5200
1109 size
CH 1-11
FCC Region:
Bandedge



QPQ5230
1109 size
CH 1-13
-IL/-VSWR

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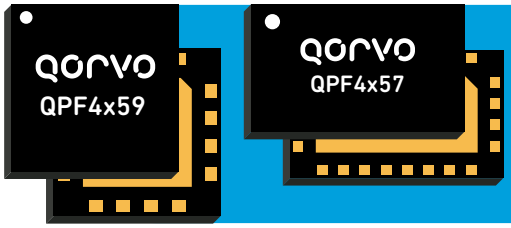
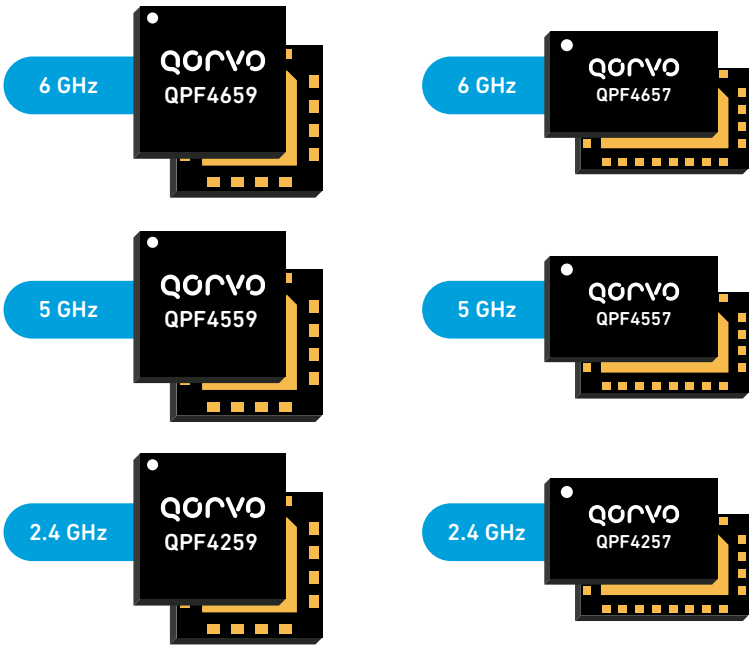
WI-FI

Front End Modules

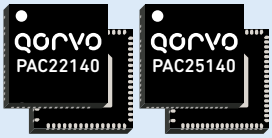
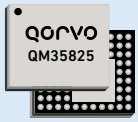
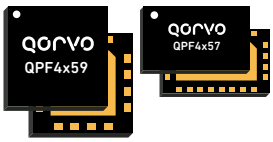
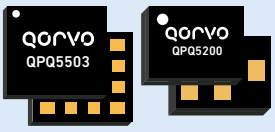


Wi-Fi 7
High Power FEMs

- Wi-Fi 7 platform-qualified on Qualcomm, MediaTek and Broadcom reference designs
- 5V-optimized PA delivers top linear power and throughput while cutting current draw
- Compact QFN footprints, 3x3mm (QPF4x59) and 3x5mm (QPF4x57), save board area
- Integrated RF + DC log detector enables closed-loop power control and health checks
- On-die harmonic and 2.4 GHz rejection filters ensure clean DBDC coexistence



PARTS OVERVIEW

Motor Control		48V BLDC Motor Controller and Driver with Charge Pump and Configurable Analog Front End
Motor Control		160V 3-phase BLDC Motor Driver with Integrated Power Manager & Configurable AFE
Battery Management		Intelligent Battery Management SoC with Integrated Arm Cortex-M0/M4F MCU Cell Balancing
Power Management		5V PMIC with 7 High Current Bucks, 6 LDOs and 10 GPIOs
Ultra-Wideband		6.5 & 8.0 GHz Ultra-Wideband (UWB) Transceiver
Wi-Fi FEMs		Wi-Fi 7 High-Power Front-End Modules (2.4/5/6 GHz)
Wi-Fi BAW Filters		High-Power Wi-Fi Coexistence BAW Bandpass Filters (2.4/5/6 GHz)