Application Note

LM5181 Bipolar + and - 18 V Output Design for Signal Chains in PLC Applications

TEXAS INSTRUMENTS

ABSTRACT

This application note describes a dual output design using the LM5181 PSR fly-back DC/DC converter. A dual isolated output voltage rail of + and - 18 V at up to 65 mA is provided from an input voltage of 16 V to 32 V. A bi-polar voltage rail is required for powering op-amps in many diverse signal chain applications.

Table of Contents

List of Figures

List of Tables

Trademarks

All trademarks are the property of their respective owners.

1 Introduction

This application report describes a dual output design using the LM5181 PSR fly-back DC/DC converter. A dual isolated output voltage rail of +/- 18 V at up to 65 mA is provided from an input voltage of 16 V to 32 V; see Table 1-1 . A bi-polar voltage rail is required for powering op-amps in many diverse signal chain applications. The design was implemented by modifying a standard dual output LM5180-Q1 EVM, found here: LM5180EVM_DUAL. Performance results, along with the schematic and BOM can be found within this report.

Although this design highlights the LM5181, other devices in this family can also be used, such as the LM5181-Q1, LM5180, and LM5180-Q1. Other common op-amp supply voltages are easily accommodated by making the changes shown in Table 1-2. For precision, low noise applications, the TPS7A39 dual LDO can be used as a post regulator.

Table 1-1. Design Ratings

Output Voltage	Input Voltage	Output Current
+/- 18 V	16 V to 32 V	65 mA (each rail)

Table 1-2. Output Voltage Options

Output Voltage	R6	R5
+/- 18 V	121 kΩ	453 kΩ
+/- 15 V	100 kΩ	383 kΩ
+/- 12 V	80.6 kΩ	309 kΩ

2 Schematic

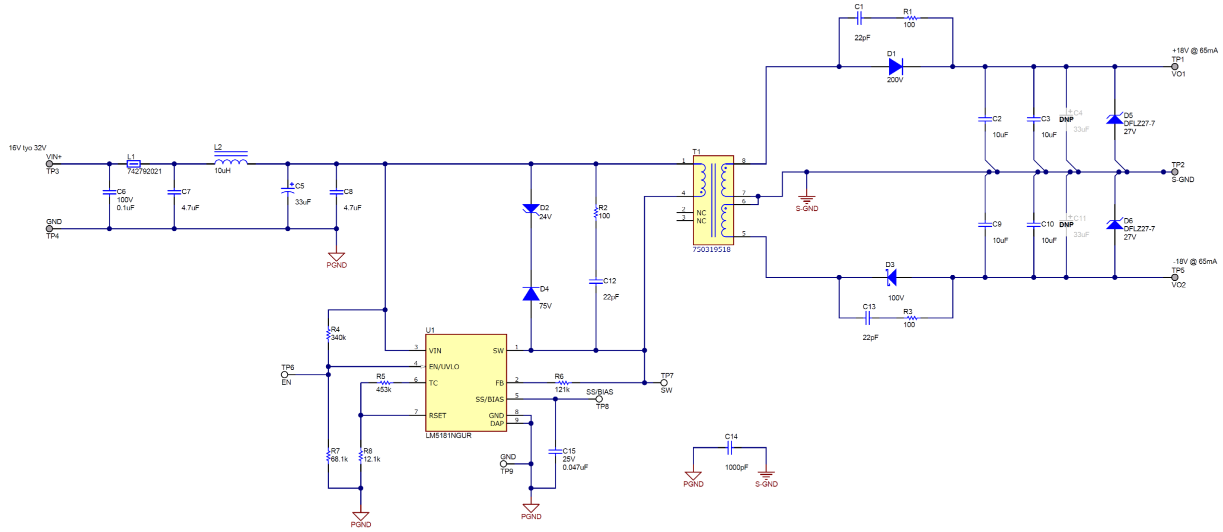


Figure 2-1. Test Schematic

3 Test Results

The data in the following graphs were taken with a common load connected between the positive and negative output voltage rails. Output current refers to the common load current. This data is valid for an ambient temperature of 25ºC.

