Richardson Electronics (RELL) Drone and UAV Solutions

Richardson Electronics
POWER & MICROWAVE TECHNOLOGIES

Rev: 2025-09-03

Overview

- Market Landscape
- Drone Classification
- Key Design Considerations
- Richardson Electronics - Drone Design Solutions
- Richardson Electronics - Value Proposition

Market Overview

Projected Growth:

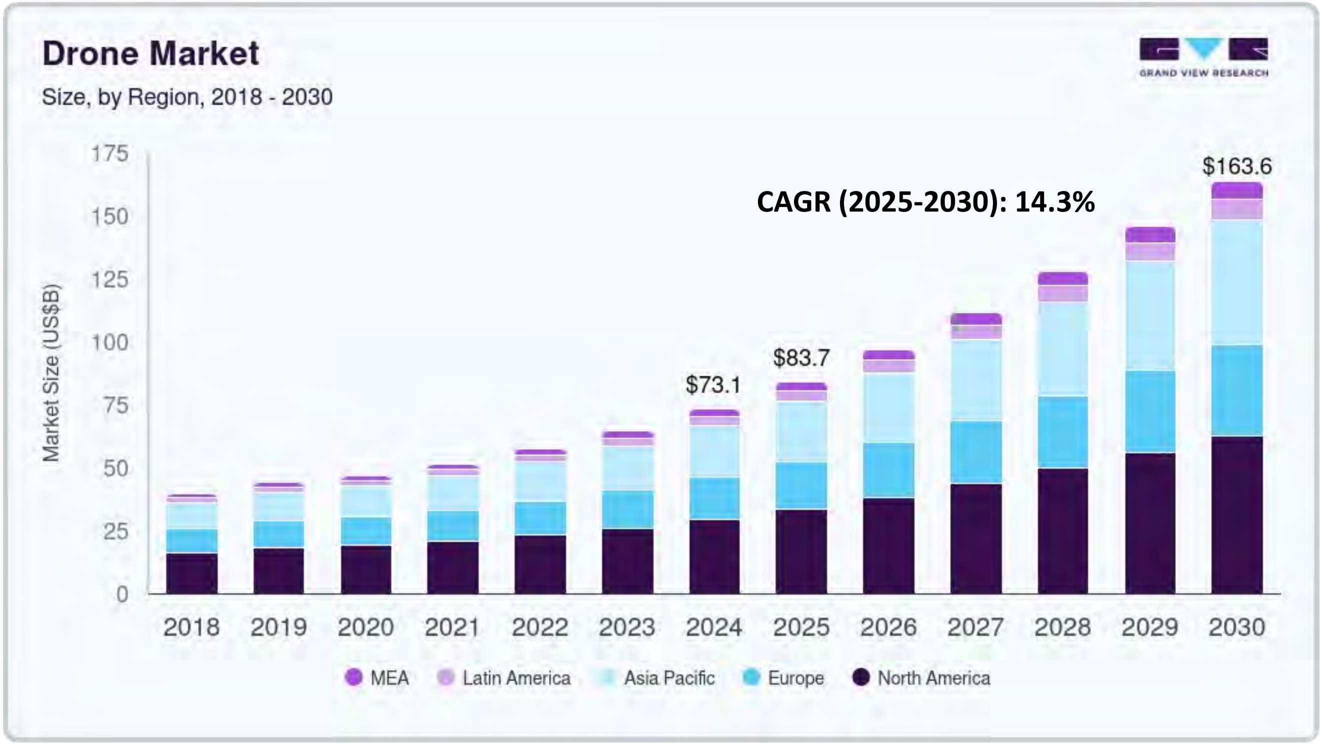
- Global drone market size is expected to surpass $100 billion by 2030, with ~14% CAGR.
- **North America** remains a dominant market, supported by favorable government regulations.
- **Europe** is also a key growth region, with countries like the UK and Germany leading in logistics and technological innovation, respectively.
- **Asia Pacific** is the fastest-growing market, driven by advancements in technology for Japan meanwhile while China's market grows due to strong manufacturing, significant investment, and favorable government policies.

Market Drivers:

- **Automation:** Autonomous flight and AI-powered tasks are reducing operational costs and increasing efficiency.
- **Data Acquisition:** Drones provide high-resolution, real-time data for industries like agriculture, construction, and energy inspection.
- **Military & Security:** Increasing demand for unmanned aerial vehicles (UAVs) for surveillance, reconnaissance, and combat operations.
- **Hardware Advancement:** Continuous improvements in battery life, imaging sensors, connectivity (including 5G and IoT) and LiDAR integration are expanding drone capabilities.

Trends:

- **Shifting Segments:** The commercial drone market is growing faster than the military segment, but the military sector remains dominant in terms of R&D and high-value components.
- **Drone-as-a-Service (DaaS):** Making drone technology more accessible to a broader range of businesses.



Source: Grand View Research

Market Ecosystem

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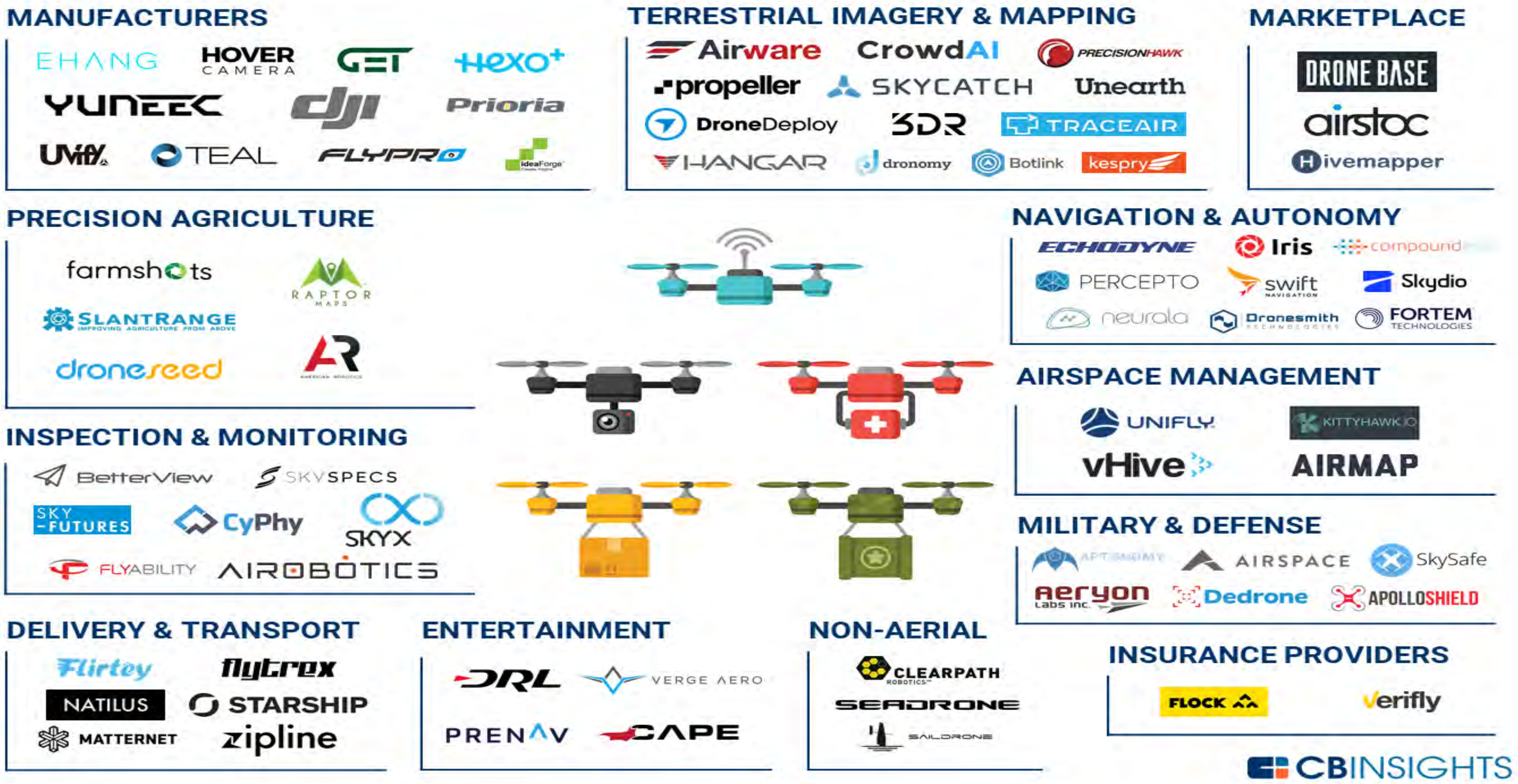

Source: https://www.cbinsights.com/research/drones-startup-market-map/

Drone Classification

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Consumer

Commercial / Industrial

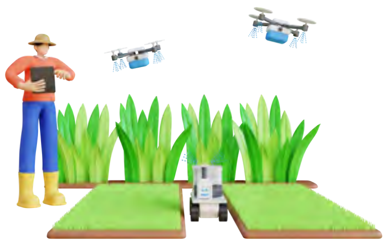
Military

Primary Use	Hobby, photography, light recreational use	Professional/commercial work	Defense, surveillance, tactical operations
Flight Time	20–40 min	30 min – 2 hrs (some fixed-wing > 5 hrs)	Several hours to > 24 hrs
Range	2–15 km	10–100 km	150–1,500+ km
Speed	40–80 km/h	60–160 km/h	100–300+ km/h
Payload Capacity	200 g – 1 kg	2–30 kg	50–1,000+ kg
Sensors	GPS, IMU, obstacle sensors	GPS, RTK GNSS, LiDAR, thermal, multispectral	Multi-band GNSS, SAR radar, SIGINT sensors
Navigation	GPS + visual positioning	GPS/RTK, AI object detection, pre-programmed routes	GPS + inertial navigation + anti-jamming
Battery Voltage	11.1–14.8 V (3S–4S LiPo)	14.8–44.4 V (4S–12S LiPo/Li-ion)	44.4 V and above for electric; higher voltages for hybrid systems
Battery Power Output	~100–500 W	~500 W – 5 kW	5 kW – 100+ kW depending on mission profile
Power Source	Battery only	Battery, hybrid battery–fuel cell, small combustion engines	Battery, hybrid, turbine/combustion engine
Regulation	Light regulation (hobbyist rules)	Licensed operation, commercial flight approvals	Strict national defense control

How Are Drones Being Deployed?

