NanoBuck - 3.3V, 5V, 9V or 12V Configurable Fixed 2.3A Output, Compact, High Efficiency 4.5V - 36V Input DC-DC Buck Converter

1 Features

- DC-DC Buck Converter
- Wide 4.5–36 V input range (40 V transient protection)
- Selectable fixed outputs: 3.3, 5, 9, 12 V
- Up to 2.5 A output current
- High efficiency: 80-95% typical across load range
- Dynamic switching frequency for enhanced efficiency at each output voltage.
- Integrated Inductor Technology allows for optimized EMI performance with dual random spread spectrum (CISPR 11 Class B capable)
- 4 ms soft-start prevents inrush current
- Breadboard-compatible; castellated edges for direct soldering to PCBs.
- Overcurrent & thermal shutdown
- Enable pin (EN): logic-controlled on/off.
- Power Good (PG) signal: open-drain indicator for output status and sequencing

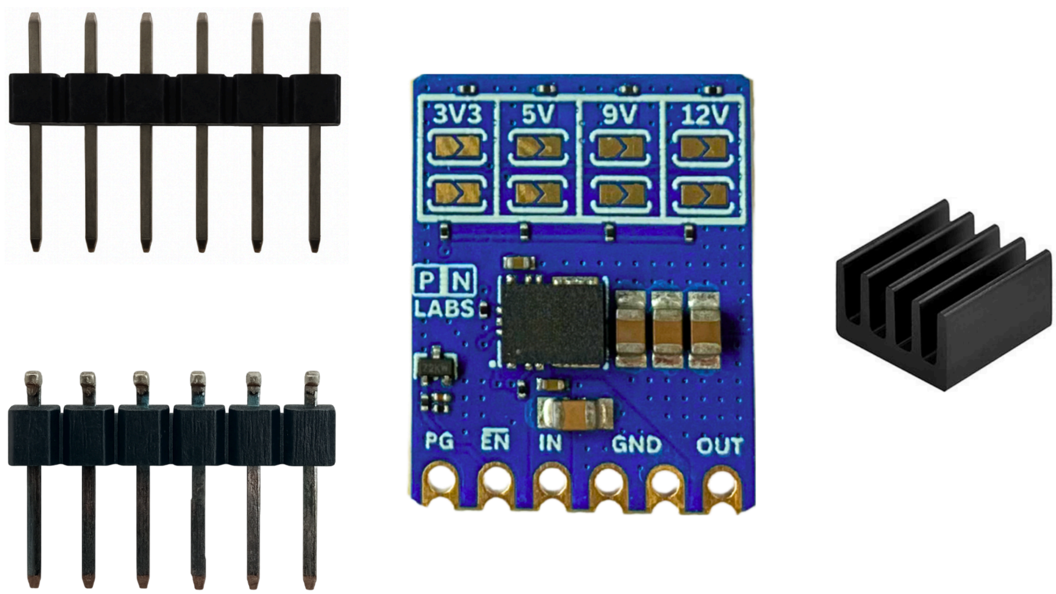
2 Applications

- Embedded systems and microcontrollers that operate at 3.3 or 5 V, and their peripherals
- Embedded applications relying upon remote enabling
- Robotics and automation
- Prototyping and development boards requiring different output voltages

3 Description

The PN Labs NanoBuck is an ultra-compact, breadboard-friendly DC-DC buck converter designed for embedded systems and rapid prototyping. With a wide 4.5-36 V input range and selectable fixed outputs (3.3, 5, 9, or 12 V), it achieves 80-95% efficiency and in a tiny 16x20 mm (0.63x.79”) footprint. Featuring a 4 ms soft-start, and optimized EMI performance, the NanoBuck also includes EN and Power Good signals for sequencing and monitoring, plus built-in protections for overcurrent and thermal shutdown. Breadboard-compatible headers and castellated edges allow easy prototyping or direct PCB integration, making the NanoBuck a versatile and reliable power solution for makers and engineers.