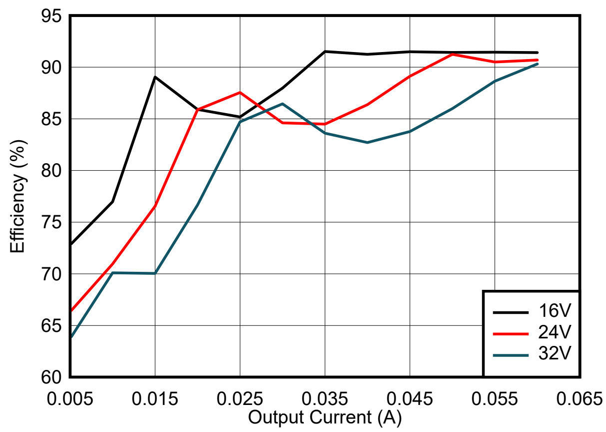


Figure 3-1. Efficiency

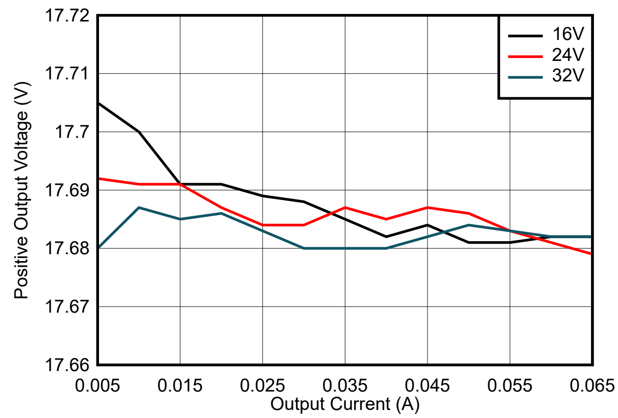


Figure 3-2. Positive Rail Output Voltage

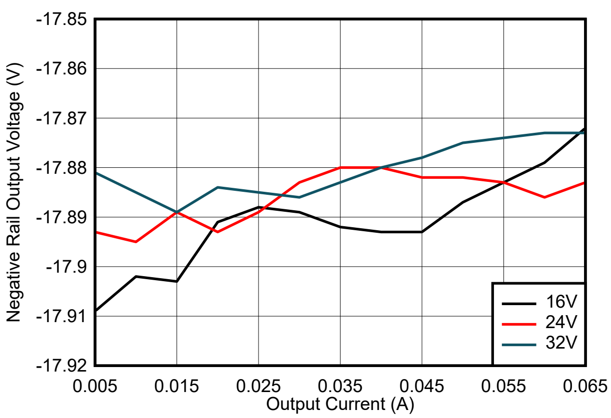


Figure 3-3. Negative Rail Output Voltage

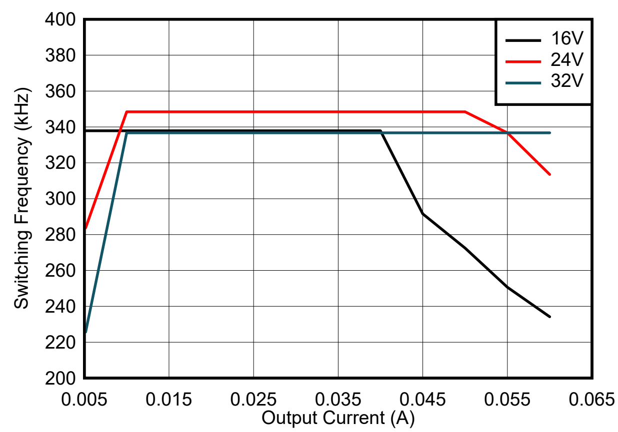
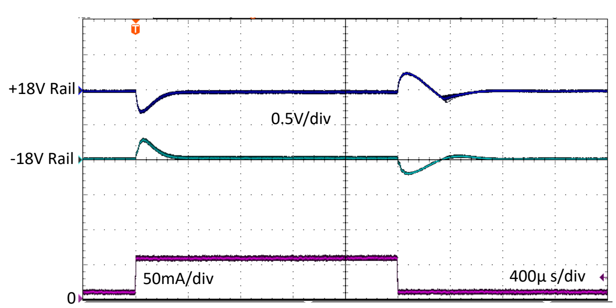


