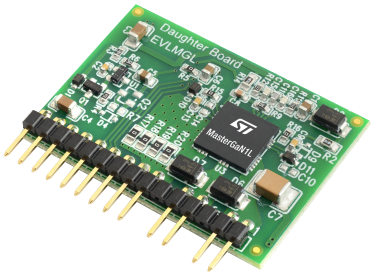
EVLMG1LPBRDR1

Data brief

MASTERGAN1L power module for high efficiency Half-Bridge-GaN-based power supply applications



Features

- GaN half-bridge daughter board equipped with MASTERGAN1L, suitable for power applications requiring fast wake up time.
- Embedded independently adjustable dead times for LIN and HIN signals.
- On board alternate option for 6 V.
- Discrete bootstrap diode and capacitor for high frequency solutions.
- Adjustable low side shunt to serve peak current mode control algorithms.
- External parallel body diodes to serve LLC application needs.
- 45 °C/W junction to ambient thermal resistance to evaluate large power topologies.
- RoHS compliant.

Description

The EVLMG1LPBRDR1 is a GaN-based half-bridge power module equipped with MASTERGAN1L, which quickly creates new topologies without needing a complete PCB design.

The module is fine-tuned to work in an LLC application: in fact, the low side resistors are set to zero and two external body diodes are connected in parallel to each half-bridge GaN.

The module can also work in active clamp or resonant peak current mode flyback applications simply by properly adjusting the low side sense resistor and removing the parallel diodes.

Two alternative 6 V linear regulators are embedded in the PCB: a simple low-cost regulator and a more precise temperature-independent one. Due to the external bootstrap diode and capacitor, a proper supply for VCC, PVCC, and Vbo is provided.

The module accepts only separate driving signals and the delay time can be modulated by adjusting a dedicated RC filter.

The EVLMG1LPBRDR1 is a 30 x 40 mm wide FR-4 PCB, resulting in an $R_{th(J-A)}$ of 45 °C/W, without forced airflow.

Product status link
EVLMG1LPBRDR1

1 Board pin description

Figure 1 shows the pin connections of the power module: the connector map is reported and summarized in Table 1.

Pins 1 to 8 are dedicated to the half-bridge terminals of each drain-source GaN.

In a typical application, an external supply coming from the motherboard should be connected to the VAUX REG pin. An on-board regulator provides a regulated voltage to MASTERGAN1L. Two different regulator types can be selected (the low cost one is not mounted).

LIN and HIN (pins 11 and 12) receive the driving signals that come from the controller.

SENSE (pin 13) provides the low side current signal to a peak current mode controller to define the switching-on time of the low side GaN. In this case, sense resistors should be sized properly. In fact, the board is sold with 0 ohm resistors.

SD/OD (pin 9) can be used to disable MASTERGAN1L outputs independently from LIN and HIN.