Precision agriculture

Soil monitoring
Spraying and seeding
Crop health monitoring



Military and Security

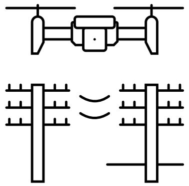
Real-time surveillance
National border monitoring
Combat operation

Disaster Management

Rapid assessment
Search and rescue
Critical supplies delivery

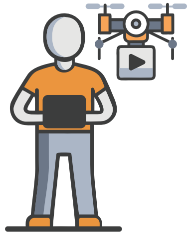
Urban Development

Mapping and planning
Infrastructure inspection
Environmental monitoring
Traffic management



Energy Infrastructure Inspection and Maintenance

Power lines
Wind turbines
Solar farms
Oil and gas



Commercial

Aerial videography
Logistics & goods delivery

Key Design Considerations

Power & Energy Efficiency *

- **Battery Limitations** – Li-ion/LiPo batteries have limited energy density; larger batteries add weight and reduce gains.
- **Propulsion System Efficiency** – Optimizing motor and propeller design for maximum thrust with minimal energy use.
- **Aerodynamics** – Reducing drag through better shape and weight distribution to extend flight time.

Flight Autonomy & Safety *

- **Obstacle Avoidance** – Sensors (LiDAR, radar, cameras) plus real-time processing
- **AI-based software –** For both drone & Ground Control Station (GCS)
- **Navigation Without GPS** – Using SLAM and vision-based navigation indoors or in GPS-denied areas.
- **Failsafe Systems** – Automatic return-to-home, emergency landing, and redundancy for critical components.

Materials & Structural Integrity

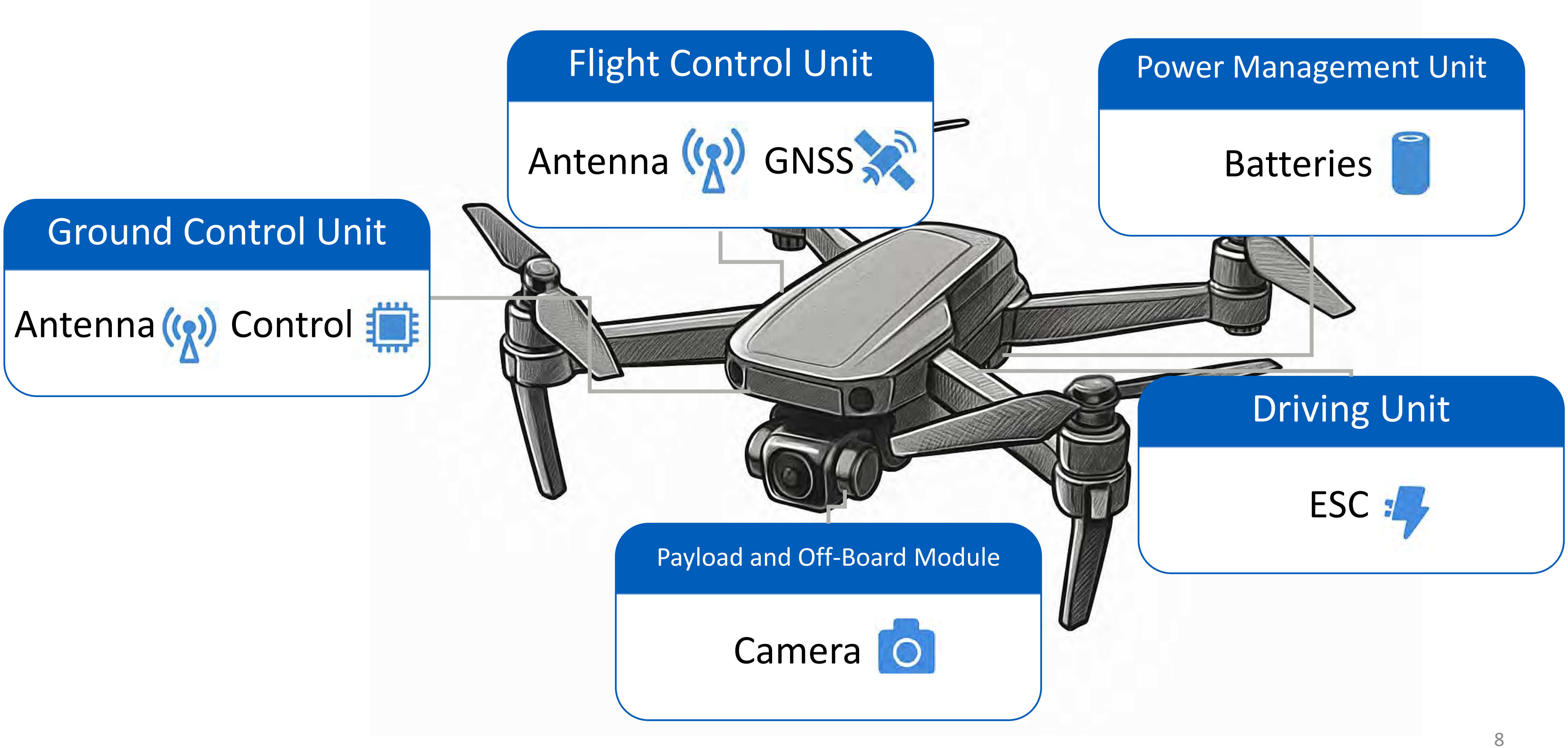
- **Weight vs. Durability** – Balancing lightness for longer flight with strength for crash resistance.
- **Material Trade-offs** –
  - Carbon fiber: Strong, light, expensive.
  - Aluminum: Strong, affordable, heavier.
  - Plastics: Light, cheap, less durable.

Payload & Thermal Management *

- **Payload Capacity** – Supporting payload weight without losing stability.
- **Heat Dissipation** – Cooling for motors, batteries, and processors to prevent overheating.
- **Modularity** – Swappable payloads for different missions (cameras, LiDAR, delivery pods).

*** RELL adds value by assisting with these key design elements.**

Drone Block Diagram with Solutions from Richardson Electronics



Richardson Electronics-Drone Design Solutions

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Ground Control Unit

Human Machine Interface
- MEMS Force Sensor

Communication & Connectivity
- RF Front End
- Antenna
- UWB Transceiver Module
- EMI/RFI Shielding

Flight Control Unit

Navigation & Sensing
- Inertial Measurement Unit (IMU)
- Inertial Navigation System (INS)
- Tilt Sensor

Communication & Connectivity
- RF Front End
- Antenna
- UWB Transceiver Module
- EMI/RFI Shielding

Microcontroller (MCU)

Payloads / Off-Board Modules

- LiDAR Sensor
- Gimbal Control
- Fertilizer Spray Tank
- Synthetic Aperture Radar (SAR)
- Electronic Warfare Payload
- Delivery Box
- Camera

Power Management Unit

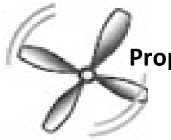
Power Management
- Power Management IC (PMIC)
- Current Sensor
- Magnetic
- Capacitor
- DC/DC Converter

Thermal Management
- Heatsink
- Thermal Interface Material

Battery Management
- Battery Management IC
- DC/DC Converter

Energy Storage
- Battery
- Ultracapacitor

Driving Unit



Motor

ESC & Motor Controller
- BLDC Motor Controller IC
- Power MOSFET
- Current Sensor
- Capacitor
- Magnetic
- EMI Filter

Thermal Management
- Heatsink
- Thermal Interface Material

RELL solutions

Payloads in which RELL solutions is applicable. Refer Appendix 1 for details.

MCU options are available, depending on the application and requirement.

Human Machine Interface

Human Machine Interface(HMI)

MEMS Force Sensor

Ground Control Unit

- Enable innovative human machine interface (HMI) and gapless industrial design.
- Add the element of “intent” to any touch surface.
- Highest sensitivity, linearity > 99%, lowest power, smallest form factor (1.3x1.3x0.22mm)
- Key advantages:
  - Environmental immunity: immune to moisture/water/ice/dust/RF/EMI
  - Work with any input: gloves/prosthetics/stylus
  - Material agnostic: works on glass, metal, plastic, etc.
- Target Applications on drone controller HMI: Buttons, sliders, smart surfaces, multi-level force sensing, display force support, XYZ measurement, wake up function.

Traditional design of drone controller can be upgraded with touch-sensitive Qorvo HMI force sensor

Communication & Connectivity

Communication & Connectivity

RF Front End

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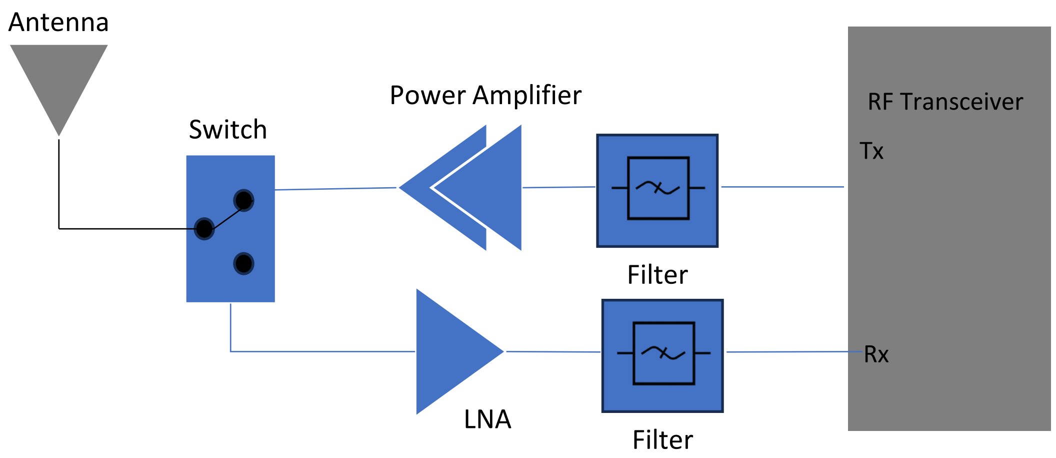
Ground Control Unit

Flight Control Unit



- Enables reliable communication & control between drone and ground station
- Typical frequency bands for drone: ISM bands, 2.4GHz, 5.8GHz, licensed bands.
- RF front end key components: Power Amplifier(PA), Low-Noise Amplifier(LNA), Filter, Switch
- Featured Qorvo components:
  - LNA: QPL9504, QPL9058
  - Power Amplifier Driver: QPA9126, QPA9127
  - GaN PA: QPA0106
- Advanced drone features can be achieved with RF front ends, i.e.
  - Beamforming & phased arrays equipped drone.
  - Software defined radio(SDR) UAV.

