Getting started with STEVAL-6986YT2DL evaluation board, 5 W dual isolated output, SIP7 compatible, isobuck-boost converter based on A6986I

Introduction

The STEVAL-6986YT2DL is an evaluation board based on A6986I. The STEVAL-6986YT2DL implements an isobuck-boost topology. The input voltage can go up to 24 V. Thanks to the embedded two secondary windings transformer, a dual isolated output is available (around 20 V and around -5 V). the isolated output power can reach 5 W.

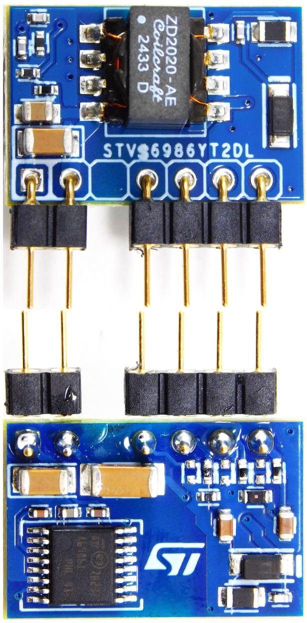
The peculiarity of this board is its compatibility with a SIP7 module both in terms of pinout and concerning the size.

Further flexibility is achieved by matching SIP7 modules with different output voltage pinouts (available on pins 4-5-6 or 5-6-7)

The STEVAL-6986YT2DL works at 250 kHz switching frequency and embeds all the standard protections offered by the A6986I (against overvoltage, overcurrent and overtemperature events).

The embedded transformer offers 1.5 kV isolation.

Figure 1. STEVAL-6986YT2DL board



*Notice: For dedicated assistance, submit a request through our online support portal at **www.st.com/support**.*

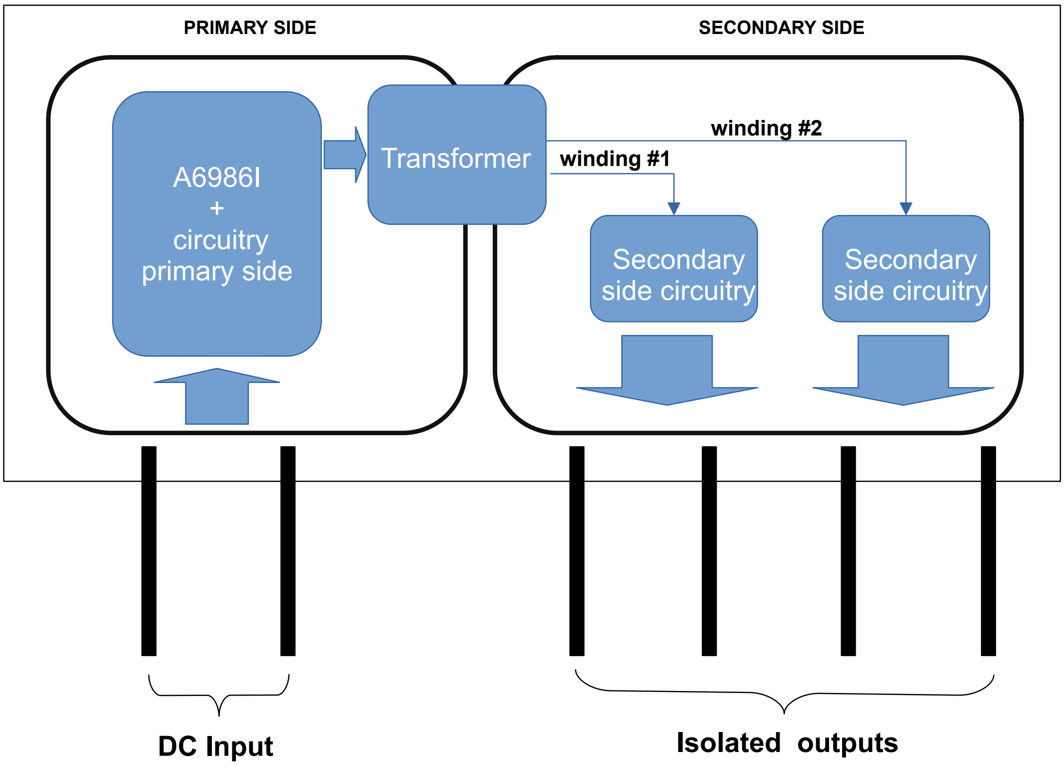
1 Getting started

1.1 Safety instructions

This board is intended for use by skilled technical personnel who are suitably qualified and familiar with the installation, use and maintenance of power electronic systems. The same personnel must be aware of and must apply national accident prevention rules. The electrical installation shall be completed in accordance with the appropriate requirements (e.g., cross-sectional areas of conductors, fusing, and GND connections).