Figure 1. EVLMG1LPBRDR1– Supply and signal connection

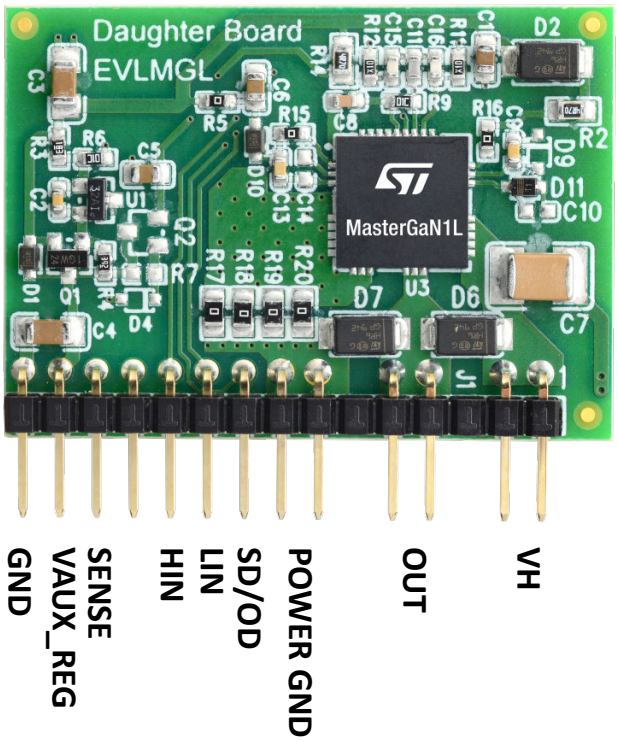


Table 1. Connector Map

Ref.	Pin #	Name	Function	Description
J1	1, 2	VH	INPUT power	These two pins are connected to the VS pins of MASTERGAN1L: connect high voltage potential to this pin according to MASTERGAN1L recommended values (520V).
	4, 5	OUT	OUT power	These two pins are connected to the OUT pins of MASTERGAN1L: connect the load to this terminal (e.g. resonant tanks, transformers, etc.).
	7, 8	GND	POWER GND	These two pins are the reference voltage of power components (POWER GND).
	9	SD/OD	Enable/Disable	It is pull-up to VCC, thanks to an external signal it is used to disable or enable the device.
	10	LIN	INPUT	Direct connection to the LIN of the MASTERGAN1L pins. LIN input range: up to 20V.
	11	HIN	INPUT	Direct connection to the HIN of the MASTERGAN1L pins. HIN input range: up to 20V.
	13	SENSE	INPUT	This pin is connected to the SENSE pins of MASTERGAN1L: the board is configured with shorted sense resistors (R17, R18, R19, and R20) for LLC topology. As necessary, a peak current mode loop can be sensed here.
	14	VAUX REG.	INPUT power	It is the input of the on-board voltage regulator for properly supplying MASTERGAN1L. There are two possible voltage regulator circuits: a low cost one (not assembled) and a more accurate and temperature stable one (default configuration).
	15	GND	POWER GND	Daughter board reference potential.

2 Schematics diagram

Figure 2 shows the schematics of the MASTERGAN1L power module.

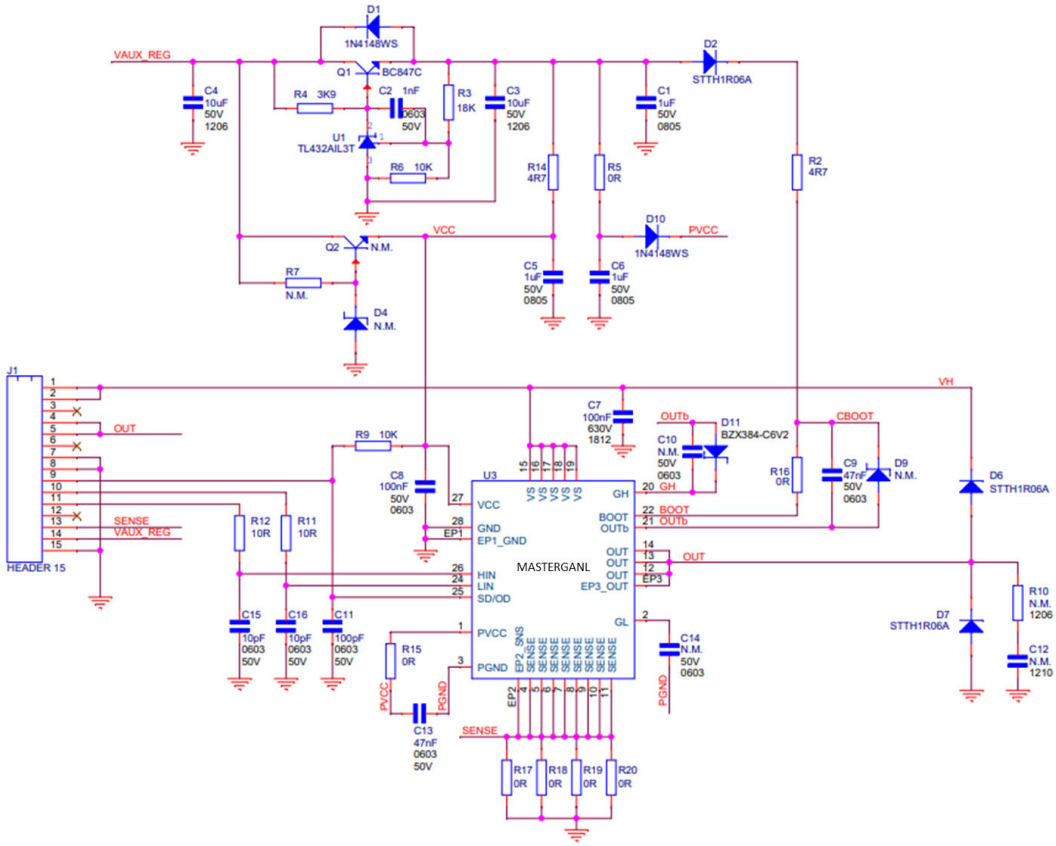
An input supply coming from the motherboard is applied to VAUX_REG. The voltage regulator composed by U1 and Q1 sets a precisely regulated 6 V voltage thanks to the R3 and R6 resistors. This voltage is then applied to the VCC pin by means of a diode (D10) to the PVCC (low side supply). Due to the external bootstrap diode D2 and the bootstrap capacitor C9, a regulated 6 V voltage is applied to the high side driver.

