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**EN2160 - Electronic Design Realization**



# **Identification of Key Features of a Commercial Electronic Product**

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**Index Number : 200172F**

**February 5, 2025**

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# Chapter 1

## Key Features of a Commercial Electronic Product

Professional commercial electronic products are designed for reliability, scalability, and compliance with industry standards. Below are the key features that define them:

### 1.1 Regulatory Compliance & Certifications

Professional electronic products comply with various industry regulations and certifications, such as CE, FCC, UL, RoHS, REACH, ISO 9001, IPC-A-610, and others. These certifications ensure that the product meets safety, environmental, and electromagnetic compatibility (EMI/EMC) standards.

### 1.2 Robust Design & Reliability

Designed for continuous operation, professional electronics are used in industrial environments, medical devices, automotive, and aerospace applications. These products use extended temperature range components and often incorporate conformal coating or potting for environmental protection. Additionally, they have a high MTBF (Mean Time Between Failures) rating, ensuring longevity and reliability under harsh conditions.

### 1.3 High-Quality Components

Professional products utilize industrial-grade or automotive-grade components, which offer better durability and longer lifespans. Manufacturers prioritize sourcing components from verified suppliers to avoid counterfeits, ensuring a guaranteed lifecycle of 10+ years for critical applications.

### 1.4 Scalability & Mass Production Readiness

Commercial products are designed for automated assembly, including SMT (Surface Mount Technology) pick-and-place and wave soldering processes. Engineers implement DFM (Design for Manufacturing) and DFA (Design for Assembly) techniques to optimize

production efficiency. Many products also support firmware upgradeability via OTA (Over-the-Air) or secure bootloaders, ensuring easy updates and scalability.

## 1.5 Power Efficiency & Thermal Management

Efficiency is a key aspect of professional electronics. These products feature optimized power consumption using low-power MCUs, sleep modes, and efficient power supplies. Proper thermal management is implemented through heat sinking, cooling solutions, and PCB layout optimization, preventing overheating and improving longevity.

## 1.6 Enclosure & Mechanical Durability

Professional electronics use injection-molded or die-cast metal enclosures for superior durability. These enclosures comply with Ingress Protection (IP) ratings (e.g., IP67 for waterproofing) and meet shock & vibration standards such as MIL-STD-810, ensuring mechanical robustness.

## 1.7 Security & Firmware Protection

Professional products prioritize security with secure bootloaders, encrypted firmware, and authentication mechanisms. They incorporate tamper detection, secure key storage, and hardware-level security features like TPM (Trusted Platform Module) and HSM (Hardware Security Module). Additional measures, such as reverse engineering protection and obfuscation, safeguard intellectual property.

## 1.8 Proper PCB Design & Manufacturing Standards

The printed circuit boards (PCBs) in professional electronics follow strict multi-layer designs with controlled impedance, ground planes, and signal integrity considerations. High-quality materials, such as FR4-TG170, Rogers, or flexible PCBs, are used for specialized applications. These designs adhere to IPC standards, including IPC-2221 and IPC-6012, ensuring reliability and manufacturability.

## 1.9 Reliable Connectivity & Communication Protocols

Professional products use industrial communication protocols such as CAN, RS485, Modbus, EtherCAT, and Profibus. Secure wireless communication protocols, like Bluetooth LE, Wi-Fi with WPA3, and LoRaWAN with encryption, enhance data security. Redundancy and failover mechanisms further improve reliability in networking applications.

## **1.10 Comprehensive Testing & Quality Control**

Professional electronics undergo rigorous testing to ensure quality and reliability. This includes Automated Testing (ATE), In-Circuit Testing (ICT), Environmental Stress Testing (HALT, HASS), Burn-in Testing, EMI/EMC Testing, and ESD Protection Testing. These processes help identify potential failures before the product reaches the market.

## **1.11 Long-Term Support & Documentation**

Professional electronics come with comprehensive technical support, firmware updates, and security patches. Manufacturers provide detailed datasheets, application notes, and technical documentation. Additionally, robust RMA (Return Merchandise Authorization) and warranty policies ensure customer support and product reliability.

