

Test Report: PMP21953

40-V Isolated Comparator-Based Power Supply Reference Design



Description

This reference design demonstrates a cost focused approach of an isolated power supplies with low current capability. The design consists of three options of three different topologies. All three design options are based on a high voltage comparator TLV1805-Q1 which works as a free-running oscillator and a driver. There is no control loop therefore the output voltage depends on the input voltage and load.

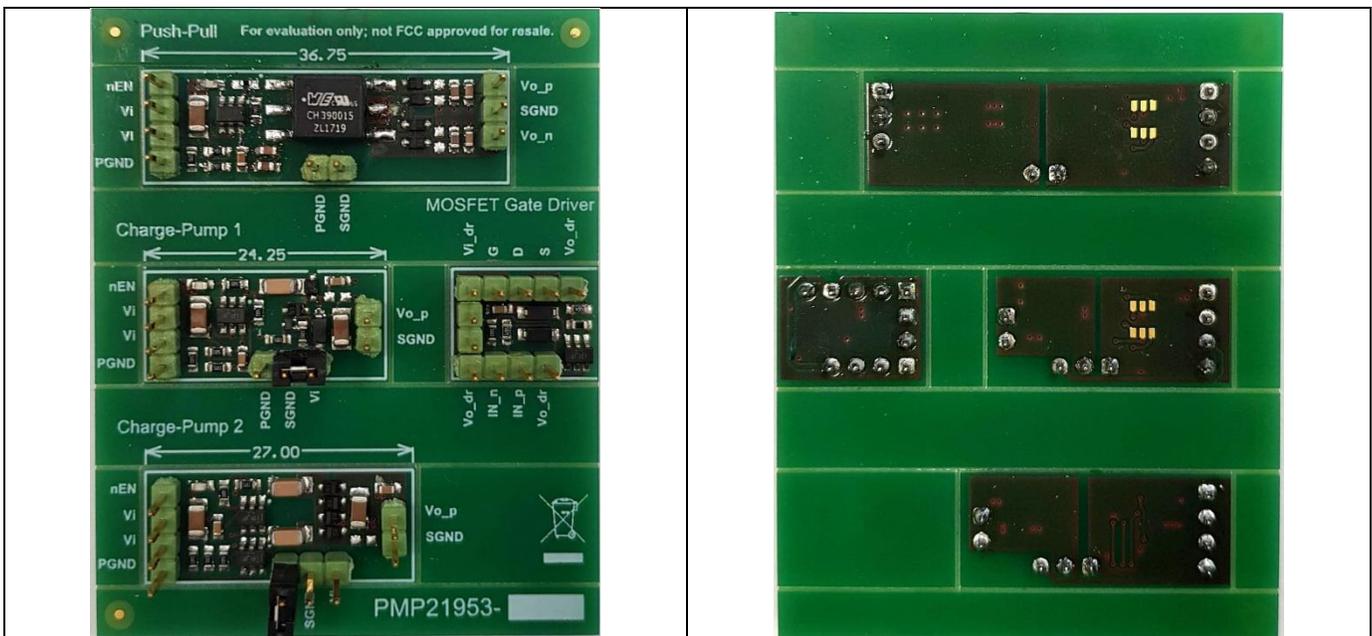
Designs are intended to be used in automotive applications for example:

- Isolation amplifier supply for hot-side current sensing
- NFET reverse polarity protection charge pump
- Back-to-back NFET gate drive charge-pump (e.g. power disconnecter)
- Small IGBT/SiC gate drive power supply