Communication & Connectivity

RF Front End – Low Noise Amplifier

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Ground Control Unit

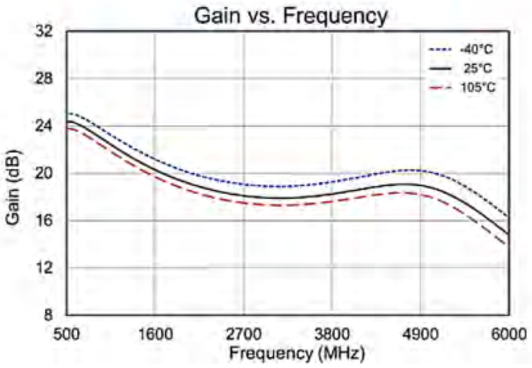
Flight Control Unit

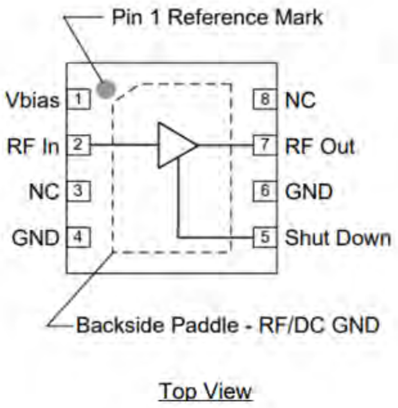
Wideband, Ultra Low Noise, High Gain LNAs

Product Features

- Best-in-class NF performance
- Wideband, 50Ω matched
- > 20dB gain across 1.5-6.0GHz
- 1.8V TTL control for shutdown
- Maintains OFF state under high drive
- <1us switching speeds

QPL9058 Gain vs. Frequency





P/N	Freq	Gain 0.9G	Gain 1.9G	OIP3 0.9G	OIP3 1.9G	NF 0.9G	NF 1.9G	P1dB 0.9G	P1dB 1.9G	Vdd	Idd	Pkg
	(GHz)	(dB)	(dB)	(dBm)	(dBm)	(dB)	(dB)	(dBm)	(dBm)	(V)	(mA)	(mm)
QPL9504	0.6-6.0		21.5		34.5		0.70		18	5	50	2 x 2
QPL9058	1.0-5.0	22	18	35	35	0.4	0.6	18	21	5	57	2 x 2

Communication & Connectivity

RF Front End – Power Amplifier Driver

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Ground Control Unit

Flight Control Unit

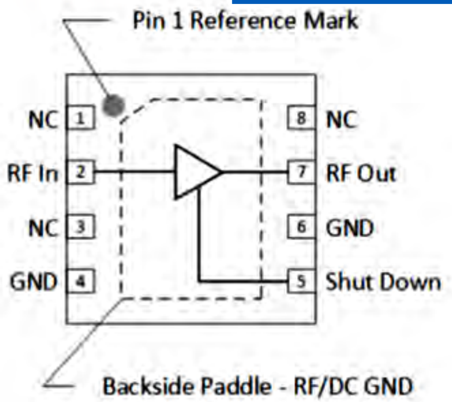
High Linearity Gain Block Amplifiers

Product Features

- 1-6GHz
- 50 Ω matched RF input and output
- 20dB gain
- +35dBm output IP3
- +20dBm P1dB
- +5V single supply with DC shutdown

Benefits

- High gain and high linearity
- Internally matched to 50 Ohms
- Power down control pin
- 1.8V logic level compatible



P/N	Freq (GHz)	Gain (dB)	OP1dB (dBm)	OIP3 (dBm)	Voltage (V)	Current (mA)	Pkg (mm)
QPA9126	1-6	16	+20	+35	5	70	2 x 2
QPA9127	1-6	20	+20	+35	5	70	2 x 2
QPA9442	0.6-5	17	+30	+46	5	235	4 x 4
QPA9119	0.4-4.2	17	+27	+44	5	137	3 x 3

Communication & Connectivity

RF Front End – GaN Power Amplifier

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Ground Control Unit

Flight Control Unit

QPA0106: 1GHz – 6GHZ GaN PA

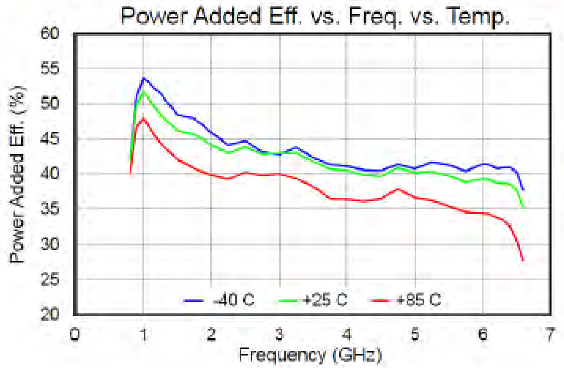
Product Features

- Frequency: 1 – 6 GHz
- P_{SAT}: 18W
- PAE: 38 – 50 %
- LSG: 24 dB
- Bias: 22V

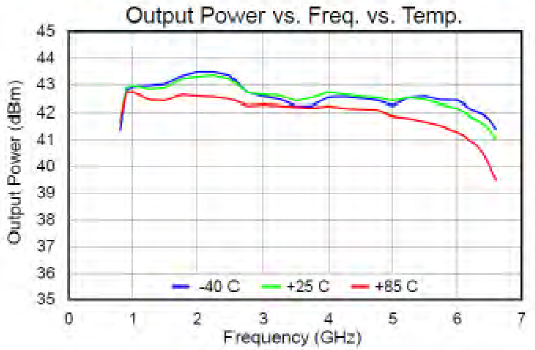
Benefits

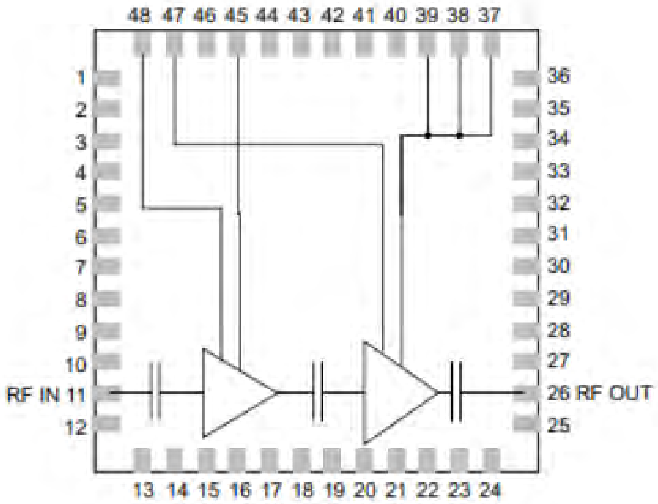
- Flat Wideband Saturated Power
- Excellent Efficiency
- High Large Signal Gain
- QFN SMT Package

QPA0106 Power Added Eff. Vs Freq. vs Temp.



QPA0106 Gain vs. Frequency





Top View

Communication & Connectivity

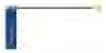
Antenna

Ground Control Unit

Flight Control Unit

ISM

- Telemetry & control links
- To cover up 433, 868, 915 MHz
- SMD and cable assembly with compact size


PCB+cable

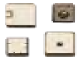
Enclosure


Chip

GNSS

- Positioning & navigation of drones
- To receive satellite signal for positioning
- Low AR(axial ratio)
- To cover up GNSS L1, GNSS L2, GNSS L5 and RTK Inmarsat
- Good isolation in stacked patch


FPCB


Patch


Embedded Active


External Active


Chip


LDS+carrier

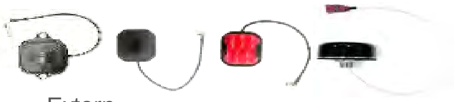
Cellular LTE/4G/5G

- BVLOS(Beyond Visual Line of Sight) drone operations
- To transmit & receive cellular 4G LTE, 5G signals
- High efficiency in a small size


PCB+cable


Carrier


Chip


External

Available as 2 in 1 Antenna

- Multi-band GNSS and LTE Antenna design in one case
- Good isolation between with LTE and GNSS Antenna

Bluetooth / WiFi

- Bluetooth: for short range pairing/configuration
- WiFi: short to medium range drone communication
- To communicate portable device / IEEE 802.11 b/g/a/n communication
- Compact size / SMD type

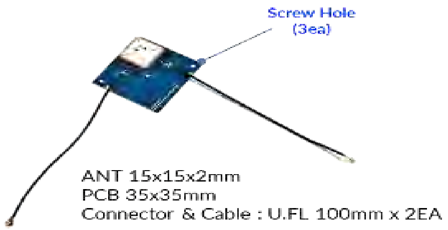

Chip


Carrier


Metal stamping


FPCB


PCB+cable



WIFI6E 2x2 MIMO with cable & connector


WIFI6E 2x2 MIMO Patch Antenna (15x15x2mm, SMD)