1.2 Functional block diagram

Figure 2. STEVAL_6986YT2DL block diagram



1.3 Features

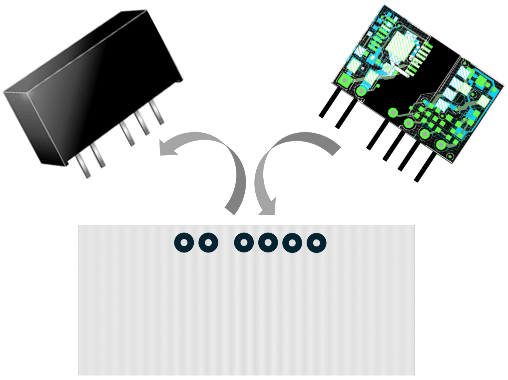
- Isobuck-boost topology
- Up to 24 V operating input voltage
- Compatible with SIP7 modules
- Up to 5 W isolated output capability
- 20 V/-5 V isolated output voltages
- Isolated outputs available at pins 4-5-6 or 5-6-7 (selectable)
- 250 kHz switching frequency
- Protections against overvoltage, overcurrent and overtemperature events

2 How to use the board

The STEVAL-6986YT2DL is configured to deliver a dual voltage (around 20 V and -5 V) at the isolated output that slightly varies with the applied load (see load regulation curves in Section 8). Switching frequency is set to 250 kHz.

The size and the pinout of the STEVAL-6986YT2DL make it suitable for an easy test in any system where a SIP7 module is used. The simplicity of a plug&play test is depicted in Figure 3.

Figure 3. STEVAL-6986YT2DL as replacement of a SIP7 module



In case the STEVAL-6986YT2DL is tested with standard lab equipment, the Figure 4 shows how to connect the instruments. To start any measurement, the below mentioned steps should be followed.

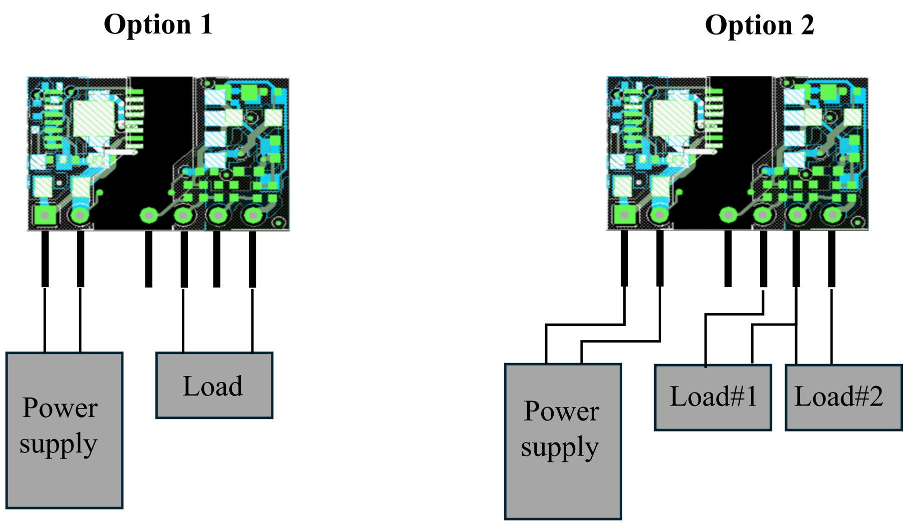
Step 1. Connect the power supply to the test points of VIN and GND.

Step 2. Connect the load between the pin 7 and 5 (option 1) or two different loads, one between pins 7 and 6 and the other one between pin 6 and 5 (option 2).

Step 3. Set the supply voltage VIN from 5 V to 24 V and switch the power supply on.

Step 4. Regulate the current of active load(s).

Figure 4. STEVAL-6986YT2DL basic testing setup



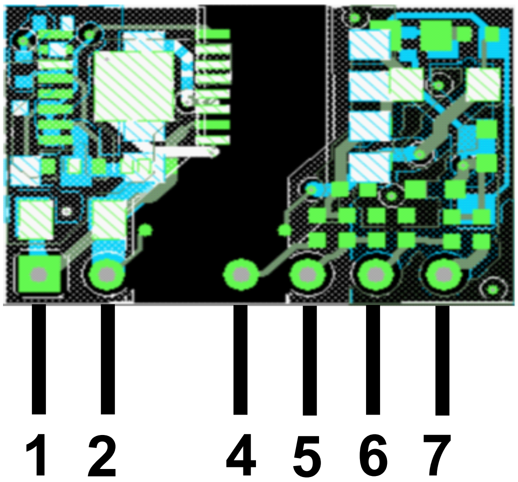
3 Connectors and test points

3.1 J1

This connector is the only one available on the board and is used for the input supply voltage as well the isolated output voltages.