Product Photo



4 Revision History

August 2025 - Initial Release

5 Description (Continued)

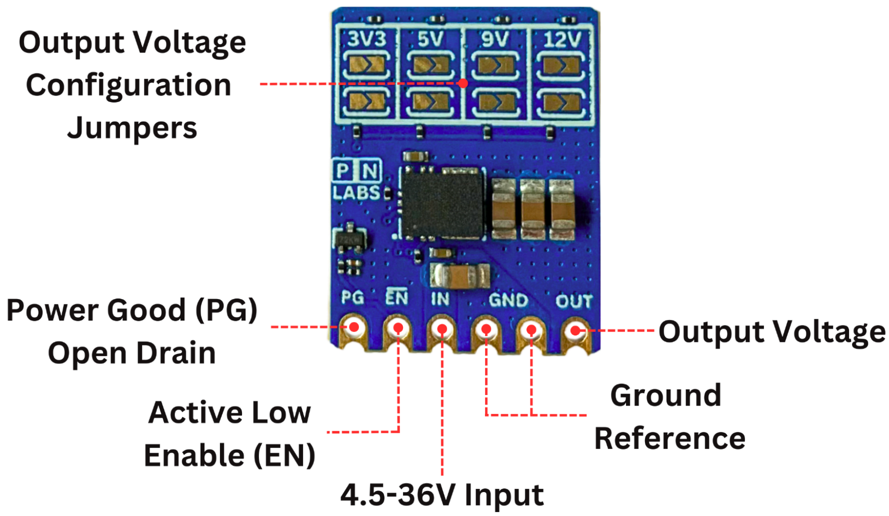
The PN Labs NanoBuck is a compact, high-efficiency DC-DC buck converter designed for embedded systems, prototyping, and small-scale applications. Supporting a wide 4.5 V to 36 V input range (with 40 V transient protection), it provides selectable fixed outputs of 3.3, 5, 9, or 12 V, making it a versatile choice for breadboard development, robotics, and custom PCBs.

With typical efficiencies of 80-95%, the NanoBuck delivers stable, reliable power while minimizing heat generation. A 4 ms soft-start sequence prevents inrush currents.

Built-in protections, including cycle-by-cycle overcurrent limiting and thermal shutdown, safeguard both the module and connected devices. Additional features such as EN for logic-controlled enable and PG for power-good indication allow seamless power sequencing and system monitoring.

With breadboard-compatible pin spacing and castellated edges for direct PCB soldering, the NanoBuck integrates easily into both prototypes and production hardware. Whether on the bench or in a finished design, the PN Labs NanoBuck delivers compact, efficient, and dependable power.

6 Pin Configuration and Functions



NAME	TYPE	DESCRIPTION
PG	D	Power-good monitor. Open-drain output that asserts low if the feedback voltage is not within the specified window thresholds. Add a 10-100 kΩ pullup resistor to your logic level voltage. If not used, this pin can be left open or connected to GND. High = power OK, Low = power . PGOOD pin goes low when EN = Low.
EN	D	Enable input pin. Low or floating = ON, High = OFF. High voltage must be above the EN_THRESHOLD.
IN	P	Input supply voltage. Connect the input supply to these pins.
GND	G	Output voltage. Connect this pin to the output load.
OUT	P	Power ground terminal. Connect to system ground.
D = Digital, P = Power, G = Ground		

7 Specifications

7.1 Absolute Maximum Ratings

Limits apply over TJ = -40°C to 125°C (unless otherwise noted).

		MIN	NOM	MAX	UNIT
Input Voltage	IN to GND	-0.3	-	40	V
	EN to GND	0	-	15	V
	PG to GND	0	-	20	V
Output Voltage	OUT to GND	-0.3	-	16	V
Input current	PG	-	-	10	mA
T_J	Junction temperature	-40	-	125	°C
T_A	Ambient temperature	-40	-	105	°C

*Stresses beyond those listed under Section 6.1 may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Section 6.2. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

7.2 ESD Ratings

			VALUE	UNIT
V_{ESD}	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001	±2000	V
		Charged-device model (CDM), per ANSI/ESDA/JEDEC JS-002	±1000	V

7.3. Recommended Operating Conditions

Limits apply over TJ = –40°C to 125°C (unless otherwise noted).