Figure 3-4. Switching Frequency



V_{IN} = 24 V I_{OUT} = 5 mA to 65 mA

Figure 3-5. Load Transient

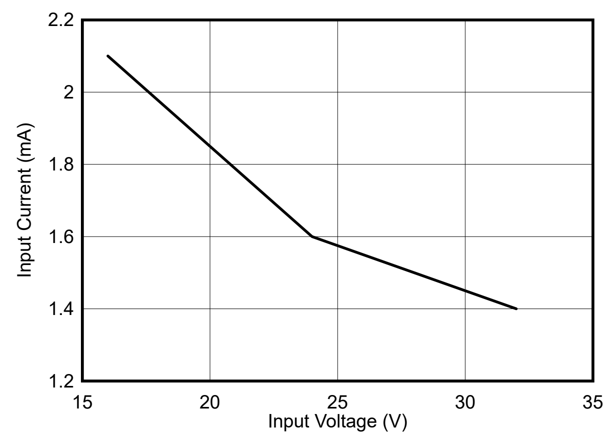
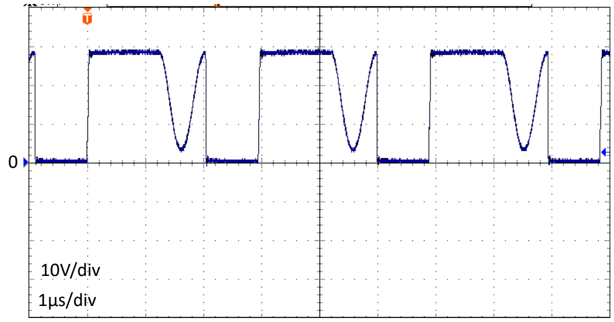
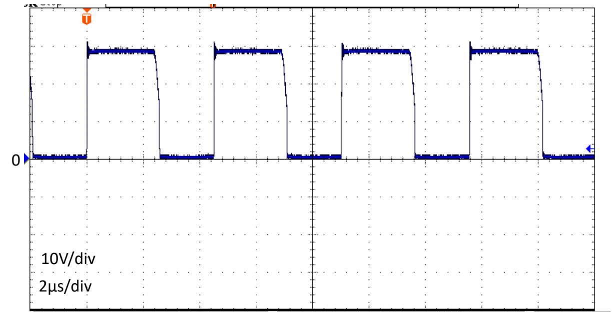