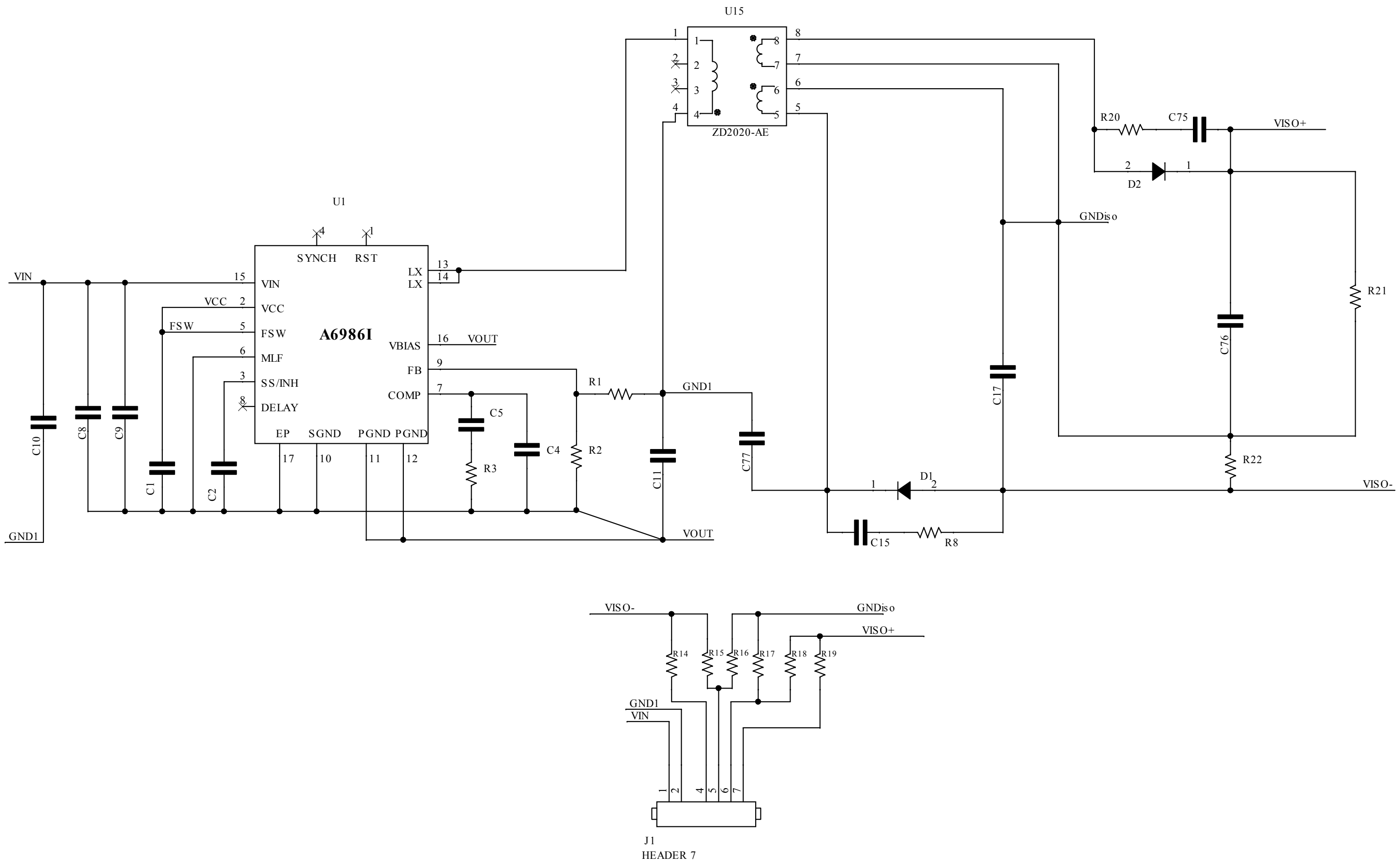
Figure 5 shows which signal each pin of the connector J1 is connected to. Figure 5 shows the corresponding pin numbers at PCB level.