## **1.12 Supply Chain & Lifecycle Management**

Manufacturers implement obsolescence management and component sourcing strategies to ensure long-term availability. BOM (Bill of Materials) optimization helps avoid supply chain disruptions, while PLM (Product Lifecycle Management) tools track product evolution and maintain quality standards.

# Chapter 2

## Keysight E36300 Series Bench Power Supplies.

To compare commercial professional electronic products, the Keysight E36300 bench power supply series serves as an excellent example. Recognized worldwide, it is widely used in industrial, R&D, and production environments due to its high precision, reliability, and compliance with industry standards. The E36300 series meets strict safety, EMI/EMC, and quality certifications, ensuring consistent performance in professional applications. It features low noise output, robust thermal management, advanced connectivity options, and secure firmware. Its rugged design, long-term support, and lifecycle management make it a benchmark for professional power supplies, demonstrating the key characteristics of a true commercial-grade electronic product.



Figure 2.1: Keysight E36300 Bench Power Supply Series

## **2.1 Regulatory Compliance & Certifications**

The Keysight E36300 series complies with industry-standard regulations to ensure electrical safety and performance. It meets certifications such as CE, CSA, UL, and IEC 61010-1, guaranteeing that the power supply adheres to international safety requirements. Additionally, the series complies with EMC standards (IEC 61326-1), ensuring minimal electromagnetic interference and stable operation in professional environments.

## **2.2 High-Quality Components**

The internal components of the E36300 series are industrial-grade to ensure high durability and stability. Precision voltage and current regulation components enable accurate and repeatable performance. High-quality capacitors, resistors, and semiconductors minimize electrical drift over time, extending the product's lifespan. Additionally, Keysight's rigorous sourcing policies prevent the use of counterfeit components, ensuring long-term reliability.

## **2.3 Scalability & Mass Production Readiness**

This power supply is designed for scalable deployment in both research and production settings. Its modular design supports easy integration into automated test environments. With multiple output channels, it allows efficient testing of multi-rail circuits, making it ideal for R&D and production testing. The firmware is also upgradeable, ensuring long-term compatibility with evolving test requirements and automation platforms.

## **2.4 Power Efficiency & Thermal Management**

Power efficiency is a key aspect of the E36300 series. It features optimized power conversion, reducing energy losses and ensuring high efficiency in continuous-use applications. To prevent overheating, the unit incorporates intelligent thermal management, including built-in cooling fans and thermal sensors. This ensures stable operation across a wide range of environmental conditions while extending the lifespan of internal components.

## **2.5 Robust Design & Reliability**

The E36300 series is engineered for continuous operation in industrial, R&D, and production environments. It features low ripple and noise power output, providing high stability for sensitive electronic testing. [5] The inclusion of overvoltage (OVP), overcurrent (OCP), and overpower (OPP) protection ensures reliable operation and safeguards both the power supply and the connected devices. Designed for long operational life, the E36300 series maintains consistent performance under demanding conditions.

Front panel at a glance



Item	Description
1	Information-packed, high contrast LED display; easily viewable even from sharp angles
2	Output selection keys Selects an output to control. The lit key indicates the selected output. Tip: When this key is selected, pressing this key again will toggle between multiple and single output view.
3	Voltage/Current knobs Set the voltage and current of the selected output.
4	Meter View, Tracking and Store/Recall keys - [Meter View] turns on the meter view for the selected output. - [Tracking] turns on or off the track mode for output 2 and 3. (E36312A and E36313A only) - [Store/Recall] opens the Store/Recall menu.
5	Navigation keys. - Navigate through the control dialog windows; press [Enter] key to select a control.
6	Numeric keypad - Enters numeric values. Press [Enter] key to complete the entry. - Deletes the values entered into the dialog using the back key.
7	Output On key Turns individual outputs On or Off; outputs are on when the key is lit.
8	Output terminals

Figure 2.2: Keysight E36300 Series - front panel

## 2.6 Security & Firmware Protection

Security is a crucial feature in professional-grade equipment. The E36300 series incorporates firmware encryption and authentication mechanisms to prevent unauthorized modifications or hacking attempts. It supports a secure boot mechanism to ensure only genuine firmware is executed, preventing tampering. Additionally, data logging and time-stamped measurement storage enhance traceability for regulatory compliance and audit purposes.