Figure 3-6. No Load Input Supply Current



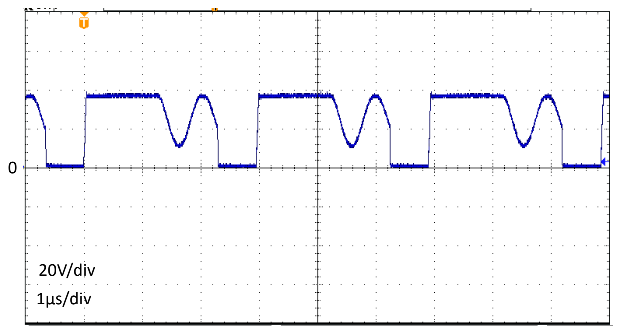
V_{IN} = 16 V I_{OUT} = 25 mA

Figure 3-7. Switch Node



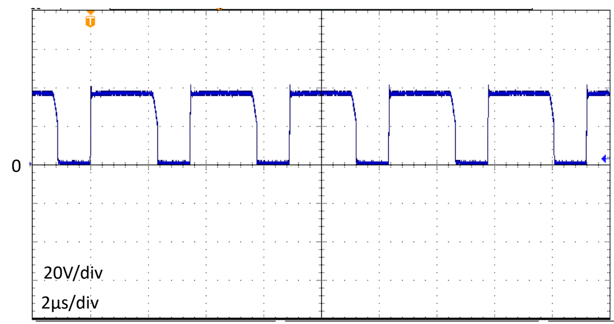
V_{IN} = 16 V I_{OUT} = 65 mA

Figure 3-8. Switch Node



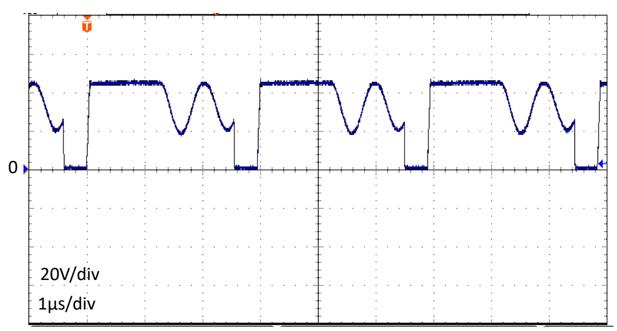
V_{IN} = 24 V I_{OUT} = 25 mA

Figure 3-9. Switch Node



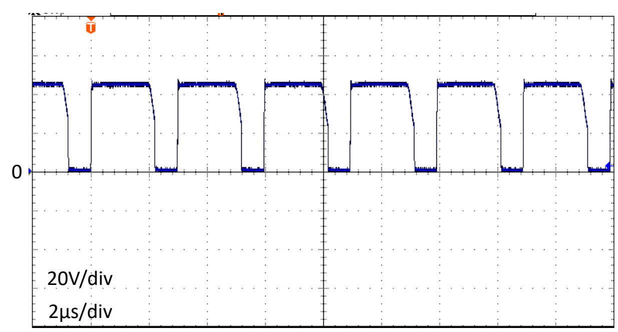
V_{IN} = 24 V I_{OUT} = 65 mA

Figure 3-10. Switch Node



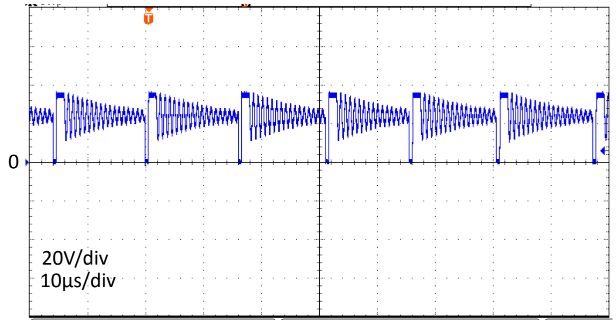
V_{IN} = 32 V I_{OUT} = 25 mA

Figure 3-11. Switch Node



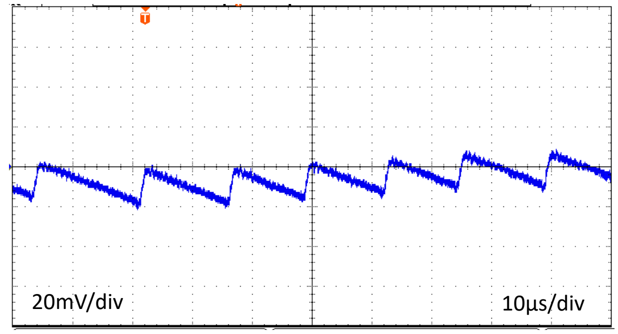
V_{IN} = 32 V I_{OUT} = 65 mA

Figure 3-12. Switch Node



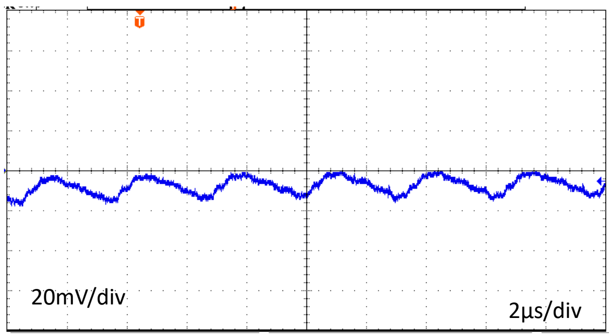
V_{IN} = 24 V I_{OUT} = 5 mA

Figure 3-13. Switch Node