		MIN	NOM	MAX*	UNIT
Input voltage	Input needed for full load without drop	4.3		36	V
Output voltage	Output Adjustment Range	3.4		12.0	V
Output Current (3.3 V)			2.35	2.6	A
Output Current (5 V)			2.2	2.55	A

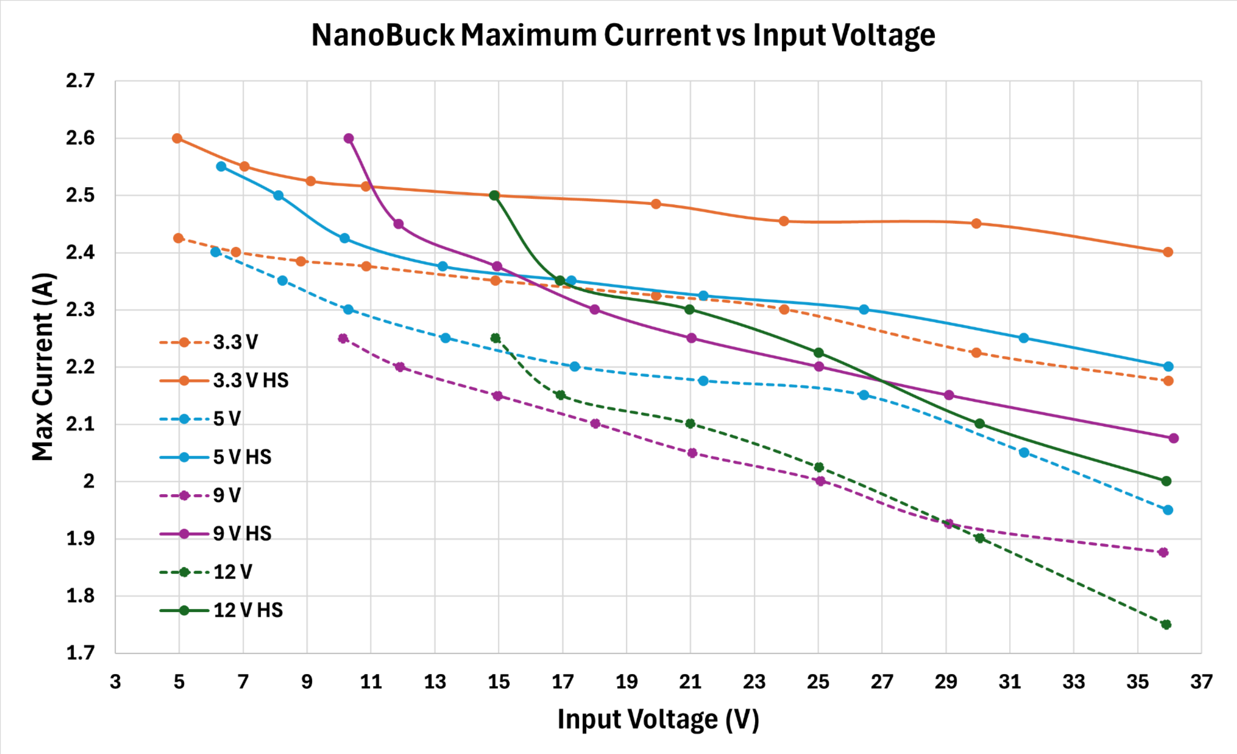
Output Current (9 V)			2	2.6	A
Output Current (12 V)			2	2.5	A

*Maximum current values are only achievable by using the supplied heat sink. The ambient temperature of testing was 25 C.

7.4 Electrical Characteristics

At 25 °C ambient temperature.