Figure 5. Pin numbering



4 Schematic diagrams

Figure 6. STEVAL-6986YT2DL circuit schematic



5 Bill of materials

Table 1. **STEVAL-6986YT2DL bill of materials**

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	C1	470nF, 16V	CAP, AEC-Q200, 0.47UF, 16V, MLCC, 0402	Taiyo Yuden	EMK105ABJ474KVHF
2	1	C2	68nF, 16V	Condensatore ceramico multistrato SMD, 0.068 µF, 16 V, 0402 [1005 metrico], ± 10%, X7R	YAGEO	AC0402KRX7R7BB683
3	1	C4	10pF, 50V	Condensatore ceramico multistrato SMD, 10 pF, 50 V, 0402 [1005 metrico], ± 5%, C0G / NP0	Murata	GCM1555C1H100JA16D
4	1	C5	680pF, 25V	Condensatori in ceramica multistrato MLCC - SMD/SMT 680 pF 25 VDC 5% 0402 C0G (NP0) AEC-Q200	Murata	GRT1555C1E681JA02J
5	2	C17, C76	4.7uF, 35V	Condensatore ceramico multistrato SMD, 4.7 µF, 35 V, 0603 [1608 metrico], ± 10%, X5R	Murata	GRT188R6YA475KE13D
		C77	4.7nF, 2kV	Condensatore ceramico multistrato SMD, alta tensione, 4700 pF, 2 kV, 1808 [4520 metrico], ± 10%	KEMET	C1808C472KGRACTU
6	2	C8, C10	10uF, 50V	Condensatore ceramico multistrato SMD, 10 µF, 50 V, 1206 [3216 metrico], ± 10%, X5R	Murata	GRT31CR61H106KE01L
7	1	C9	100nF, 50V	Condensatore ceramico multistrato SMD, 0.1 µF, 50 V, 0402 [1005 metrico], ± 10%, X7R	TDK	CGA2B3X7R1H104K050BB
8	1	C11	22uF, 25V	Condensatore ceramico multistrato SMD, 22 µF, 25 V, 0805 [2012 metrico], ± 20%, X5R	Murata	GRT21BR61E226ME13L
9	1	C15	82pF, 50V	Condensatore ceramico multistrato SMD, 82 pF, 50 V, 0402 [1005 metrico], ± 5%, C0G / NP0	YAGEO	AQ0402JRNPO9BN820
10	1	C75	82pF, 50V	Condensatore ceramico multistrato SMD, 82 pF, 50 V, 0402 [1005 metrico], ± 5%, C0G / NP0	YAGEO	AQ0402JRNPO9BN820
11	1	R1	16kΩ	Resistore a chip SMD, 16 kohm, ± 1%, 62.5 mW, 0402 [1005 metrico], film spesso	Vishay	CRCW040216K0FKED
12	1	R2	1.1kΩ	Resistore a chip SMD, 1.1 kohm, ± 1%, 100 mW, 0402 [1005 metrico], film spesso, precisione	KOA	RK73H1ETTP1101F
13	1	R3	33kΩ	Thick Film Resistors - SMD 33 k Ohm 62.5mW 0402 5% AEC-Q200 Standard Power Version	YAGEO	AC0402JR-0733KL
14	1	R8	600	Resistore a chip SMD, 600 ohm, ± 1%, 500 mW, 0805 [2012 metrico], film spesso, alta potenza	Vishay	CRCW0805600RFKEAHP
15	-	R14	--			

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
16	1	R15	0Ω	Thick Film Resistors - SMD 0402 Zero ohm Jumper 0.05ohm AEC-Q200	Panasonic	ERJ-S020R00X
17	-	R16	--			
18	1	R17	0Ω		Panasonic	ERJ-S020R00X
19	-	R18	--			
20	1	R19	0Ω		Panasonic	ERJ-S020R00X
21	1	R20	600	Resistore a chip SMD, 600 ohm, ± 1%, 500 mW, 0805 [2012 metrico], film spesso, alta potenza	Vishay	CRCW0805600RFKEAHP
22	1	R21	4.7kΩ	Resistore SMD, 4.7 kohm, ± 1%, 250 mW, 0603 [1608 metrico], film spesso	Panasonic	ERJUP3F4701V
23	1	R22	1.2kΩ	Resistore a chip SMD, 1.2 kohm, ± 1%, 62.5 mW, 0402 [1005 metrico], film spesso	Vishay	CRCW04021K20FKED
24	1	D1	Schottky diode 100V	Automotive, Raddrizzatore Schottky, 100 V, 1 A, singolo, SOD-123 F, 2 Pin, 725 mV	ST	STPST1H100ZFY
25	1	D2, SOD123Flat	Schottky diode 100V	Automotive, Raddrizzatore Schottky, 100 V, 1 A, singolo, SOD-123 F, 2 Pin, 725 mV	ST	STPST1H100ZFY
26	1	U1, HTSSOP16	A6986ITR	isobuck converter	ST	A6986ITR
27	1	U15	ZD2020-AE	Transformer, dual secondary winding, 1.5kV isolation	Coilcraft	ZD2020-AE
28	1	J1	header	Connettore maschio Preci-Dip, 4 vie, 1 fila, passo 2.54mm	Mill-Max manufacturing comp.	399-10-104-10-009000
29	1	J1	header	Connettore maschio Preci-Dip, 2 vie, 1 fila, passo 2.54mm	Mill-Max manufacturing comp.	399-10-102-10-009000

Table 2. Main parameters of the transformer ZD202-AE

Description	Value
Turn ratio 1 (primary winding vs secondary winding #1)	1:1.563
Turn ratio 1 (primary winding vs secondary winding #2)	1:0.438
Magnetizing inductance (typ.)	20 µH
Leakage inductance (typ.)	250 nH
Primary winding resistance (typ.)	120 mΩ
Secondary winding resistance #1 (typ.)	370 mΩ
Secondary winding resistance #2 (typ.)	160 mΩ

6 STEVAL-6986YT2DL layout

The STEVAL-6986YT2DL is a 4-layer PCB with 1oz copper thickness.