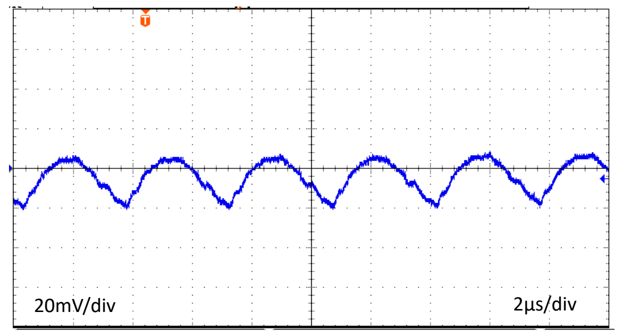
V_{IN} = 24 V I_{OUT} = 5 mA

Figure 3-14. Positive Output Voltage Ripple



V_{IN} = 24 V I_{OUT} = 25 mA

Figure 3-15. Positive Output Voltage Ripple

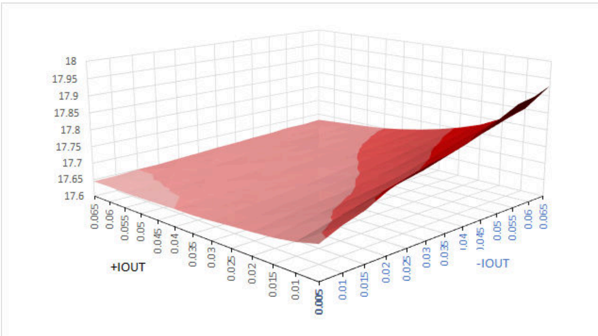


V_{IN} = 24 V I_{OUT} = 65 mA

Figure 3-16. Positive Output Voltage Ripple

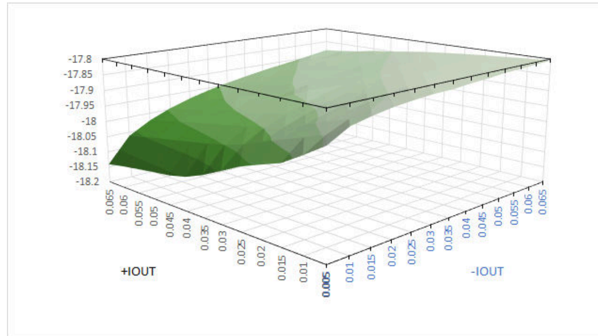
3.1 Cross-regulation

The following results were obtained by independently varying the load current on both the positive and negative rail. In this way a measure of the typical cross regulation performance is illustrated.



V_{IN} = 24 V

Figure 3-17. Positive Rail Load Regulation



V_{IN} = 24 V

Figure 3-18. Negative Rail Load Regulation

4 Bill of Materials

Table 4-1. Bill of Materials (BOM)