UWB

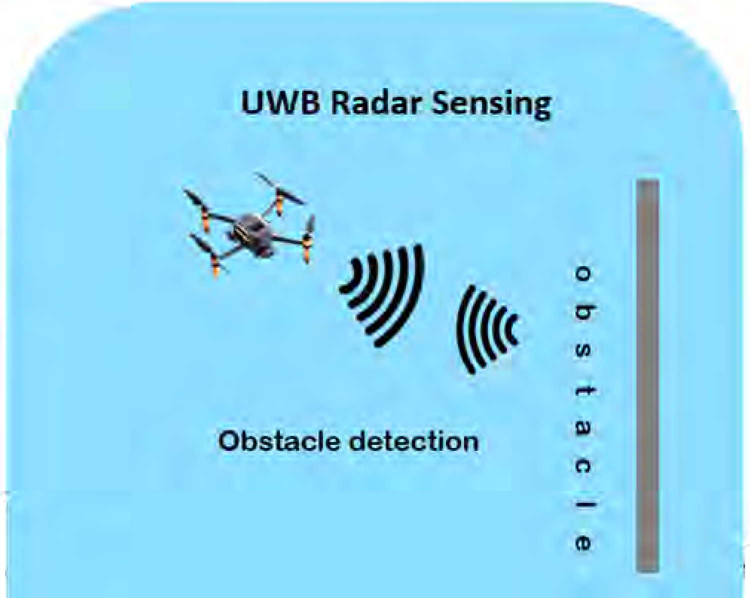
- Indoor drone navigation, collision avoidance
- Circular polarization antenna for UWB anchor
- Compact size / SMD type

Communication & Connectivity
UWB Transceiver Module

3D accurate positioning in real time & radar

QM35825: UWB Low , 6.5 & 8.0 GHz SoC compliant with IEEE 802.15.4z™-2024

- UWB radar for automated obstacle detection significantly preventing crashes
- Drone 3D location is determined in real time using fixed UWB anchors on the ground, achieving accuracy of ±5 cm and ±2° angle.
- Real time location enables :
  - "Find My Drone" localization (hidden in vegetation after landing) – QPG6200 needed for BLE out of Band pairing with smart phone.
  - Flight control feedback loop in case of wind drift for automated & stabilized flight
  - Swarm of drones : drone to drone precise 3D real-time positioning (drone choreography with accurate positioning)
  - Automated return to base & safe landing indoor

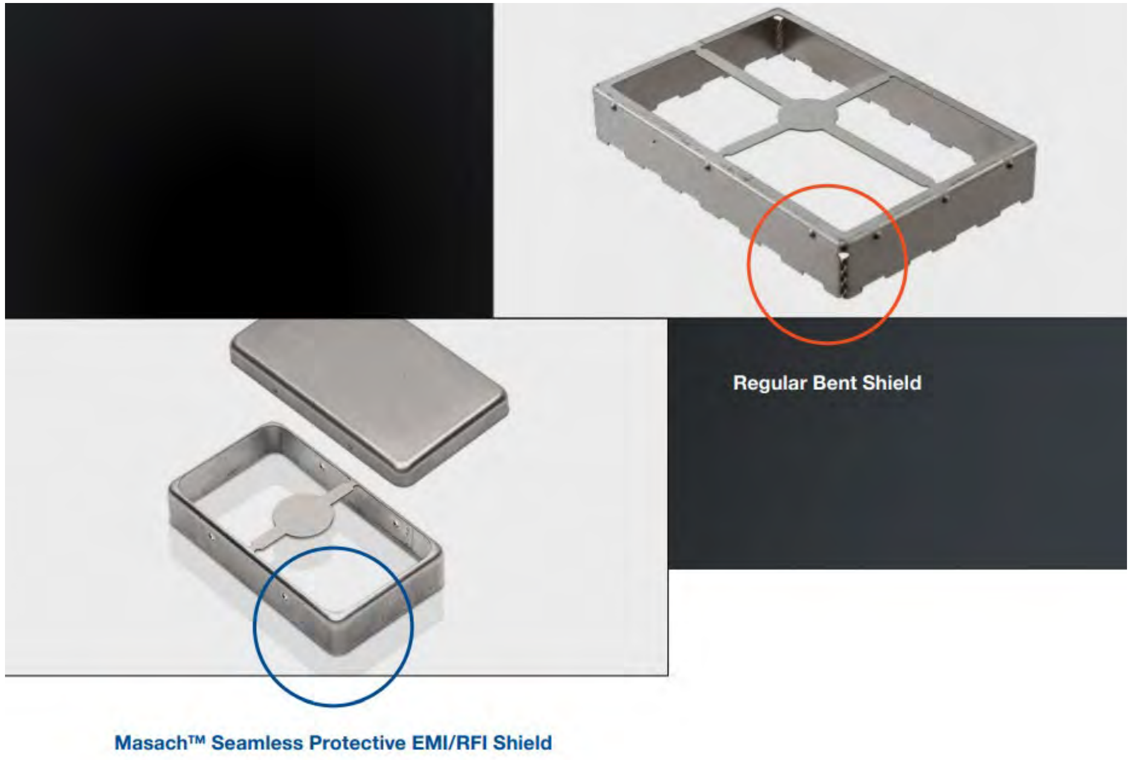


Ground Control Unit

Flight Control Unit

Communication & Connectivity

EMI/RFI Shielding



Why EMI/RFI Shielding is required in drone?

- **Miniaturization and Density:** Drone components are small and densely packed, results in internal signals interfering with one another. EMI/RFI shielding **prevents this crosstalk between adjacent circuits.**

Ground Control Unit

Flight Control Unit

- **Mission-Critical Protection:** Protecting drone vital systems, such as flight control , navigation and payloads from internal & external interference.

- **Stable communication links:** Ensure **uninterrupted communication links** between drone and ground control unit.

Features & Benefits:-

- Seamless Protective Cage for higher shielding effectiveness.
- Optimal Planarity for higher yield on reflow soldering
- Solid Construction to resist dents and warps
- Two-piece Shield Design enables to repair components without removing the shield, saving time and reducing repair damage.

Masach Tech is certified AS9100 standard, which is a necessary requirement for military drone.

Navigation & Sensing

Navigation & Sensing

IMU, INS, Tilt Sensor

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Flight Control Unit

Product	Use Case in Drone
Inertial Measurement Unit (IMU)	• Provides calibrated 3D acceleration and angular rate for navigation and attitude. • Necessary for flight stabilization and motion tracking.
Inertial Navigation System (INS)	• Combines IMU + GNSS with sensor fusion algorithm to provide optimized position-velocity-time + attitude measurement for L2-L5 navigation and safety. • Used for autonomous navigation and Beyond Visual Line of Sight(BVLOS) flights.
Dynamic Tilt Sensor	• Combines accelerometer, gyro and temperature sensor w/advanced calibration and algorithms to provide accurate pitch and roll in dynamic situations. • Ensures stability, level flight, and safe landing. • Critical for hovering, take-off, and obstacle avoidance.

Navigation & Sensing

IMU, INS, Tilt Sensor

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Flight Control Unit

IMU383ZA

- Triple redundant sensor architecture for ultra-high reliability
- 6DOF
- High performance (1.3 deg/hr, 0.08 deg/root-hr)
- Interface: SPI/UART

MTLT335D

- Triple redundant sensors with fault detection
- 6DOF
- Interface: CAN2.0 and RS232

OpenIMU335RI

- Triple redundant sensors with fault detection
- 6DOF(9DOF optional)
- Interface: CAN2.0 and RS232
- Open-Source Tools

INS401 / INS402

- INS with multi-band RTK/ GNSS receiver
- Triple-redundant inertial sensors, and Positioning Engine.
- Single (INS401) and Dual (INS402) antenna versions available
- Interface: Ethernet, UART, SPI and CAN

Power Management

Power Management IC

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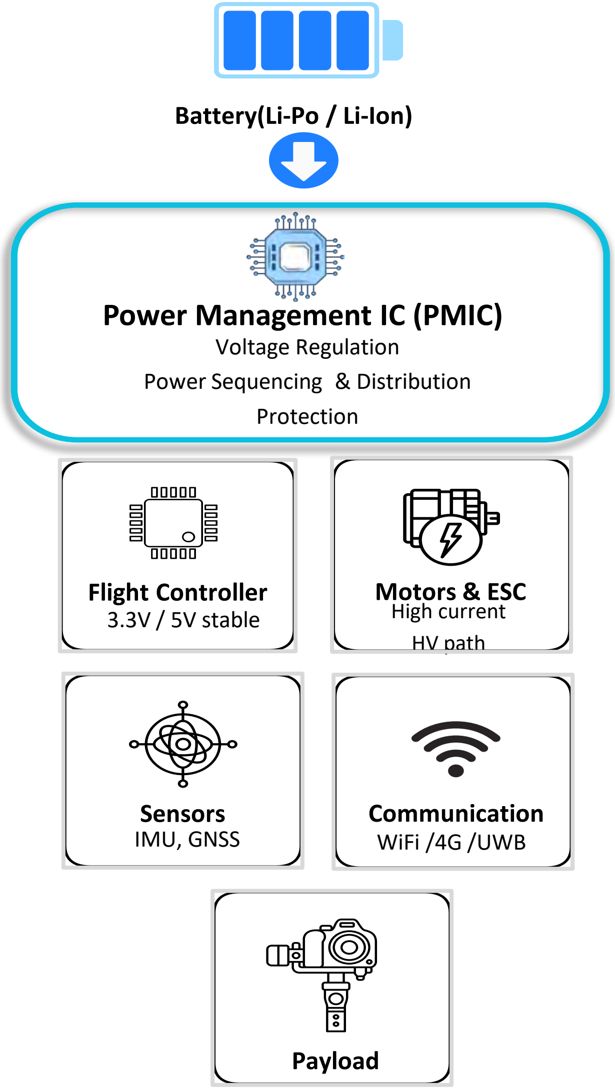
Power Management Unit

Drone Power Tree



PMIC ensures efficient energy conversion → stable flight, longer battery life, and safer drone operation.