A lower cost solution composed of Q2 and D4 is alternatively available on PCB.

R12 and C15, R11 and C16 help filter undesired glitches and can be exploited to introduce an adjustable delay to input LIN and HIN driving signals.

SD/OD pin can be used as an enable/disable pin for special algorithms or protection implementation.

Figure 2. EVLMG1LPBRDR1– schematic – High density power driver



3 Special setting configurations

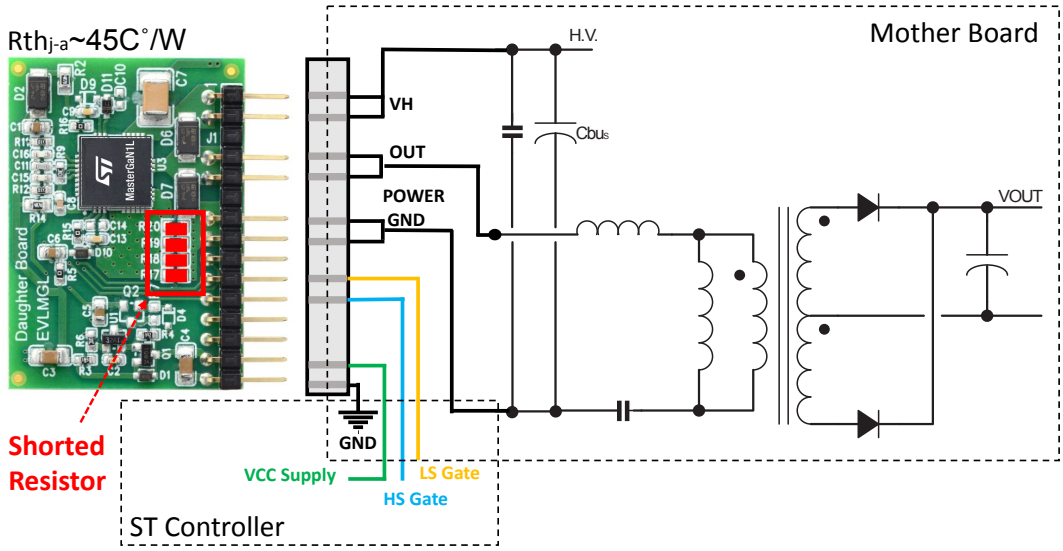
The following paragraph describes graphically the main applications where EVLMG1LPBRDR1 can work properly. Some possible modifications are described to help designers to fit their own application.

3.1 LLC applications

EVLMG1LPBRDR1 is ready to be used in LLC applications.

Figure 3 shows how to connect EVLMG1LPBRDR1 to a resonant LLC motherboard with a dedicated STMicroelectronics IC controller [2] .

Figure 3. EVLMG1LPBRDR1 – Typical Resonant LLC application



Usually, LLC topologies do not sense the resonant current on low side source connection, therefore R17, R18, R19, and R20 are set to 0R to directly connect low side source GaN to power GND.

Body diodes D6 and D7 are mounted in parallel to each high side and low side GaN to minimize the voltage drop during current recirculation and optimize efficiency.

C12 and R10, placed on the bottom side of the PCB, can be populated with a snubber network to adjust EMI contribution, if needed.

A 6.2 V clamping Zener diode between GH and OUTb is always suggested even if a negative voltage on the low side source is already clamped from D7 in this topology.

MASTERGAN1L guarantees a very fast wake up time after the first HIN pulse after LIN generation: this ensures a very high burst mode efficiency.