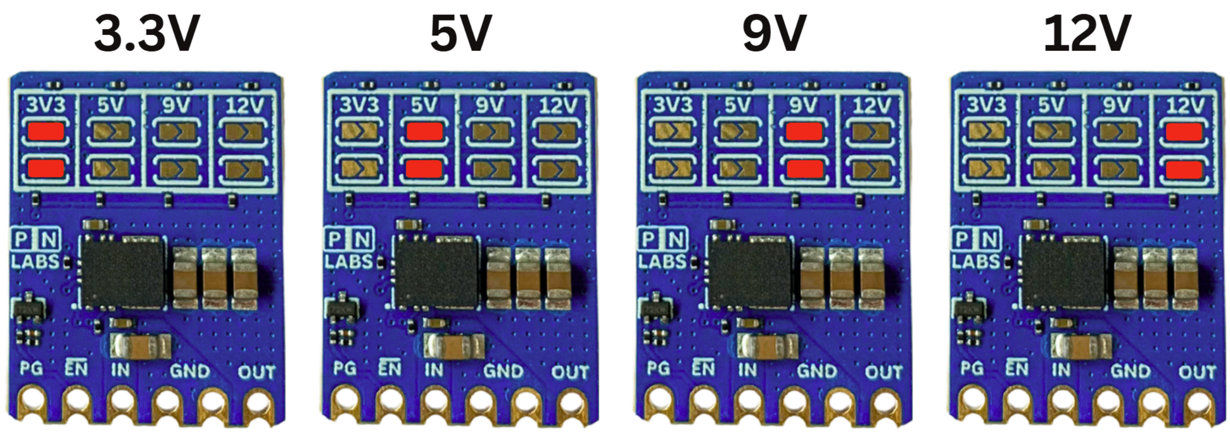
	MIN	TYP	MAX	UNIT
Minimum V_{IN} for 3.3V Config		4.5		V
Minimum V_{IN} for 5V Config		6		V
Minimum V_{IN} for 9V Config		10.3		V
Minimum V_{IN} for 12V Config		13		V
Input operating quiescent current		7		uA
V_{IN} shutdown quiescent current.	200		1000	uA
EN pin high threshold (EN_THRESHOLD)	1.0	1.6	2.5	V
Softstart Time	2	3.5	4.6	ms
Short circuit wait time “hiccup” mode	30	50	75	ms
PG upper threshold - rising	104	108	11	%
PG lower threshold - falling	89	91	94.2	%
Switching frequency range	800	-	2000	kHz
Thermal shutdown threshold	158	168	186	°C
Thermal shutdown hysteresis	-	15	20	°C



8 Feature Descriptions

8.1 Output Voltage Selection (with integrated solder jumpers)

The NanoBuck provides four selectable fixed outputs (3.3 V, 5 V, 9 V, or 12 V). Due to the buck regulator architecture, the input voltage must always be slightly above the selected output voltage by about 1-2 V so that the output does not drop under load. Output voltage is selected with convenient solder jumpers on the board. This makes it easy to adapt the same module to different projects, whether for logic-level electronics at 3.3 V or higher-voltage peripherals at 12 V. These two jumpers are selecting the desired output voltage and also configuring the switching frequency for optimal performance.



Simply solder the two jumpers which correspond to the desired output voltage. Ensure that only these two jumpers are soldered together and they are shorted as shown in the photo above.

* Failure in doing so will cause undefined behaviour and potentially damage your downstream circuitry. Check the output voltage of the regulator before integrating into your circuit.

8.2 Enable (EN) Pin Operation

The NanoBuck includes an active-low EN (Enable) pin that allows logic-controlled shutdown of the regulator. When EN is above EN_THRESHOLD, the module is disabled and the output is turned off. Pulling EN low or leaving floating enables normal operation and initiates the 4 ms soft-start sequence. This pin can be tied to a system power controller or another regulator's PG output to implement supply sequencing. For always-on operation, EN can be connected directly to VIN.

8.3 Power-Good Output Operation

A dedicated **PG (Power Good)** pin provides an open-drain status signal that asserts high when the output is within regulation. This pin can be used to enable a load switch or another voltage regulator when the voltage becomes stable, indicating that the regulator is working optimally.