Voltage Regulation

- Converts battery voltage into stable DC voltage rails
- Ensures flight controller & sensors run reliably

Power Sequencing & Distribution

- Activates critical systems first (flight controller, sensors)
- Delays non-essential payloads
- Prevents inrush current & improves efficiency

Built-in protection

- Prevents damage from high or low battery voltage
- Stops excess current or short-circuits
- Shuts down if overheating occurs

Qorvo's Power Management ICs (PMICs)

- Reduce cost & size with integrated power management.
- Shorten time-to-market.
- Add flexibility through programmable features.
- No custom firmware needed – configure via I²C + ActiveCiPS™ dongle.

Power Management

Power Management

Power Management IC

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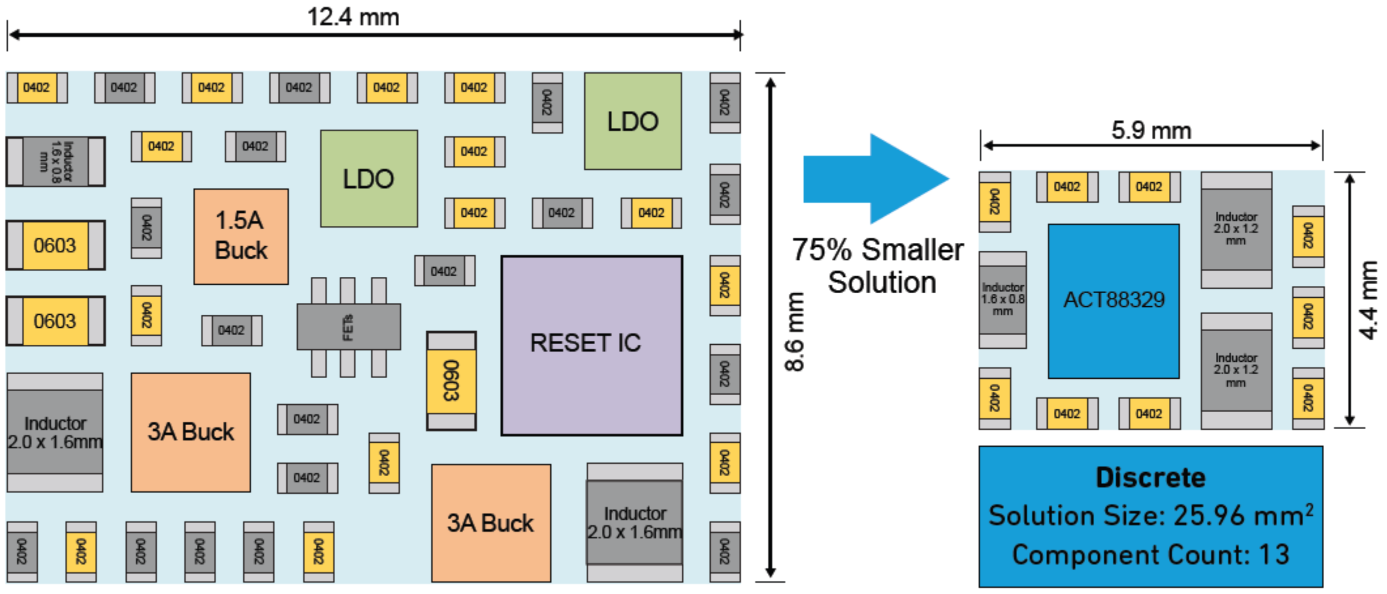
Power Management Unit

ACT88329

ActiveCiPS is not just reduction of external components but also:

- Configurable via I2C current limits
- Adjust GPIO functionality
- Adjust current limits and other protection features during system development
- Multi-time programmable
- Customer developed startup and shutdown configurations



Discrete
Solution Size: 106.64 mm^2 • Component Count: 46

* All components size in scale with 0.5mm clearance.

The diagram above illustrates a typical size reduction achieved through the use of Qorvo's innovative, configurable power supply solutions.

Power Management

Power Management IC

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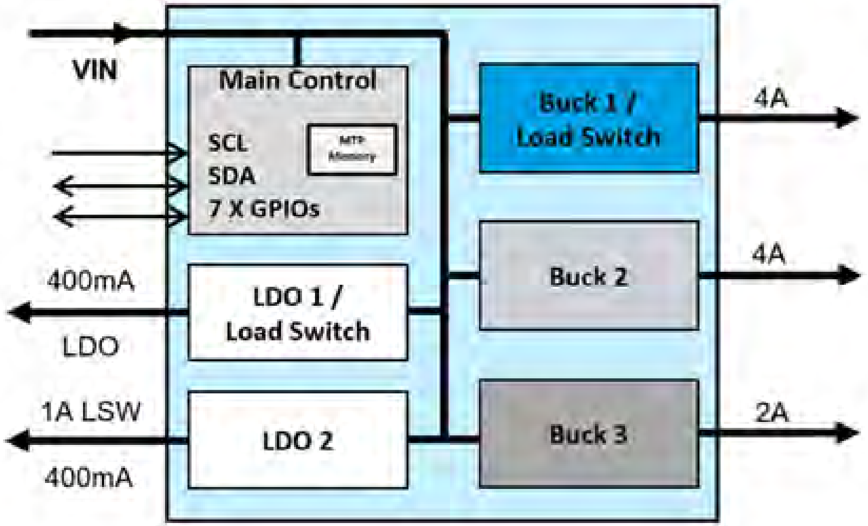
Supporting PMIC for QM35825 UWB Solution

Reference Design Available

Power Management Unit

ACT88329: Five Rail, Fully Configurable, Small WLCSP Package PMIC

- Optimized Transient Performance with COT Control
- 2x 4A Bucks, 1 x 2A Buck
- All Buck Work with 0.47uH Inductor /22uF caps.
- 2x 390mA LDOs
- 7 Programmable GPIOs
- Multi-time Programmability with Integrated I2C Interface for Monitoring & Control



System Performance Comparison between ACT88329 and Discrete Solution

Power Solution	Max I_battery Rx (mA)	Max I_battery Tx (mA)	Sensitivity (dBm)	PER (%)
ACT88329	117	150	-96.5	0.9
Discrete	177	204	-96.6	1.0

Power Management

Power Management IC

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Provides configurable options to manage power for Drones requiring high voltage rail counts

ACT88760: Dual-Phase Bucks, High PSSR LDOs, 13 voltage rail PMIC

- ACT88760 can support 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 need only 3 external components (each) to operate
- Each block is highly configurable

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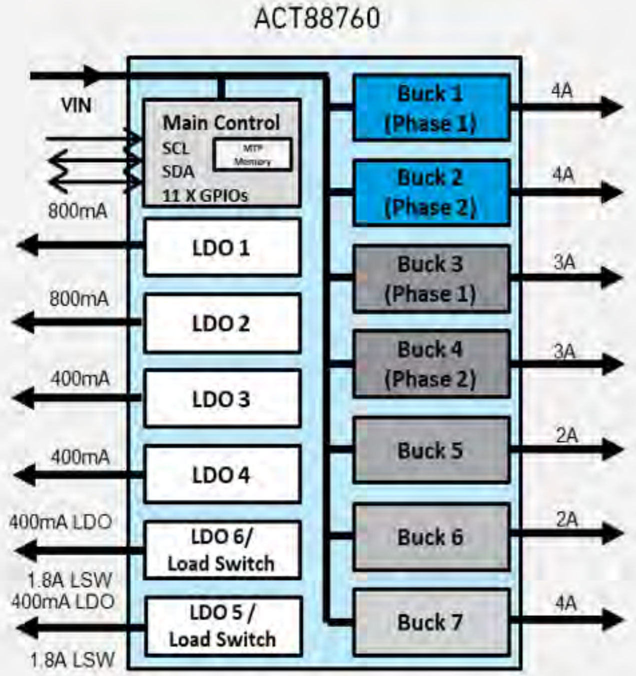
Power Management Unit



Power Management

Current Sensor

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Power Management Unit

- Essential in drones for monitoring, protection, efficiency, and telemetry to ensure safe flights and optimal battery usage.
- xMR current sensor combine **accuracy**, **efficiency** and **compact size** which fits for drone application. (xMR = magneto-resistive)

XMR current sensor vs other technologies

ACEINNA xMR vs Hall Effect

- Higher bandwidth, lower phase shift
- Faster response time
- Lower offset and Noise
- Better accuracy

ACEINNA xMR vs Current Transformer

- Response to DC and AC
- No core saturation effects
- Smaller size
- Simpler to design

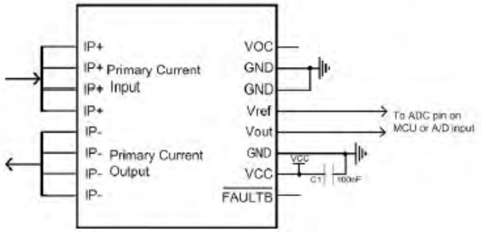
ACEINNA xMR vs Shunt Resistor

- Inherent isolation
- Lower power loss
- Less components, space savings
- Simpler solution

<u>Aceinna MCx1101 & MCx2101</u>

Bandwidth : 1.5MHz(3dB) MCx1101
5.0MHz(3dB) MCx2101
Gain Type : Fixed or Ratiometric Gain
Package : SOIC
Current Range Options: ±5A, ±20A, ±50A, ±65A
Supply Voltage Option: 3.3V, 5.0V