Figure 7. PCB layout (top)

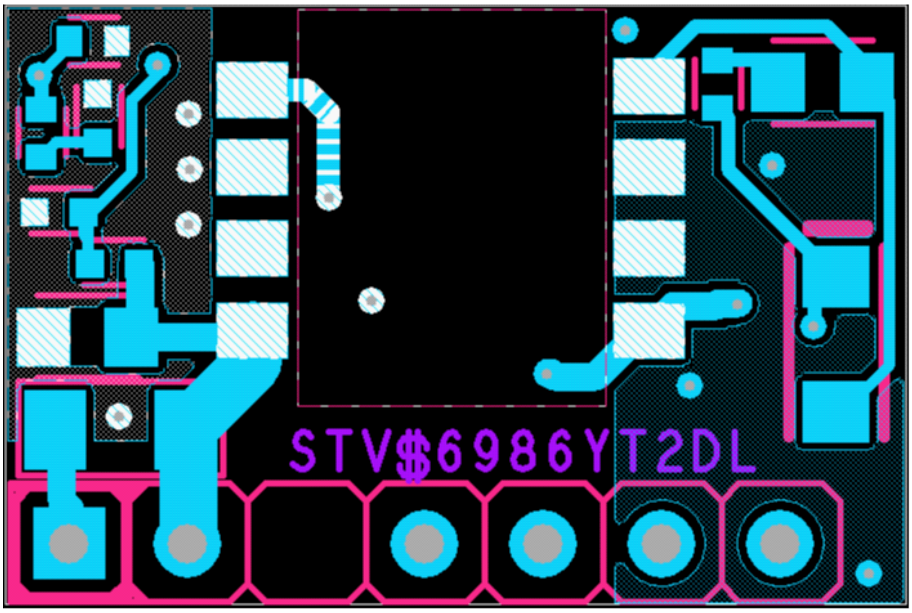
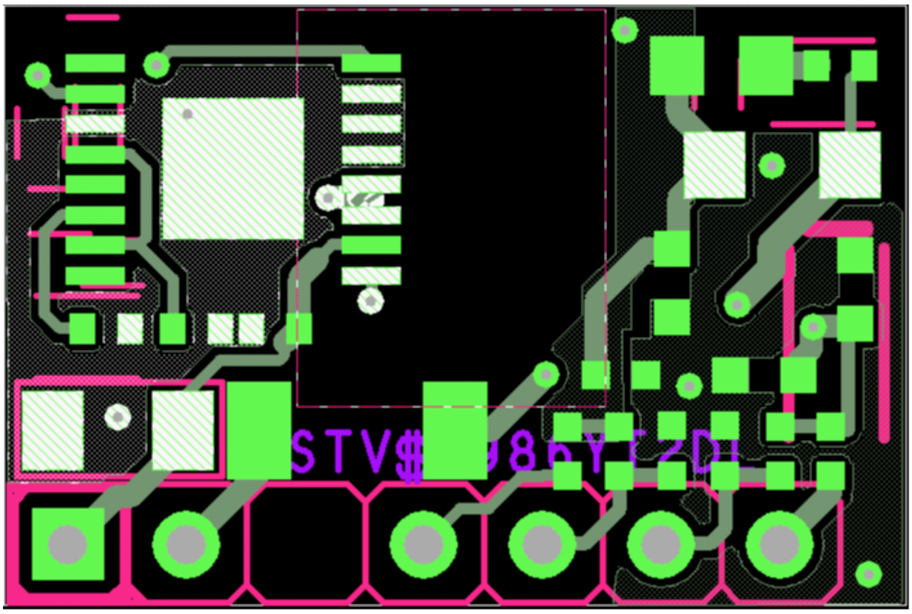


Figure 8. PCB layout (bottom)



7 Board versions

Table 3. STEVAL-6986YT2DL versions

Finished good	Schematic diagrams	Bill of materials
STV$6986YT2DL [1]	STV$6986YT2DL schematic diagrams	STV$6986YT2DL bill of materials

1. This code identifies the STEVAL-6986YT2DL evaluation board first version.

8 STEVAL-6986YT2DL performance

Load regulation

The load regulation is here defined under two different load configurations:

- Balanced load, load connected between V_{ISO+} and V_{ISO-} (the same current drawn from V_{ISO+} is sourced to V_{ISO-}, see Figure 8).
- Unbalanced load, two different and independent loads, one connected between V_{ISO+} and GND_{iso}, the other one between GND_{iso} and V_{ISO-} (see Figure 8).

Figure 9. Description of the possible load connections for the load regulation measurements