To use this with a microcontroller, simply connect the PG signal to your logic level voltage via a 10-100k pullup resistor. When the regulator is in proper regulation, the signal will be high, otherwise it will be low.

When PG is High:

- EN pulled high (device enabled).

- Output voltage within the regulation band.
- No fault conditions (OCP, OTP, etc.).

8.4 Dropout

In dropout conditions, when the input voltage approaches the output voltage, the NanoBuck maintains regulation by automatically lowering its switching frequency. If input voltage falls below the module's minimum headroom, the output smoothly tracks slightly below VIN, ensuring graceful recovery once input returns to normal.

8.5 Why Integrated Inductor Technology is Better

Unlike conventional buck regulators that rely on bulky external inductors, integrated inductor technology embeds the inductor directly into the package alongside the controller and switching elements. This integration reduces PCB footprint, increases power density, and simplifies board layout by eliminating the critical high-current loop from the external design.

With the inductor shielded and internally packaged, parasitic resistance and inductance are minimized, enabling higher switching frequencies with lower losses and improved transient response. The result is better efficiency, reduced radiated EMI and an overall smaller footprint. The IC also incorporates Dual Random Spread Spectrum (DRSS) technology to reduce EMI peaks.

8.6 EMI Reduction

The NanoBuck uses Dual Random Spread Spectrum (DRSS) modulation, which spreads energy across a range of frequencies to reduce peak EMI emissions. Combined with the shielded integrated inductor and compact switching layout, the NanoBuck can achieve CISPR 11 Class B performance without requiring bulky external filters*.

*The NanoBuck itself has not been officially certified to achieve CISPR 11 Class B performance, but the IC has.

8.7 Overcurrent Protection

The NanoBuck features cycle-by-cycle current limiting on both high-side and low-side MOSFETs. In case of a persistent overload (~3A) or short circuit, the module enters hiccup mode, periodically retrying startup every 50 ms until the fault is cleared. This protects both the regulator and downstream electronics from damage.

8.8 Over Temperature Protection

If the internal junction temperature exceeds safe limits (typically 168 °C), the NanoBuck automatically shuts down. Once the device cools by approximately 20 °C, it restarts with a controlled soft-start, preventing thermal damage and ensuring long-term reliability.

* The NanoBuck can get hot enough to burn you during normal operation. If operating the NanoBuck:

- With a high input to output voltage ratio
- With a high output current
- In hot ambient conditions

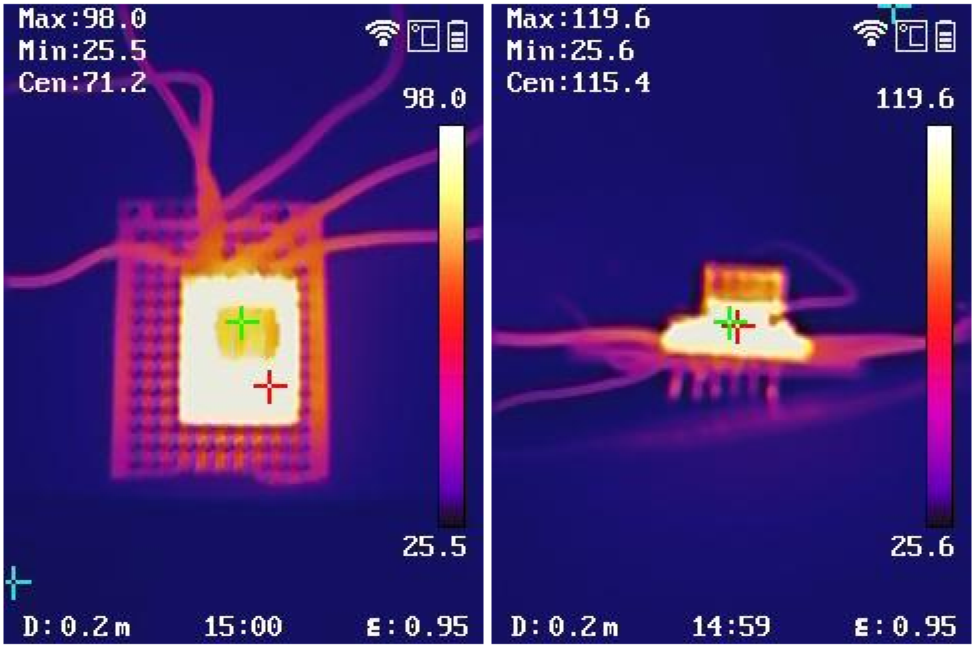
Be cautious when handling. See the maximum device limits for more information.