The thermal resistance of the board is measured equal to Rth ~45˚C/W: operating ambient temperature and resonant tank characteristics define the maximum manageable power. An example of the LLC design can be found in the AN5644 - EVLMG1-250 W LLC demo board [2] .

3.2 Flyback applications

A half-bridge is also used in active clamp or resonant flyback applications. Figure 4 and Figure 5 show how to connect the EVLMG1LPBRDR1 respectively to an active clamp flyback and a resonant flyback.

For these applications, sense resistors R17, R18, R19, and R20 must be sized properly, depending on the output final target power [3] .

The SENSE pin is connected to the controller to close the peak current mode loop.

External body diodes D6 and D7 are not used here and can be removed, but the high side GaN gate must mandatorily protect from an external D11 Zener diode of 6.2 V.

Figure 4. **EVLMG1LPBRDR1 – Typical ACF Flyback application**

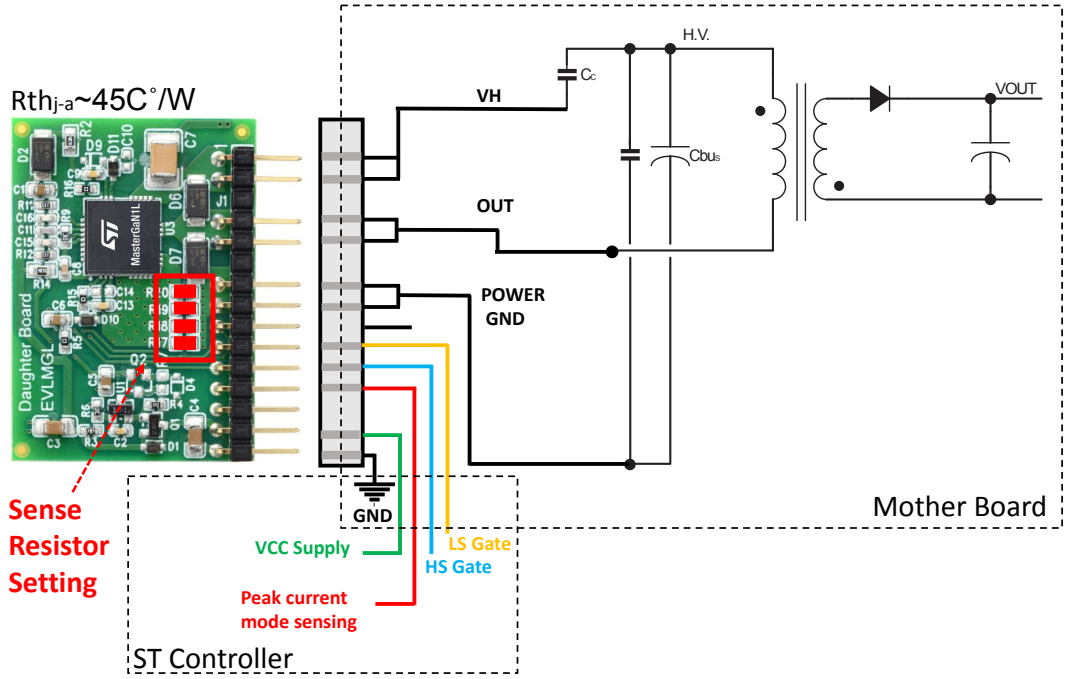
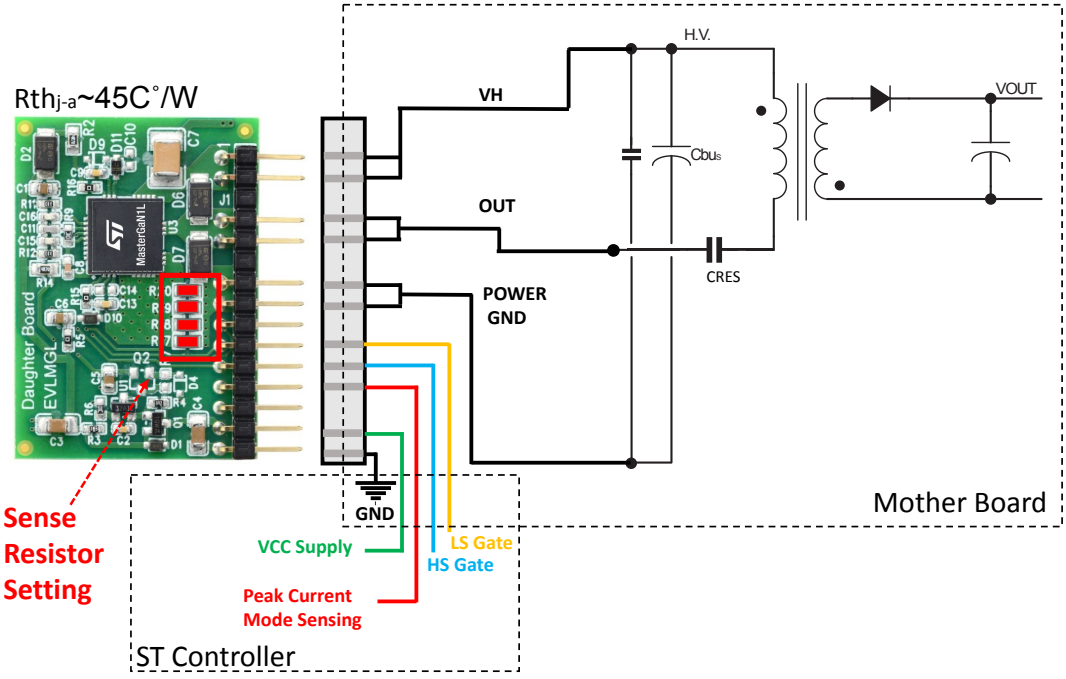