Evaluation board available for rapid prototyping



Power Management

Current Sensor

MCx1101

Power Management Unit

Features

Production

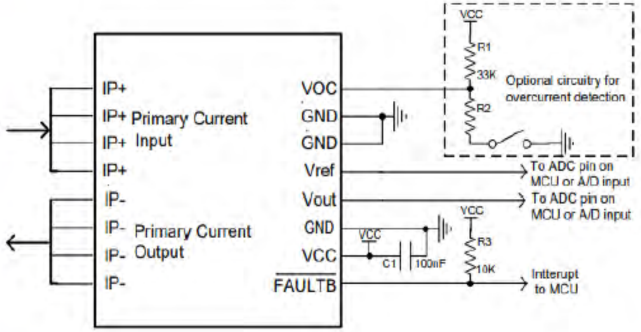
- 5MHz bandwidth
- 80ns output response time
- 2% accuracy
- 35 µA/√Hz noise density
- UL/IEC/EN62368-1 certified
- 1118 Vrms basic isolation and 4.8kV dielectric isolation
- Ratiometric and Absolute gain options
- ±5, ±20, ±50, ±65A, 3.3V and 5V, SOIC-16 package
- -40 to +105°C operating temperature range

Applications

- Motor drivers, inverters and servo drives
- AC-DC power systems (PFC)
- Solar panel inverters
- Data center/Server power supplies
- Uninterruptible power supplies (UPS)
- Battery management and protection
- Audio amplifiers

Benefits

- High bandwidth for fast switching SiC/GaN
- Low phase delay for fast and stable power control
- Fast output response for optimum overcurrent protection
- High accuracy
- Low noise density for high SNR
- Isolated, bidirectional AC or DC current measurement
- Dedicated pin for overcurrent fault detection
- Low primary resistance (0.9mOhm)



Power Management

Magnetics

SESI Series

Magnetics | **Power Inductors**

CCM Series (Chameleon Concept Magnetics)

Magnetics | **Power Inductors**

Overmolded Nanocrystalline Toroids

Magnetics |

Common Mode Chokes

CUSTOM EXAMPLE

Dual Active Bridge Transformer

Magnetics | **SMPS**

CUSTOM EXAMPLE

<u>Magnetics Application:</u>

- **Energy Conversion:** Inductors enable efficient buck/boost DC/DC conversion.
- **Filtering:** Reduces noise & ripple, ensures clean voltage rails for sub-system in drone.
- **Isolation & Safety:** Transformers provide galvanic isolation in HV paths.
- **Miniaturization:** Compact CCM & SESI Series inductors handle high currents in small footprints.
- **High Reliability:** Aerospace-grade magnetics designed for shock, vibration & high temperature.

<u>Product Series:</u>

- SESI & CCM Series inductors → energy storage & efficient DC/DC conversion.
- Nanocrystalline Toroids (chokes) → EMI filtering & noise suppression.
- DAB Transformer → for galvanic isolation and bidirectional power transfer.

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EXXELIA

Power Management Unit

Driving Unit

Exxelia is EN 9100 certified, and the magnetic components are designed to meet MIL-STD.

Power Management

Capacitors

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EXXELIA

Power Management Unit

Driving Unit

Capacitors Application:

- **Energy Storage:** Supplies short bursts of current to motors/ESCs.
- **Voltage Smoothing:** Works with inductors for stable DC/DC output rails.
- **Decoupling:** Filters high-frequency noise → protects sensitive IMU, GPS, comms.

Key Highlights:

- Designed to operate from –55 °C to +150 °C, withstanding altitude, shock, and vibration.
- Certifications: Meet MIL-PRF, EN9100, and NADCAP aerospace standards → trusted for defense and avionics applications.

Product Series

- **MML**:Light weight,high energy density film capacitors for PMUs/DC-DC
- **PM90X**: High-capacitance power film capacitors for DC-link & propulsion
- **CT79 / CT79E**: Wet tantalum, MIL-qualified; robust for avionics & defense drones
- **PPA**: High-voltage filtering film capacitors for PMU smoothing
- **PRORELISIC 125**: Axial capacitors, reliable at up to 125 °C
- **880P / 882P**: Stable film capacitors for avionics & signal-critical circuits

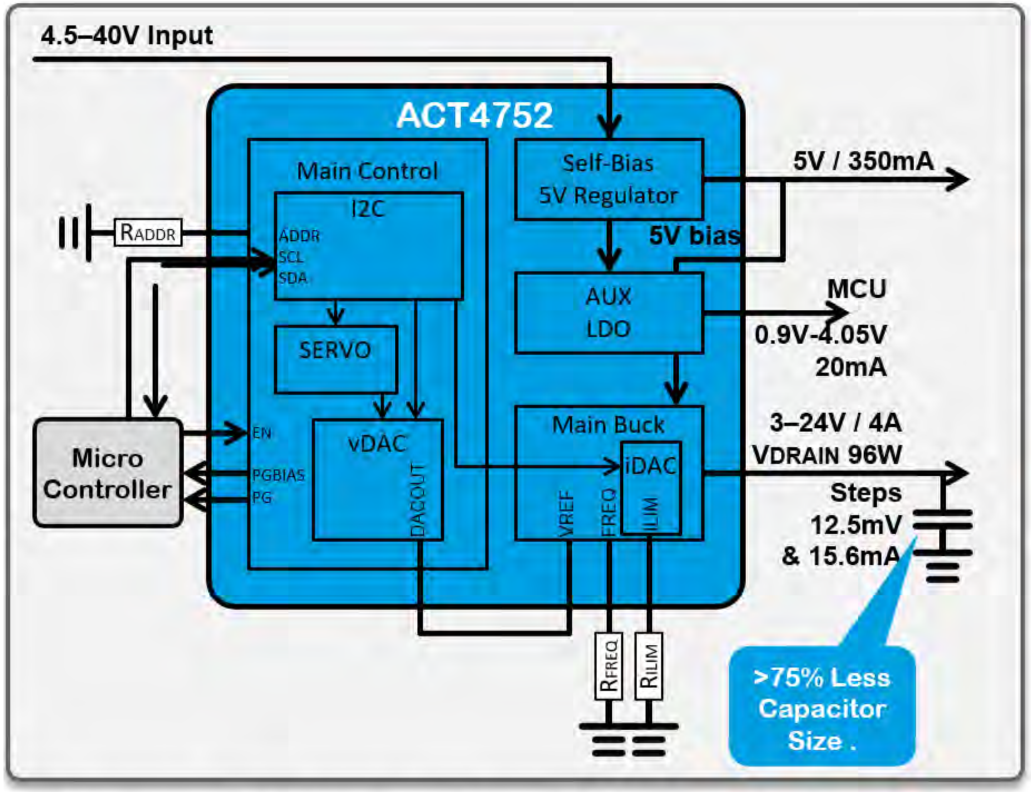
Power Management

DC/DC Converter

Use Case: As an external DC/DC when PMIC rails are insufficient

ACT4752

96W/40VIN, Industrial CC/CV Regulator, with low-power self-biasing



Thermally Enhanced 5 mm × 5 mm QFN Package

✓Optimized for small sized MLCC caps.

- Eliminates the need for expensive large Aluminum Caps.
- Integrated FETs for small FF design.
- 2 additional rails available for MCU and Peripherals

✓Low Noise for Sensitive RF Power Supply

- Sync to external clock or internal oscillator (450KHz-2.25MHz) for reduced noise and EMI
- Multiple EMI Configurations via I²C
- Spread spectrum

✓Programmable Output

Full Control via I²C.

- Voltage Range: 3 – 21V in 12.5mV Step
  Current Range: 0 – 4A in 256 steps of 15.6mA
- Factory-Programmed Defaults,
  with *Optional* I2C On-the-fly Control
- iDAC for precise current limit.

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qorvo

Power Management Unit

Thermal Management

Thermal Management

Richardson Electronics
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WAKEFIELDTHERMAL

Key components in drone that need thermal management:-

Motors and Electronic Speed Controllers (ESCs): Generate intense heat especially during high-load operations, long flights, or when carrying a heavy payload. Inadequate cooling can lead to reduced motor efficiency, degraded performance, or even motor failure.

Batteries: Li-Po batteries generate significant heat during charging and discharging. Thermal management is required to manage the lifespan and mitigate the thermal runaway risk, which is of critical safety concern.

Flight Controller Unit: High computational load generates a substantial amount of heat, which can lead to performance throttling or system instability if heat is not properly dissipated.

Payload Modules: Any additional sensors or equipment (e.g., thermal cameras, LiDAR, or chemical sensors) can generate their own heat, which must be accounted for in the drone's overall thermal design.

Thermal management techniques:-

Passive Cooling Systems:

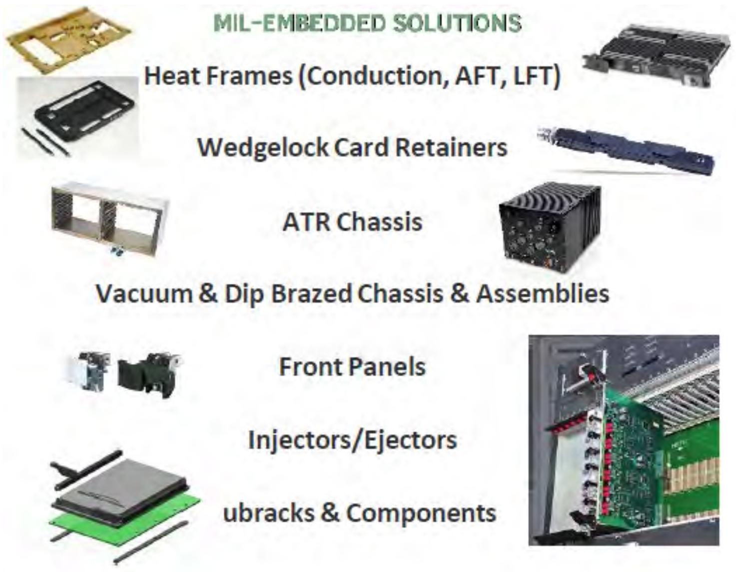
- Heatsinks
- Thermal Interface materials(TIMs)
- Heat Spreaders
- Phase Change Materials(PCMs)

Active Cooling Systems:

- Fans
- Thermoelectric Coolers
- Liquid Cooling
- Heat Spreaders
- Phase Change Materials(PCMs)

Hybrid Cooling Systems:

- Heatsinks and fans combination



Flight Control Unit

Power Management Unit

Driving Unit

Battery Management

Battery Management

Battery Management IC

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qorvo

Power Management Unit

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

PAC22140 & PAC25140: 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 50MHz ARM M0 32kB Flash/8kB SRAM
- PAC25140 150MHz ARM M4F 128kB/32kB SRAM

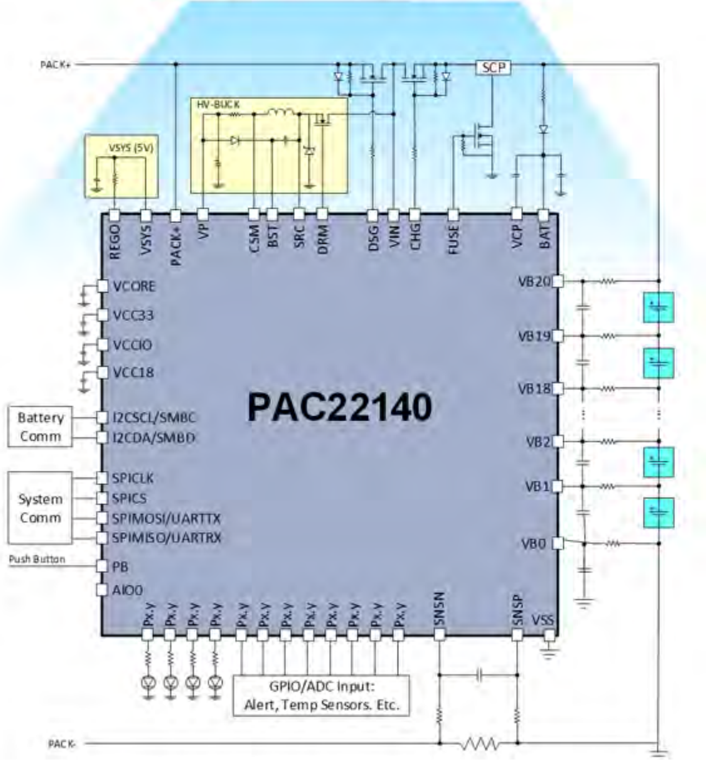
Complete Power Solution

- 145V DC/DC Buck
- 5V 225mA
- 3.3V 90mA
- MCU Vcore

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

Single IC required for complete BMS solution



Energy Storage

Energy Storage

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Power Management Unit

Drone Battery Types

	Lithium Polymer (LiPo)	Lithium-Ion (Li-ion)	Lithium Iron Phosphate(LiFePO4)	Solid-State Batteries
Nominal Voltage (per cell)	3.7V	3.6-3.7V	3.2V	3.7-4.2V
Energy Density(Wh/kg)	150-220	200-265	90–160	300-500
Discharge Rate(C Rating)	High(20-75C)	Medium(2-10C)	Medium(10-25C)	Medium(5-290C)
Weight Efficiency	★★★★☆	★★★★☆	★★☆☆☆	★★★★★
Typical Life Cycle	150-300	300-500	1500-3000	500-1000+
Safety	Low (Risk of thermal runaway if not handled safely)	Medium (Generally safer than LiPo; less prone to swelling)	High(Highly stable chemistry, very low risk of thermal runaway)	Excellent (Significantly reduced risk of thermal runaway/fire)
Common Form Factor	Pouch cells (Flexible for custom packs)	Cylindrical (e.g., 18650, 21700), some pouch cells	Cylindrical, prismatic, sometimes pouch cells	Thin-film, pouch, or custom-shaped cells
Common Use Cases	FPV racing drones, aerial photography drones needing bursts of power	Long-endurance inspection, mapping, surveillance, logistics drones	Agricultural drones, industrial drones, delivery drones where safety is critical	Advanced long-endurance, high-safety industrial drone
Key Advantage	High power delivery, good power-to-weight ratio	Longer flight times due to higher energy density	Exceptional safety, very long lifespan, high stability	Superior safety, potential for breakthrough in energy density
Key Disadvantage	Requires careful handling, lower energy density than Li-ion for endurance	Generally lower peak discharge rates than LiPo	Lower energy density (heavier for the same capacity), lower nominal voltage per cell	Expensive, still under development for mass drone adoption

RELL can support the above battery types – standard or custom battery cell or module.

Energy Storage

Combining battery & ultracapacitor for hybrid power supply system

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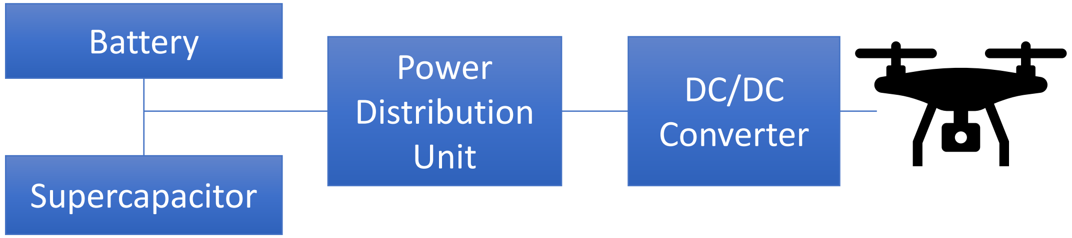
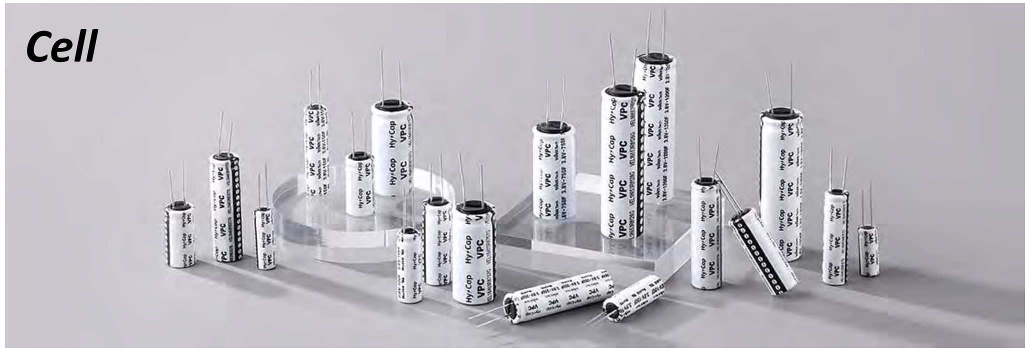
VINATech

Power Management Unit





Module

Why Hybrid?

- **Batteries:** High energy density, but limited peak current and cycle life.
- **Ultracapacitors:** Ultra-high power density, rapid charge/discharge, long cycle life, but low energy density.
- **Benefit:** Supercap handles sudden spikes; battery delivers sustained energy.

Key Applications in Drones

- **Takeoff & Climb:** Supercap supplies burst power, reducing battery stress.
- **Maneuvers & Wind Gust Rejection:** Immediate high-current response.
- **Emergency Power:** Brownout protection for flight controller & communication systems.
- **Regenerative Capture:** Absorbs energy during prop braking or rapid descent.

ESC & Motor Controller

ESC & Motor Controller

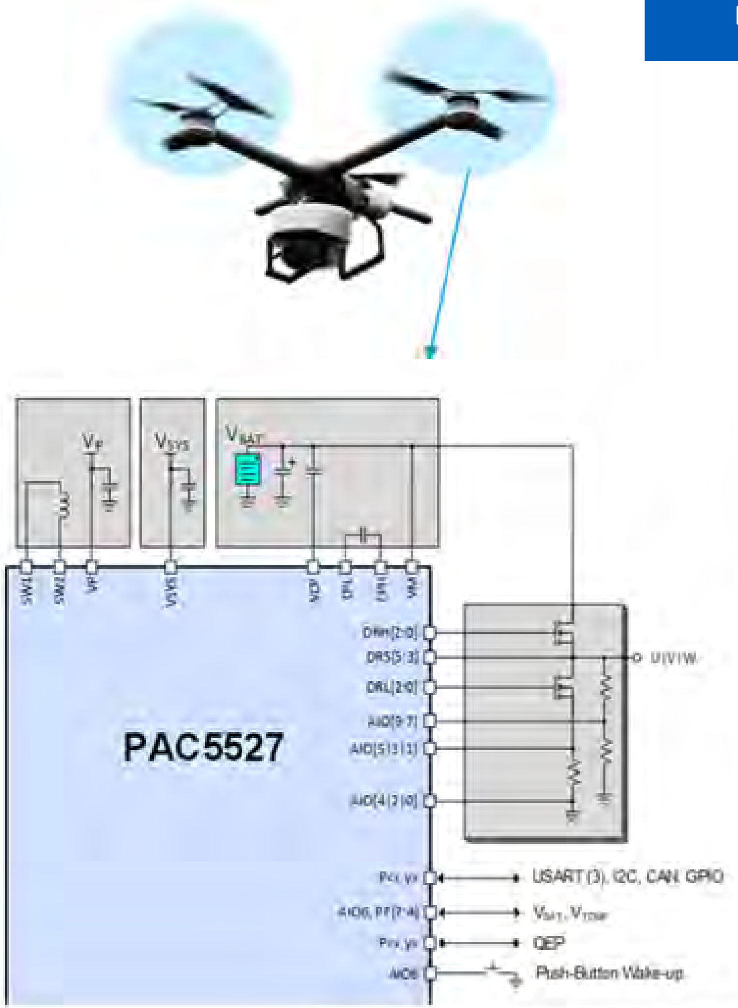
BLDC Motor Controller IC

Provide precise and efficient control for ESCs and payload wenches

PAC5527: 48V BLDC Motor Controller and Driver with Charge Pump and Configurable AFE

- 150MHz Arm® Cortex®-M4F with 128kB FLASH, 32kB SRAM with ECC 16 x 3.3V IO
- 6V - 48V Supply Input
- Charge Pump DC/DC for HS Gate Drive
- Buck-Boost DC/DC for LS Gate Drive
- 3 x Differential, 4 x Single-Ended PGAs
- 6x6mm, 48-pin QFN