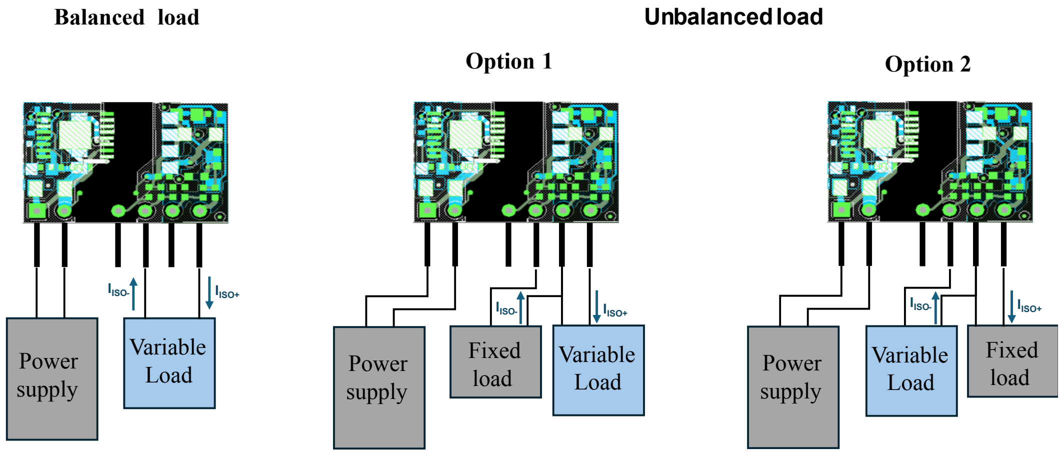


Figure 10. Load regulation at different V_{IN}, positive output (balanced load)

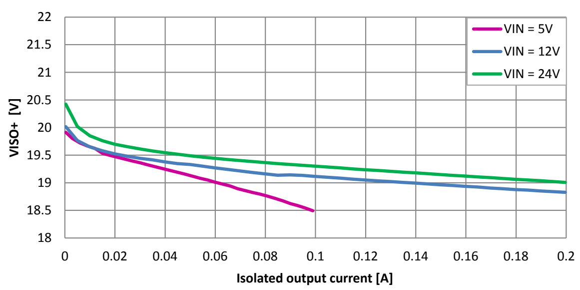


Figure 11. Load regulation at different V_{IN}, negative output (balanced load)

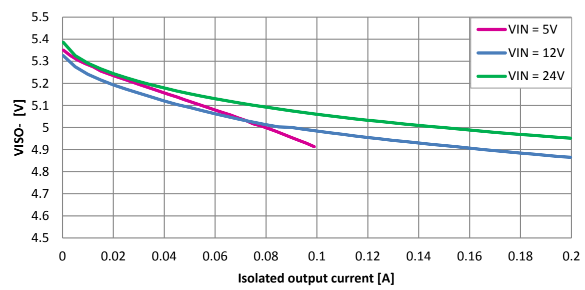


Figure 12. Load regulation positive output, unbalanced load, option1

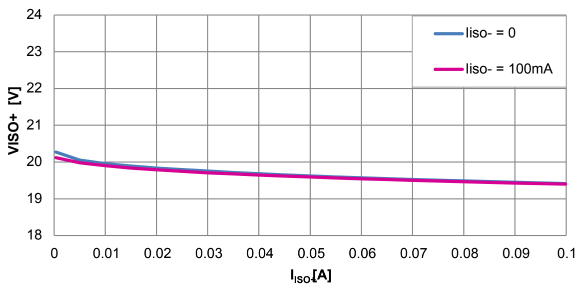


Figure 13. Load regulation negative output, unbalanced load, option1

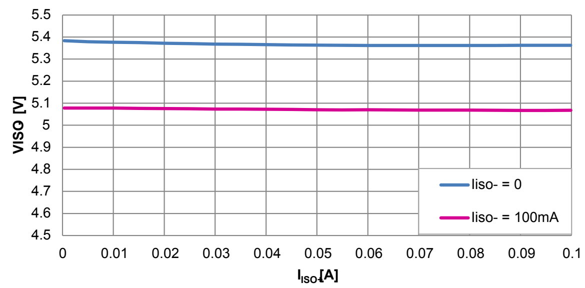


Figure 14. Load regulation positive output, unbalanced load, option1

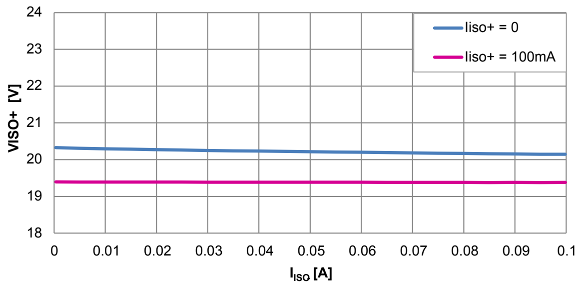
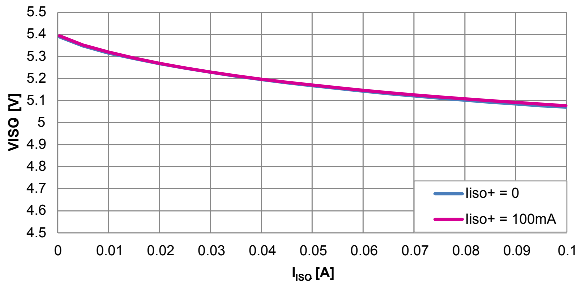


Figure 15. Load regulation negative output, unbalanced load, option1



9 Disclaimer

The certification of the STEVAL-6986YT2DL is fulfilled with the schematic, the layout and the BOM indicated in the sections Section 4: Schematic diagrams, Section 5: Bill of materials and Section 6: STEVAL-6986YT2DL layout.

Any drift from the schematic, the layout and the BOM described in the sections Section 4: Schematic diagrams, Section 5: Bill of materials and Section 6: STEVAL-6986YT2DL layout, invalidates the certification and the EMC compliance of the STEVAL-6986YT2DL is no longer ensured.