Figure 5. **EVLMG1LPBRDR1 – Typical Resonant Flyback application**



3.3 Synchronous inverse buck

A half-bridge can be used in synchronous inverse buck applications.

Figure 6 shows how to connect the EVLMG1LPBRDR1 to a non-isolated inverse buck in which the switching element and diode are replaced by the MASTERGAN1L.

For these applications sense resistors R17, R18, R19, and R20 must be sized properly depending on the output's final target power.

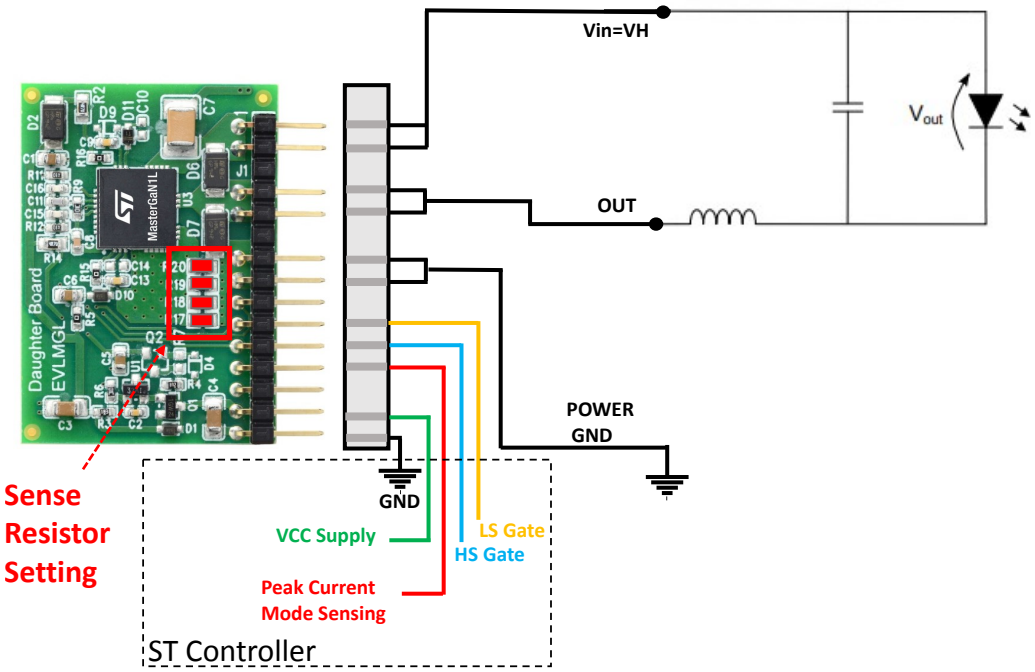
In reference [3] , a dimmable GaN based LED driver has been designed to provide up to 500 W with an applied input voltage of 400 V and an output 1.2 A LED string voltage range between 150 V and 350 V.