Electronic Speed Control



Driving Unit

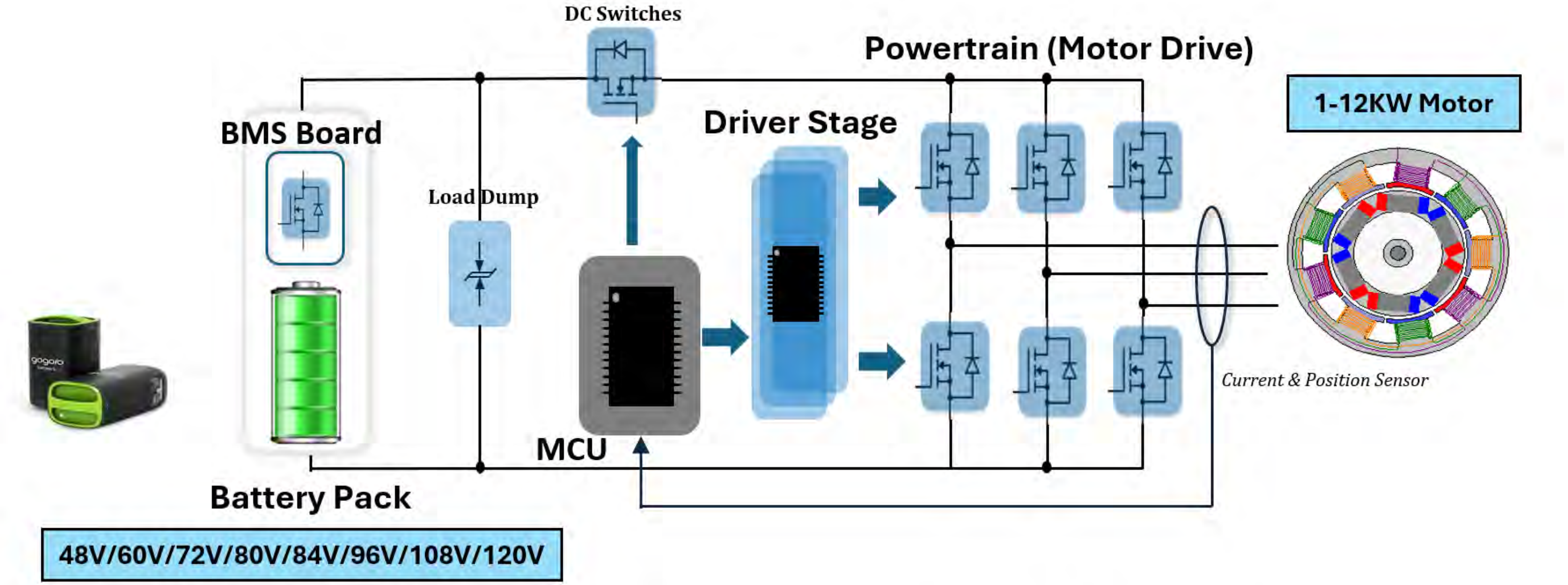
ESC & Motor Controller

Power MOSFET

Patented SuperQ™ technology 150V & 200V MOSFETs

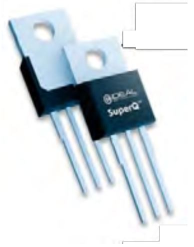
- ✓ Industry’s lowest on-resistance
- ✓ Robustness under fault conditions
- ✓ Optimized gate design for wide SOA

Driving Unit



iS15M7R1S1C

150V, 6.4mΩ max, N-Channel MOSFET in PDFN 5x6mm package



iS20M028S1P

200V, 25mΩ max, N-Channel MOSFET in TO-220 package

BMS + DC Switches – Optimized for low Rds,on, Linear operation, Wide SOA, Ruggedness

Motor Drive Switches – Optimized for Ruggedness, Low Rds,on and High Current Rating, Low Switching Loss

ESC & Motor Controller

EMI Filter

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AMO
AMOTECH

Driving Unit

Functions:

✓ Reduces EMI noise generated from complex electronic system including ESC, motor and MOSFET.
✓ Prevent malfunctions and ensure reliable operation of drone.
✓ Ensure drone design is meeting the electromagnetic compatibility(EMC) standard.

General part (Pin to Pin)

◈ ESD Suppressor

- Size : 1.0X0.5mm / 1.6X0.8mm
- Part name : AIES
- Strong point : Open mode, Ultra low cap (0.1pF ↓)

◈ CMF

- Size : 1.2X1.0mm(2ch) / 2.0X1.2mm (4ch)
- Part name : AHFE
- Strong point : Small package, high attenuation

◈ ESD Varistor

- Size : 1.0X0.5mm / 1.6X0.8mm
- Part name : AVMC
- Strong point : High temperature – 125℃

Customized part

◈ Wideband EMI ESD filter

- Size : 1.6X0.8mm(1ch) / 2.0x1.2mm (4ch)
- Part name : ASF (1ch) ADF (4ch)
- Strong point : High Performance , ESD protection

◈ Differential line ESD filter

- Size : 1.2X1.0mm / 2.0X1.2mm
- Part name : AHFE (Common mode)
  : ADMF (Differential mode)
- Strong point : Small package, ESD protection

※ AEC Q200 compliance

▣ Features

【 Wideband EMI Solution 】

* Various Sizes
* High Current
* Low ESL
* RoHS Compliant

▣ Product Family

Part Number	Size EIA (inch)	Size JIS (mm)	WVDC (V)	Rated Current	Capacitance
AFC16S03A22MCD	0603	1608	16	1A	0.022uF
AFC16S03A104MPD	0603	1608	16	2A	0.1uF
AFC25S06C155MPL	1806	4516	25	6A	1.5uF
AFC50S06C105SPL	1806	4516	50	6A	1.0uF
AFX1BS10F102SPL	1210	3225	100	20A	0.001uF

– AFC : Feedthru Capacitor
– AFX : Feedthru Capacitor Coaxial

Richardson Electronics: Value Proposition

One-Stop Solution for Drone Design

Comprehensive power & RF components coverage

- Critical parts for Power, Safety, Payload and Thermal Management in drone design.
- Ruggedized & reliable parts (EN/AS9100, MIL-STD grade magnetics and capacitors).

Cutting-Edge Technologies

- Aceinna xMR Current Sensor - Precise sensing measurement with magneto resistive sensor.
- iDEAL Semiconductor SuperQ MOSFET - High-efficiency SuperQ switching.
- Qorvo MEMS force sensor – Enable sleek and innovative HMI design.
- Qorvo Programmble PMIC- Flexible and configurable power sequencing.

Full Support from Richardson Electronics

- Design support on components selection, reference designs and evaluation kits.
- End-to-end supply chain integration, from concept design to production.

Richardson Electronics
POWER & MICROWAVE TECHNOLOGIES

Identify & Design-in New, Disruptive Technologies

Industry Leader in Power & Microwave

Provide Technical Expertise & Engineered

Provide Exceptional Global Support

Provide High Quality Products for Over 75 Years

rellpower@rell.com | rellpower.com

Appendix 1

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Component	Payload Type	Function
Inertial Measurement Unit (IMU)	Payload - Gimbal Control	Gimbal stabilization feedback (pitch/roll/yaw)
BLDC Motor Controller IC (MCU + Gate Driver IC + Voltage Regulator)	Payload - Gimbal Control	3-axis brushless gimbal motor control
Power MOSFET	Payload - Gimbal Control	Motor phase switching for gimbal axes
Current Sensor	Payload - Gimbal Control	Motor current monitoring & protection
Capacitor	Payload - Gimbal Control	Bulk/snubbers for driver supply & transients
Magnetic	Payload - Gimbal Control	Inductors/chokes in driver power path
EMI Filter / Ferrite Bead	Payload - Gimbal Control	Cable/common-mode noise suppression
Heatsink	Payload - Gimbal Control	Thermal dissipation for drivers & MOSFETs
Power Management IC	Payload - Gimbal Control	Local regulation for gimbal controller & sensors
DC/DC Converter	Payload - Gimbal Control	Step-down from flight battery to logic/driver rails
Thermal Interface Material (TIM)	Payload - Gimbal Control	Improve heat transfer to heatsink
Inertial Measurement Unit (IMU)	Payload - LiDAR	Motion compensation for point-cloud accuracy
EMI/RFI shielding	Payload - LiDAR	Reduce interference to/from laser drivers & receivers
Power Management IC	Payload - LiDAR	Stable rails for laser, APD/receiver & MCU/FPGA
DC/DC Converter	Payload - LiDAR	High-efficiency step-down for laser/logic rails
Current Sensor	Payload - LiDAR	Laser driver current monitoring & safety
Capacitor	Payload - LiDAR	Decoupling & ripple suppression near laser/ADC
Magnetic	Payload - LiDAR	Inductors for converters & filtering
Heatsink	Payload - LiDAR	Thermal management for laser driver & processor
Thermal Interface Material (TIM)	Payload - LiDAR	Couple hot devices to heatsink/case
RF Front End	Payload - SAR	Up/Down-conversion, LNA, PA chain for radar
Antenna	Payload - SAR	Transmit/receive array (patch/waveguide)
EMI/RFI shielding	Payload - SAR	Contain RF energy; protect avionics
Power Management IC	Payload - SAR	Multiple regulated rails for RF/logic
DC/DC Converter	Payload - SAR	High-power conversion for PA & FPGA/SoC
Current Sensor	Payload - SAR	Pulse current monitoring & protection
Ultracapacitor	Payload - SAR	Pulse-power buffer for transmitter bursts
Capacitor	Payload - SAR	RF chain decoupling, bias tees, bulk storage
Magnetic	Payload - SAR	Inductors/chokes in RF supply filters
Heatsink	Payload - SAR	Dissipate PA, LNA and processing heat
Thermal Interface Material (TIM)	Payload - SAR	Improve conduction to chassis/cold plate