## 2.7 Enclosure & Mechanical Durability

The E36300 series features a rugged metal chassis designed for industrial durability. The enclosure is built to withstand mechanical stress and frequent usage in laboratory and industrial environments. The front panel controls and connectors are designed to be

resistant to wear, ensuring long-term usability. Its compact form factor allows for easy placement on workbenches while maintaining structural integrity.



Figure 2.3: Keysight E36300 Series - front user interface and back view



Figure 2.4: Keysight E36300 Series - side view of the enclosure

## 2.8 Proper PCB Design & Manufacturing Standards

The printed circuit boards (PCBs) inside the E36300 series are designed according to high-reliability industry standards. The multi-layer PCB layout with controlled impedance and ground planes ensures superior signal integrity and reduced electrical noise. High-quality materials, such as FR4-TG170, enhance the thermal and electrical performance of the PCBs. The design follows IPC-6012 manufacturing standards, ensuring consistent quality and longevity.

## 2.9 Reliable Connectivity & Communication Protocols

The E36300 series offers multiple connectivity options, including USB, LAN (Ethernet), and GPIB. These interfaces allow remote control and integration into automated test setups. It also supports SCPI (Standard Commands for Programmable Instruments),

which is essential for test automation in professional environments. Compatibility with LabVIEW, MATLAB, and Python ensures seamless integration with industry-standard software tools.

Rear panel at a glance



Item	Description
1	Output 2 and 3 terminal port (E36312A and E36313A only)
2	Earth ground reference (E36312A and E36313A only)
3	Kensington security slot
4	Output 1 terminal port (E36312A and E36313A only)
5	Digital I/O terminal port (E36312A and E36313A only)
6	LAN port (E36312A and E36313A only)
7	USB port
8	GPIB port (E36312A and E36313A Option GPIB only)
9	AC inlet
10	AC selector fuse-holder assembly
11	AC selector
12	Fan ventilation hole

Figure 2.5: Keysight E36300 Series - Rear Panel

## 2.10 Comprehensive Testing & Quality Control

Each E36300 unit undergoes extensive factory testing to ensure reliability and accuracy. This includes EMC compliance testing, thermal stress testing, and electrical safety verification. The power supplies are also subjected to self-diagnostics and calibration verification during production. Automated Test Equipment (ATE) ensures each unit meets strict performance criteria before being shipped to customers.

## 2.11 Long-Term Support & Documentation

Keysight provides comprehensive technical support, firmware updates, and troubleshooting assistance for the E36300 series. Detailed user manuals, application notes, and datasheets are available, ensuring engineers have access to all necessary technical documentation. The company also offers extended warranties and service contracts, reinforcing long-term product reliability.