In that configuration, the SENSE pin is connected to the controller to close the peak current mode loop.

External body diodes D6 and D7 are not used.

Even if MASTERGAN1L is always working in CCM and the high side GaN gate is operating safely, the external D11 Zener diode is always mounted to protect the high side GaN in case of transient operations (e.g. protection tripping).

Figure 6. EVLMG1LPBRDR1 – Synchronous Inverse Buck application



4 Architecture and component placement

The EVLMG1LPBRDR1 is a 30 x 40 mm wide FR-4 PCB, resulting in an $R_{th(J-A)}$ of 45 °C/W, without forced airflow [4] .

Component placement and PCB layout of both top and bottom sides are depicted in the following pictures Figure 7 and Figure 8.

Figure 7. EVLMG1LPBRDR1 – top and bottom component placement

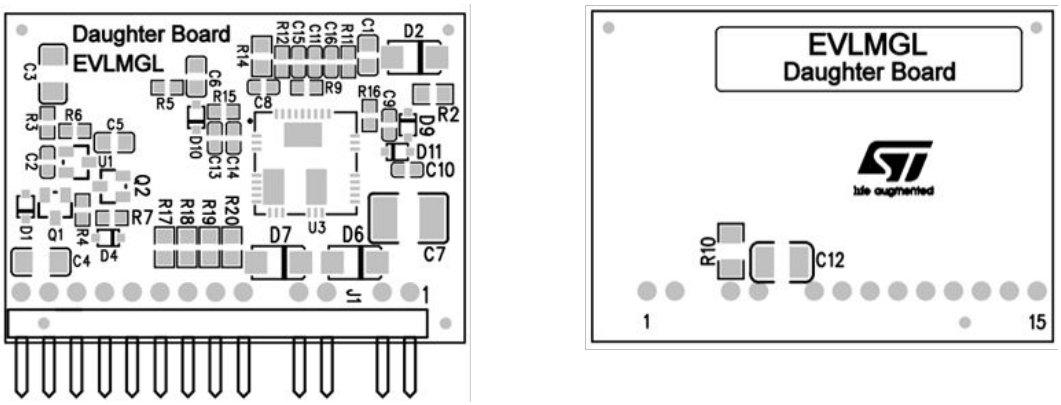
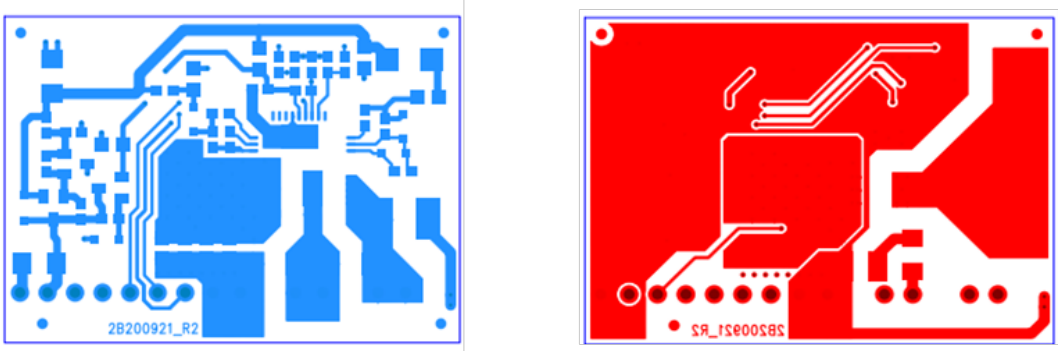