Designator	Quantity	Description	Package	PartNumber	Manufacturer
C1	1	CAP, CERM, 22 pF, 250 V,+/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	0603	251R14S220JV4T	Johanson Technology
C2, C3, C9, C10	4	CAP, CERM, 10 uF, 25 V, +/- 10%, X7R, 1206	1206	GRM31CR71E106KA12L	MuRata
C5	1	CAP, AL, 33 uF, 100 V, +/- 20%, 0.7 ohm, AEC-Q200 Grade 2, SMD	SMT Radial G	EEE-FK2A330P	Panasonic
C6	1	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7S, AEC-Q200 Grade 1, 0603	0603	CGA3E3X7S2A104K080AB	TDK
C7, C8	2	CAP, CERM, 4.7 uF, 100 V, +/- 10%, X7S, 1210	1210	GRM32DC72A475KE01L	MuRata
C12, C13	2	CAP, CERM, 22 pF, 100 V, +/- 5%, C0G/NP0, 0603	0603	GRM1885C2A220JA01D	MuRata
C14	1	CAP, CERM, 1000 pF, 2000 V, +/- 10%, X7R, 1206_190	1206_190	202R18W102KV4E	Johanson Technology
C15	1	CAP, CERM, 0.047 uF, 25 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	GCM188R71E473KA37D	MuRata
D1	1	Diode, Superfast Rectifier, 200 V, 1 A, AEC-Q101, 2.8x1.8mm	2.8x1.8mm	US1DFA	Fairchild Semiconductor
D2	1	Diode, Zener, 24 V, 1 W, PowerDI123	PowerDI123	DFLZ24-7	Diodes Inc.
D3	1	Diode, Schottky, 100 V, 1 A, AEC-Q101, SOD-123W	SOD-123W	PMEG10010ELRX	Nexperia
D4	1	Diode, Ultrafast, 75 V, 0.25 A, SOD-323	SOD-323	CMDD4448	Central Semiconductor
D5, D6	2	Diode, Zener, 27 V, 1 W, PowerDI123	PowerDI123	DFLZ27-7	Diodes Inc.
L1	1	Ferrite Bead, 22 ohm @ 100 MHz, 6 A, 0805	0805	742792021	Wurth Elektronik
L2	1	Inductor, Shielded Drum Core, Ferrite, 10 uH, 1 A, 0.12 ohm, SMD	WE-TPC-M1	744042100	Wurth Elektronik
R1, R3	2	RES, 100, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100RFKEA	Vishay-Dale
R2	1	RES, 100, 1%, 0.1 W, 0603	0603	CRCW0603100RFKEA	Vishay-Dale
R4	1	RES, 340 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603340KFKEA	Vishay-Dale

Table 4-1. Bill of Materials (BOM) (continued)

Designator	Quantity	Description	Package	PartNumber	Manufacturer
R5	1	RES, 453 k, 1%, 0.1 W, 0603	0603	RC0603FR-07453KL	Yageo
R6	1	RES, 121 k, 1%, 0.1 W, 0603	0603	RC0603FR-07121KL	Yageo
R7	1	RES, 68.1 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060368K1FKEA	Vishay-Dale
R8	1	RES, 12.1 k, 1%, 0.1 W, 0603	0603	CRCW060312K1FKEA	Vishay-Dale
T1	1	TRANSFORMER	SMT8_8MM6_8MM26	750319518	Wurth Electronics
TP1, TP2, TP3, TP4, TP5	5	Terminal, Turret, TH, Double	Keystone1573-2	1573-2	Keystone
TP6, TP7, TP8, TP9	4	Test Point, Miniature, SMT	Testpoint_Keystone_Miniature	5015	Keystone
U1	1	65-VIN PSR Flyback DC/DC Converter with 100-V, 0.75-A Integrated MOSFET	WSON8	LM5181NGUR	Texas Instruments
C4, C11	0	CAP, TA, 33 uF, 25 V, +/- 10%, 0.09 ohm, SMD	7343-31	T495D336K025ATE090	Kemet

5 References

- Texas Instruments, LM5180 65-VIN no-opto Flyback Converter with 100-V, 1.5-A Integrated MOSFET data sheet.
- Texas Instruments, LM5181 65-VIN no-opto Flyback Converter with 100-V, 0.75-A Integrated MOSFET data sheet.
- Texas Instruments, LM25184 42-VIN no-opto Flyback Converter with 65-V, 4.1-A Integrated MOSFET data sheet.
- Texas Instruments, LM5180EVM-DUAL Wide VIN PSR Flyback Converter Dual-Output Evaluation module data sheet.
- Texas Instruments, TPS7A39 150-mA, 33-V, Low-noise, High-PSRR, Dual-Channel Positive and Negative Low-Dropout Voltage Regulator data sheet.
- Texas Instruments, Selecting Output Caps to Optimize Ripple and Stability in PSR Flyback Converters data sheet.
- Texas Instruments, How an Auxless PSR-Flyback Converter can Increase PLC Reliability and Density data sheet.