Any change in the schematic, layout and BOM implemented by the user of the STEVAL-6986YT2DL are under the user's responsibility.

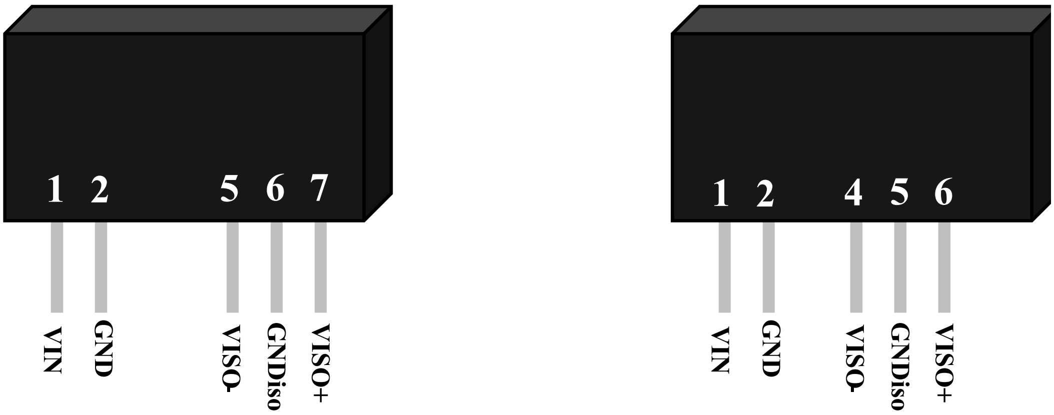
The recommended changes in the BOM described in the next chapters should be considered as possible application ideas in case the user wish to adapt the board to other typical application requirements.

Although the recommended modifications can be considered as minor changes, the certification of the STEVAL-6986YT2DL remains valid only under the conditions mentioned in the sections Section 4: Schematic diagrams, Section 5: Bill of materials and Section 6: STEVAL-6986YT2DL layout.

10 Board setting capability

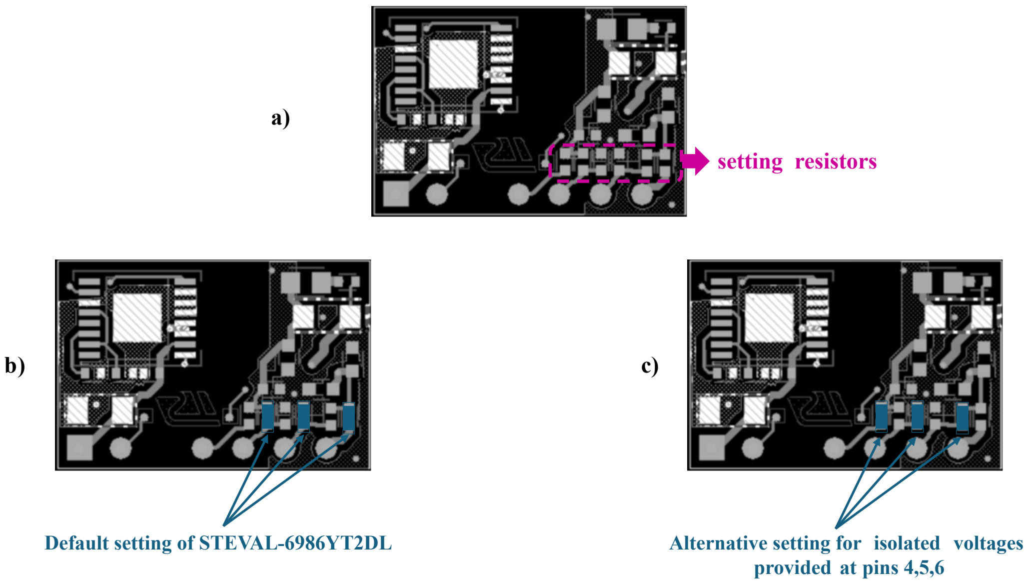
The STEVAL-6986YT2DL offers the flexibility to be adapted to the most frequent SIP7 module pinout configurations (depicted in Figure 17). STEVAL-6986YT2DL is by default configured with the isolated voltages available on the pins 5, 6, 7.

Figure 16. Typical SIP7 module pinouts (on the left the pinout provided by STEVAL-6986YT2DL



Nevertheless, the STEVAL-6986YT2DL can be easily adapted to match the other configuration. Some setting resistors (simple 0 Ω resistor) are available on the board (see Figure 18. Input EMC filter circuitry). Moving them to a different position make the isolated voltages available on pins 4, 5, 6 instead of 5, 6, 7 (see Figure 18. Input EMC filter circuitry).

Figure 17. Pinout selection capability



11 Optional EMC filter

Very often the STEVAL-6986YT2DL will be placed in an application where an input EMC filtering is already foreseen.

If this assumption is not valid or it is necessary to implement a further filtering, the filter shown in Figure 18 can be built, with the values recommended in Table 4.