Figure 8. EVLMG1LPBRDR1 – top and bottom PCB layout



5 Bill of material

Table 2. **Bill of material**

Ref.	Value	Package	Description	Supplier
C1	1uF	0805	SMD CERCAP. General Purpose 50V, +/-10%	
C2	1nF	0603	SMD CERCAP. General Purpose 50V, +/-10%	
C3	10uF	1206	SMD CERCAP. General Purpose 50V, +/-10%	
C4	10uF	1206	SMD CERCAP. General Purpose 50V, +/-10%	
C5	1uF	0805	SMD CERCAP. General Purpose 50V, +/-10%	
C6	1uF	0805	SMD CERCAP. General Purpose 50V, +/-10%	
C7	100nF	1812	SMD CERCAP. 630V, +/-10%	TDK
C8	100nF	0603	SMD CERCAP. General Purpose 50V, +/-20%	
C9	47nF	0603	SMD CERCAP. General Purpose 50V, +/-10%	
C10	N.M.	0603	SMD CERCAP. General Purpose 50V, +/-10%	
C11	100pF	0603	SMD CERCAP. General Purpose 50V, +/-5%	
C12	N.M.	0603	SMD CERCAP. General Purpose 50V, +/-10%	
C13	47nF	0603	SMD CERCAP. General Purpose 50V, +/-10%	
C14	N.M.	0603	SMD CERCAP. General Purpose 50V, +/-10%	
C15	10pF	0603	SMD CERCAP. General Purpose 50V, +/-5%	
C16	10pF	0603	SMD CERCAP. General Purpose 50V, +/-5%	
D1	1N4148WS	SOD-322	SMD Fast Switching Rectifier 100V-0.35A	
D2	STTH1R06A	SMA	SMD Rectifier 600V-1A	STMicroelectronics
D4	N.M.	SOD-322	SMD Zener Diode, +/-5%	
D6	STTH1R06A	SMA	SMD Rectifier 600V-1A	STMicroelectronics
D7	STTH1R06A	SMA	SMD Rectifier 600V-1A	STMicroelectronics
D9	N.M.	SOD-323	SMD Zener Diode, +/-5%	
D10	1N4148WS	SOD-323	SMD Fast Switching Rectifier 100V-0.35A	
D11	6V2	SOD-323	SMD Zener Diode 6.2V, +/-5%	NEXPERIA
J1	HEADER 15		Single Row Right Angle PCB Header 15 ways	Wurth code: 61304011021
Q1	BC847C	SOT23	SMD NPN Transistor General Purpose	
Q2	N.M.	SOT23	SMD NPN Transistor General Purpose	
R2	4R6	0805	SMD Resistor 1/10W, 1%	
R3	18K	0603	SMD Resistor 1/10W, 1%	
R4	3K9	0603	SMD Resistor 1/10W, 1%	
R5	0R	0603	SMD Resistor 150V, 1/10W, 1%	
R6	10K	0603	SMD Resistor 1/10W, 1%	
R7	N.M.	0603	SMD Resistor 1/10W, 1%	
R9	10K	0603	SMD Resistor 1/10W, 1%	
R10	N.M.	0603	SMD Resistor 1/10W, 1%	
R11	10R	0603	SMD Resistor 75V, 1/10W, 1%	
R12	10R	0603	SMD Resistor 75V, 1/10W, 1%	

Ref.	Value	Package	Description	Supplier
R14	4R7	0805	SMD Resistor 1/10W, 1%	
R15	0R	0603	SMD Resistor 150V, 1/10W, 1%	
R16	0R	0603	SMD Resistor 150V, 1/10W, 1%	
R17	0R	0805	SMD Resistor 150V, 1/8W, 5%	
R18	0R	0805	SMD Resistor 150V, 1/8W, 5%	
R19	0R	0805	SMD Resistor 150V, 1/8W, 5%	
R20	0R	0805	SMD Resistor 150V, 1/8W, 5%	
U1	TL432AIL3T	SOT23	Volt. Ref. Adjustable Shunt SOT23	STMicroelectronics
U3	MASTERGAN1L	QFN 9x9x1mm	600V half-bridge enhancement mode GaN HEMT with high voltage driver	STMicroelectronics

6 References

[1]
MASTERGAN1L: “600 V half-bridge enhancement mode GaN HEMT with high voltage driver” datasheet on www.st.com

[2]
AN5644: “DC/DC resonant converter for industrial applications using MasterGaN1” on www.st.com

[3]
AN5865: “High power inverse buck for dimmable LED application with MASTERGAN4, HVLED002 and VIPER06XS” on www.st.com

[4]
AN5917: “PCB design optimization for maximizing thermal dissipation in MasterGaN family” on www.st.com

Revision history

Table 3. **Document revision history**

Date	Version	Changes
15-Sep-2023	1	Initial release.

Contents

List of tables

List of figures