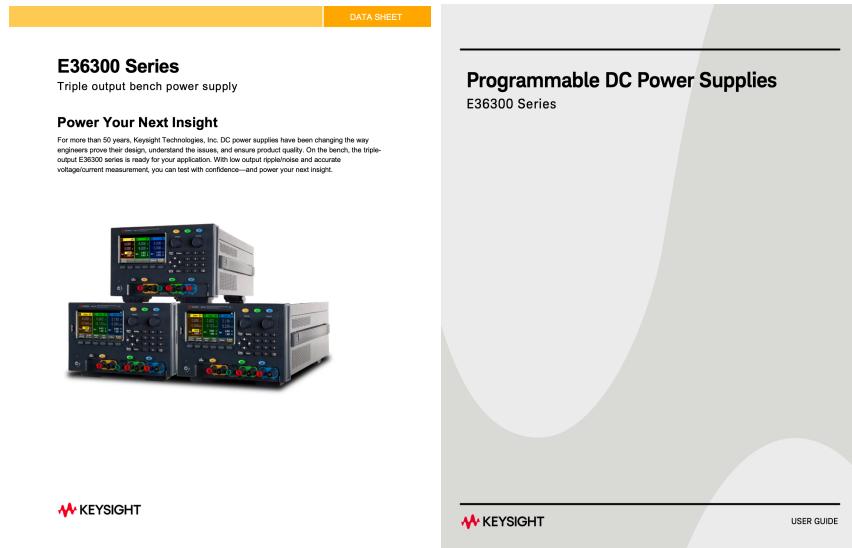


Figure 2.6: Keysight E36300 Series - Datasheet [1] & User Guide [2]

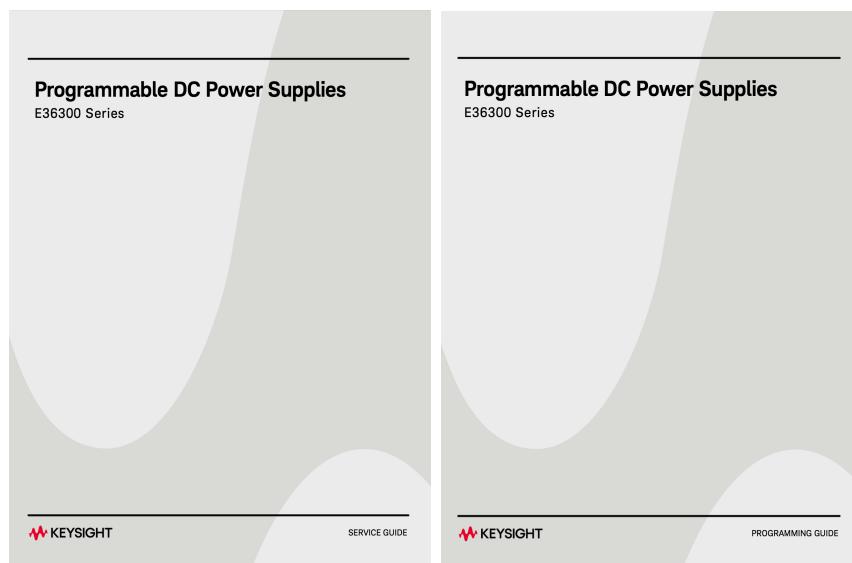


Figure 2.7: Keysight E36300 Series - Service Guide [3] & Programming Guide [4]

## **2.12 Supply Chain & Lifecycle Management**

Keysight follows strict obsolescence management policies to ensure long-term product availability. The BOM (Bill of Materials) is optimized to use components with long production life cycles, reducing the risk of supply chain disruptions. Additionally, Keysight's lifecycle management strategy ensures continued availability of replacement parts and technical support for many years.

# Chapter 3

## Conclusion

The Keysight E36300 series meets all professional commercial electronic product standards, making it a highly reliable, precise, and secure power supply for R&D, industrial, and production applications. Designed with regulatory compliance, robust construction, and high-quality components, it ensures exceptional performance and long-term value in professional environments. The intuitive front panel interface provides a user-friendly experience, featuring advanced functionalities, high-resolution displays, and easy access to settings, enhancing productivity for engineers and researchers.

The E36300 series adheres to industry standards by incorporating safety features such as overvoltage, overcurrent, and overpower protection, ensuring equipment and user safety. Its industrial-grade enclosure is built for durability and reliability, protecting internal circuits from harsh environments. Connectivity options include USB, LAN (Ethernet), and GPIB, supporting SCPI commands for automation and remote programmability, making it ideal for R&D and automated test setups.

Keysight maintains its professional reputation by providing comprehensive documentation, a strong support community, and after-sales service, ensuring users have access to firmware updates, troubleshooting guides, and expert assistance. With industry-leading performance, robust security, and long-term lifecycle management, the E36300 series exemplifies the professionalism and high standards of commercial-grade power supplies.

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