8.9 Recovery

The NanoBuck uses a monotonic 4 ms soft-start for initial power-up and for recovery from thermal shutdown or dropout. This prevents inrush currents and allows the output to rise cleanly even into pre-biased loads. During dropout recovery, the output ramps back to its set voltage at the same controlled rate as initial startup, ensuring stable and predictable system behavior.

9 Thermal Information

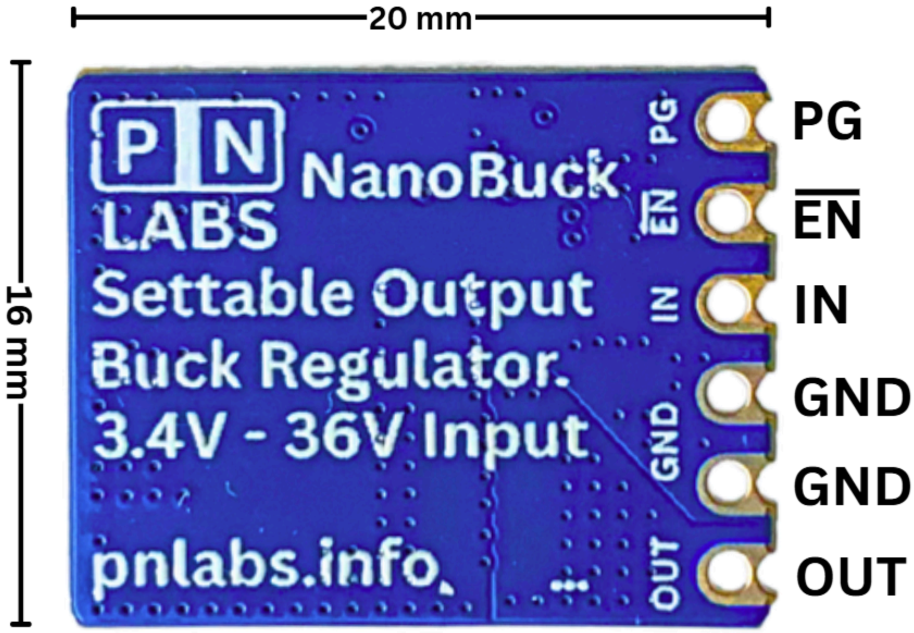
Absolute max load test. 36V input 2.45 A output ran continuously for 10 minutes, featuring top and side profiles (with heat sink).



10 Mechanical Information

The NanoBuck is designed for both prototyping and integration into finished products:

- **Breadboard-friendly:** Standard 0.1 in (2.54 mm) pin spacing for easy insertion into breadboards and perfboards.
- **Castellated edges:** Allow direct soldering onto custom PCBs as a surface-mount module.
- **Compact footprint:** Optimized to minimize board space while maintaining thermal performance.
- **Design files included:** PCB footprints and models are provided in KiCAD, Altium, EasyEDA, DXF, and STEP formats to simplify integration into custom designs. Look for it on our website, pnlabs.info


20 mm
16 mm
P N LABS
NanoBuck
Settable Output
Buck Regulator
3.4V - 36V Input
pnlabs.info
PG
EN
IN
GND
GND
OUT
PG
$\overline{EN}$
IN
GND
GND
OUT