

# Mobile Power Supply and Current Monitoring System

*A Portable DC Power Unit with Real-Time Load-Current Observation*

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Document note: This is an original, editable research-paper draft. Replace proposed design details with the exact components, circuit, photographs, and measured readings from your completed prototype before submitting or publishing.

## Abstract

Portable electronic equipment and small laboratory circuits often need a convenient low-voltage DC source. A basic supply can provide energy, but without current observation a user may not know how much current a connected load is drawing or whether the load is approaching the supply limit. This paper proposes a compact mobile power supply with a current-monitoring section intended for educational experiments, small electronics testing, and low-power portable use. A rechargeable battery provides stored energy; a regulated DC-DC stage creates the required output; and a current sensor measures the load current. A microcontroller reads the sensor signal and presents the value on a display. A voltage measurement point and configurable over-current response may be included to improve supervision. The design is modular so that the battery, regulator, sensing range, and display can be selected according to the intended load. The paper describes the operating concept, proposed hardware blocks, implementation sequence, calibration approach, and evaluation plan. Because no verified prototype readings were supplied for this draft, performance figures are not claimed; the final evaluation should use measurements collected from the actual assembled system.

**Keywords:** portable DC supply, current sensing, microcontroller, regulated output, load monitoring, over-current protection

## 1. Introduction

Electronic learning kits, sensor modules, communication circuits, and small embedded prototypes are frequently tested away from a fixed bench supply. A portable source can make these activities easier, particularly when the output is low voltage and the current demand is within a clearly defined limit. However, the source should not be treated as only a battery and connector. The user also needs a way to observe the electrical load and identify unexpected current changes.

Current monitoring is useful during troubleshooting because a short circuit, incorrectly connected component, or faulty module may draw more current than expected. A visible current reading helps the operator compare actual behaviour with the expected operating range. The proposed system combines portable energy storage, voltage regulation, current sensing, and a simple display in one unit. It is designed as an educational prototype rather than a certified commercial power product.

## 2. Problem Statement

When a small circuit is powered by a portable battery pack, the user may have no immediate indication of the current

being consumed. A separate meter adds extra wiring and can make a compact test setup less convenient. The project therefore addresses the need for a portable low-voltage supply that provides a regulated output and displays the load current in the same unit, with a clear path for adding an over-current warning or shutdown.

## 3. Aim and Objectives

**Aim:** To develop a portable DC power supply that allows the user to monitor the current drawn by a connected low-voltage load.

- Provide a portable source using a rechargeable battery or a suitable protected battery pack.
- Convert the battery voltage to a stable, specified DC output using a regulated converter.
- Measure load current using a suitable current-sensing device.
- Display the measured current clearly on a small digital display.
- Calibrate the reading against a trusted reference meter and document measurement error.
- Provide an optional warning or output-disconnect response when the current exceeds a chosen safe threshold.

- Keep the design modular so that sensing range and output rating can be changed for future versions.

#### 4. Proposed System Overview

The unit is organised into five functional blocks: energy storage, power regulation, output connection, current measurement, and display/control. The current sensor is placed in series with the load path so that the measured current corresponds to the current delivered to the output. The microcontroller reads the sensor output, applies the sensor's conversion factor and calibration offset, and updates the display. If an over-current feature is implemented, its threshold must be selected from the ratings of the battery, wiring, sensor, regulator, and connector—not from the display range alone.

| Rechargeable Battery                | DC–DC Regulator               | Current Sensor                  | Output Connector             | Microcontroller + Display                 |
|-------------------------------------|-------------------------------|---------------------------------|------------------------------|-------------------------------------------|
| Protected energy storage<br>Block 1 | Set output voltage<br>Block 2 | Measure load current<br>Block 3 | Connect test load<br>Block 4 | Read, calculate and show value<br>Block 5 |

Figure 1. Functional blocks of the proposed monitoring unit (conceptual representation).

#### 5. Hardware Components and Their Roles

| Component                        | Purpose / selection note                                                                                                                                                                |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rechargeable battery pack        | Stores energy for portable operation. Select a chemistry, voltage, capacity, and discharge rating appropriate to the final design; use a matching protection/charging circuit.          |
| Regulated DC–DC converter        | Produces the required output voltage. A buck converter is used when the required output is below the input; a boost or buck-boost design may be needed for other voltage relationships. |
| Current sensor                   | A Hall-effect sensor module or a shunt-based monitor can measure load current. Select the measurement range, insertion loss, isolation needs, and accuracy for the expected load.       |
| Microcontroller                  | Reads the sensor output, converts it into an engineering value, applies calibration, and updates the display. An Arduino-compatible board is one possible educational option.           |
| Display                          | An LCD or small OLED can show current and, if implemented, output voltage and warning status.                                                                                           |
| Fuse / electronic cutoff         | Provides an independent protective element sized for the circuit. A software warning alone must not be considered a substitute for hardware protection.                                 |
| Switch, connectors and enclosure | Provide controlled operation, reliable output connections, insulation, and protection against accidental contact or shorting.                                                           |

#### 6. Operating Principle

- The battery supplies DC energy to the power-regulation stage.
- The regulator produces the selected output voltage for the connected low-voltage device.
- The current sensor measures the current flowing through the output path.
- The controller samples the sensor signal and converts it to current using the selected sensor's sensitivity and calibration offset.
- The display is refreshed at a steady interval so the user can observe changes when the load is connected, disconnected, or changed.
- If a protection function is fitted, the controller or a dedicated hardware circuit compares current with the chosen threshold and activates the warning or cutoff.