Figure 18. Input EMC filter circuitry

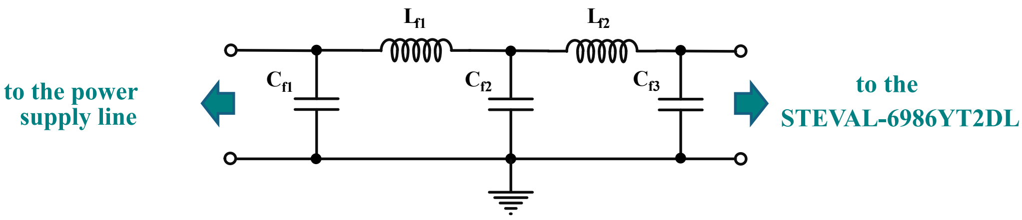


Table 4. Recommended component values for the input EMC filter

Reference	Description
Cf1	4.7 µF, 50V, MLCC
Cf2	4.7 µF, 50V, MLCC
Cf3	4.7 µF, 50V, MLCC
Lf1	Ferrite bead, 220 Ω at 100 MHz
Lf2	Inductor 4.7 µH

12 eDesignSuite

The eDesignSuite software available on the www.st.com website helps in the selection of the devices as well as in the design of the external components suitable for a certain application.

After inserting the application conditions, the device can be selected and the design of the external components is automatically carried out.

13 Application idea

Changing the transformer for GaN gate drivers compatibility

The BOM described in Section 5: Bill of materials is defined for application requiring two voltages, one positive and one negative, respectively around 20 V and -5 V. These voltages are commonly used by SiC MOSFET gate drivers.

Replacing the transformer with another one (same size and pinout, parameters described in Table 5. Main parameters of the transformer ZE2774-BE), the isolated voltages can match the typical values required by a GaN gate driver (around 6 V and -3 V).

Table 5. Main parameters of the transformer ZE2774-BE

Description	Value
Turn ratio 1 (primary winding vs secondary winding #1)	1:0.5
Turn ratio 1 (primary winding vs secondary winding #2)	1:0.27
Magnetizing inductance (typ.)	20 µH
Leakage inductance (typ.)	410 nH
Primary winding resistance (typ.)	170 mΩ
Secondary winding resistance #1 (typ.)	430 mΩ
Secondary winding resistance #2 (typ.)	300 mΩ

Here below the load regulation performance, with the assumption of using a balanced load (see Figure 8. PCB layout (bottom)).

Table 6. Main parameters of the transformer ZE2774-BE

Figure 19. Load regulation, positive output, V_{IN} = 12 V

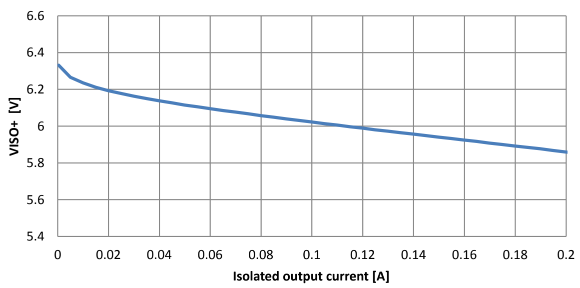
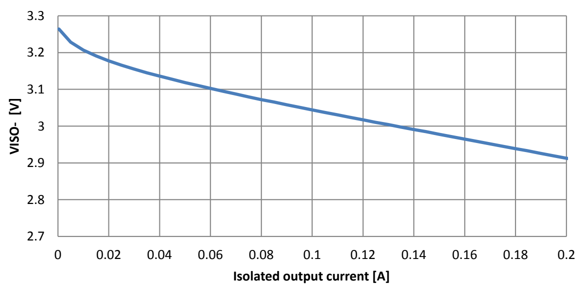


Figure 20. Load regulation, positive output, V_{IN} = 12 V



Further adjustments for the isolated voltage are possible by changing the primary output voltage resistor divider (R1 and R2), which is by default set to generate a primary output voltage of -13 V (R1 = 16 kΩ, R2 = 1.1 kΩ).

14 Regulatory compliance information

Notice for US Federal Communication Commission (FCC)

For evaluation only; not FCC approved for resale

FCC NOTICE - This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine

whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

Notice for Innovation, Science and Economic Development Canada (ISED)

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

Notice for the European Union

This device is in conformity with the essential requirements of the Directive 2014/30/EU (EMC) and of the Directive 2011/65/EU (RoHS II), including subsequent revisions and additions, as well as amended by the Delegated Directive 2015/863/EU (RoHS III). Compliance to EMC standards in Class A (industrial intended use).

Notice for the United Kingdom

This device is in compliance with the UK Electromagnetic Compatibility Regulations 2016 (UK S.I. 2016 No. 1091) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK S.I. 2012 No. 3032). Compliance to EMC standards in Class A (industrial intended use).

Revision history

Table 7. **Document revision history**

Date	Revision	Changes
04-Apr-2025	1	Initial release.
18-Apr-2025	2	Updated Cover image and Title.

Contents

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