#### 7. Design and Implementation Methodology

##### 7.1 Define the electrical requirements

Before assembling hardware, define the output voltage, maximum continuous current, expected peak current, runtime target, and type of load. These values determine the battery, regulator, sensor, connector, wire gauge, fuse, and thermal design. The design should remain within the rating of every component, including during startup and short-duration load peaks.

##### 7.2 Assemble the power path

Connect the protected battery to the regulator input according to the manufacturer's datasheet. Set and verify the regulator output using a multimeter before connecting a valuable electronic load. Place the current sensor in the intended series path and confirm the sensor's polarity and wiring. Keep high-current conductors short and secure, and prevent exposed terminals from touching the enclosure or each other.

##### 7.3 Connect the measurement and display section

Connect the sensor output to a compatible microcontroller input. If the sensor output can exceed the controller's permitted input voltage, use an appropriate interface; never assume that every sensor is safe for every board. Connect the display using its specified interface and supply voltage. The software should show a startup message, a numeric current value, and a clear indication when the reading is invalid or outside the calibrated range.

##### 7.4 Calibration

Compare the system reading with a trusted multimeter or calibrated current meter at several safe load points spanning the intended operating range. Record the reference value, system value, difference, and percentage error. If the sensor

has an offset, measure the zero-load output and apply a documented correction. Calibration must be repeated after changing the sensor, wiring arrangement, or measurement range.

### 7.5 Enclosure and usability

Fit the assembled circuit in an insulated enclosure with ventilation appropriate to the power level. Label the output voltage and maximum permitted current. Provide strain relief for external wires and keep charging connections distinct from the load output. Do not operate a prototype unattended while its protection and thermal behaviour are unverified.

## 8. Measurement and Evaluation Plan

The completed prototype should be evaluated using a controlled load such as a suitable resistor load or an electronic load. Begin with a low current and increase only within the ratings of all components. For each test point, record the reference current, displayed current, output voltage, and any observed heating or instability. Repeat readings to check consistency. The following table is intentionally left blank for real measurements; entering invented readings would make the paper unreliable.

| Test | Condition                                 | Reference current (A) | System reading (A) | Output voltage (V) | Observation |
|------|-------------------------------------------|-----------------------|--------------------|--------------------|-------------|
| 1    | No-load                                   |                       |                    |                    |             |
| 2    | Low load                                  |                       |                    |                    |             |
| 3    | Medium load                               |                       |                    |                    |             |
| 4    | High load within rated limit              |                       |                    |                    |             |
| 5    | Threshold warning/cutoff test (if fitted) |                       |                    |                    |             |

Table 1. Template for recording measurements from the actual prototype.

## 9. Data Processing

The absolute current error can be calculated as:

$$\text{Absolute error (A)} = |\text{System reading} - \text{Reference reading}|$$

For a non-zero reference reading, percentage error can be calculated as:

$$\text{Percentage error (\%)} = (\text{Absolute error} / \text{Reference reading}) \times 100$$

At zero current, percentage error is not meaningful because the reference value is zero; report the absolute offset instead. The final paper should summarise the measured range, typical error, output stability, and any limitations found during testing.

## 10. Expected Benefits and Applications

- Portable low-voltage power for educational circuit testing.
- A single unit that combines power delivery and current observation.

- Faster identification of abnormal current draw during troubleshooting.
- A modular platform for learning about sensors, microcontrollers, voltage regulation, and calibration.
- Possible use with small sensor modules, communication demonstrations, and low-power embedded prototypes, provided their electrical requirements match the unit.

## 11. Limitations and Safety Considerations

- Measurement accuracy depends on sensor quality, calibration, noise, wiring, and the controller's analogue measurement resolution.
- A switching regulator may introduce electrical noise; filtering and sensible grounding may be required.
- Battery runtime depends on battery capacity, conversion efficiency, output power, and battery condition.
- The maximum output rating must be determined from component datasheets and verified by testing; it must not be guessed from the battery capacity.
- A prototype is not a certified charger or medical/automotive power device. Do not connect it to mains voltage or use it to charge a phone unless the output standard, regulation, protection, and connector implementation have been validated.
- Use a compatible protected battery and charger, observe polarity, prevent short circuits, and stop testing if components become unusually hot, swell, smell, or behave unpredictably.

## 12. Future Scope

Future versions may add voltage and power display, data logging to a memory card, Bluetooth reporting to a phone, a configurable current limit, battery state indication, and a more accurate digital current-monitoring IC. A later design could store test records with timestamps for laboratory reports. Any added wireless or logging feature should not compromise the electrical protection or measurement reliability.

## 13. Conclusion

This paper presents a modular concept for a mobile DC power supply with integrated current monitoring. The combination of regulated output, current sensing, microcontroller processing, and a display can make low-voltage testing more informative and convenient. The usefulness of the final unit will depend on correct component selection, safe construction, calibration, and evaluation against a reference meter. The next stage is to build the circuit, record actual readings, document the exact hardware and software used, and revise the evaluation section to report verified results rather than assumed performance.

## References

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at: <https://www.analog.com/en/product-category/power-management.html> (accessed 11 October 2026).

- [5] The selected battery, regulator, current sensor, display, and microcontroller manufacturers' datasheets should be cited in the final version according to the exact components used.

## Author Declaration

The authors should review this draft, verify every technical statement against the actual circuit and component datasheets, add their own prototype photographs and measured results, and cite any sources used during development. The wording in this document has been drafted specifically for this project, but no writer or tool can guarantee a 0% similarity score across all plagiarism-checking systems. Proper citation and authentic project evidence are required for ethical submission and