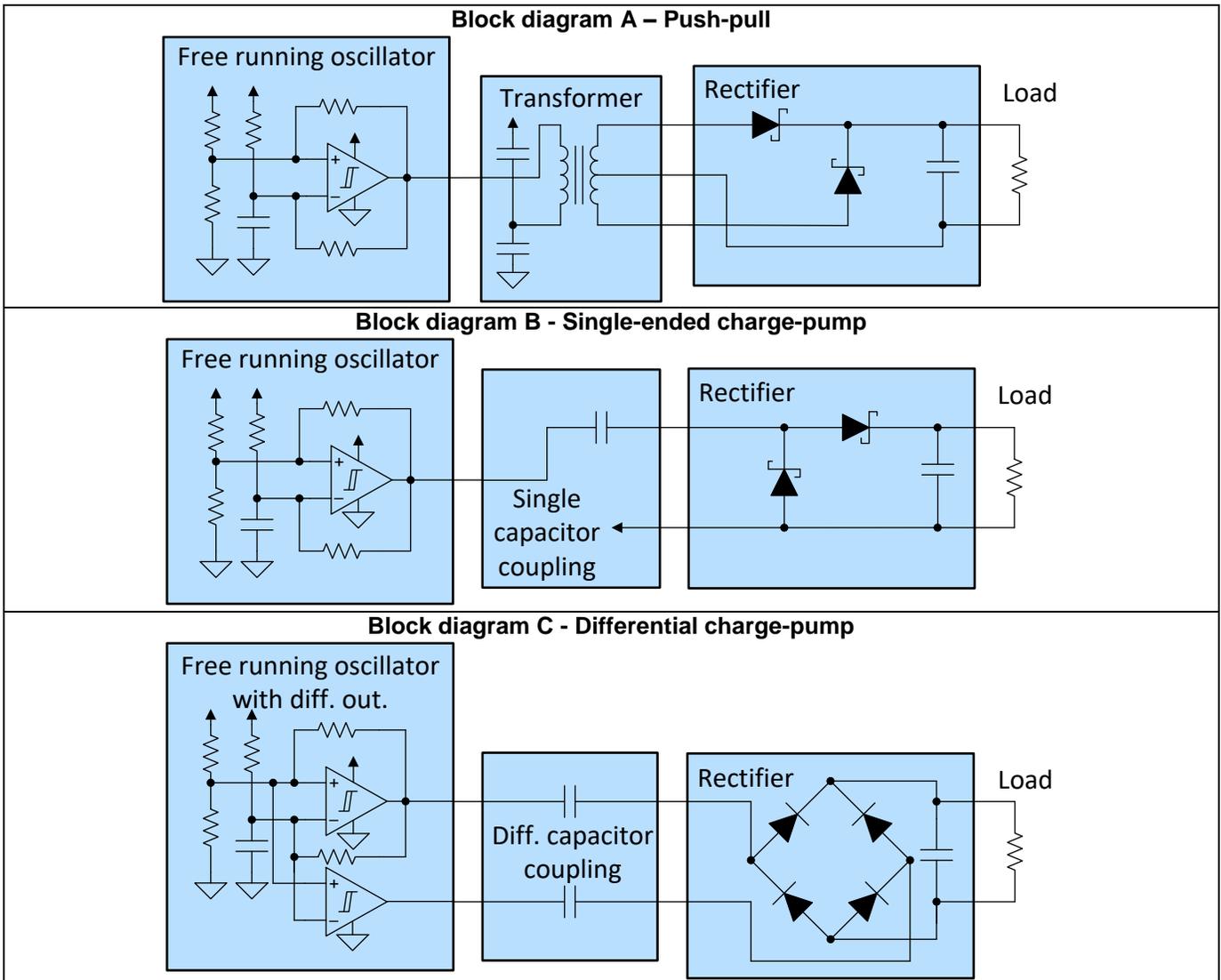
The features common to all three topologies:

- Automotive voltage input allows direct connection to car battery ($V_{in_max}=40V$)
- Easy customizable for various applications
- Low BOM cost
- Tiny PCB area

Additionally a simple output voltage limiter was designed single-ended charge-pump topology. Purpose of this is to statically drive a gate of a NFET while not exceeding VGS of the NFET even in case of higher input voltage. This replaces using just Zener diode. Use of this voltage limiter results in significant decrease of static current consumption because the oscillator gets disabled as soon as the output voltage reaches desired value. However this creates slow secondary voltage oscillations.



An IMPORTANT NOTICE at the end of this TI reference design addresses authorized use, intellectual property matters and other important disclaimers and information.



1 Test Prerequisites

1.1 Voltage and Current Requirements

Table 1. Voltage and Current Requirements – topology A (Push-Pull)

PARAMETER	SPECIFICATIONS
Input voltage	8..36VDC
Output voltage	4..18VDC
Output current	5..50mA

Table 2. Voltage and Current Requirements – topology B (Single-ended Charge-pump)

PARAMETER	SPECIFICATIONS
Input voltage	8..36VDC
Output voltage	8..36VDC
Output current	5..45mA

Table 3. Voltage and Current Requirements – topology C (Single-ended Charge-pump)

PARAMETER	SPECIFICATIONS
Input voltage	8..36VDC
Output voltage	8..36VDC
Output current	5..50mA

1.2 Required Equipment

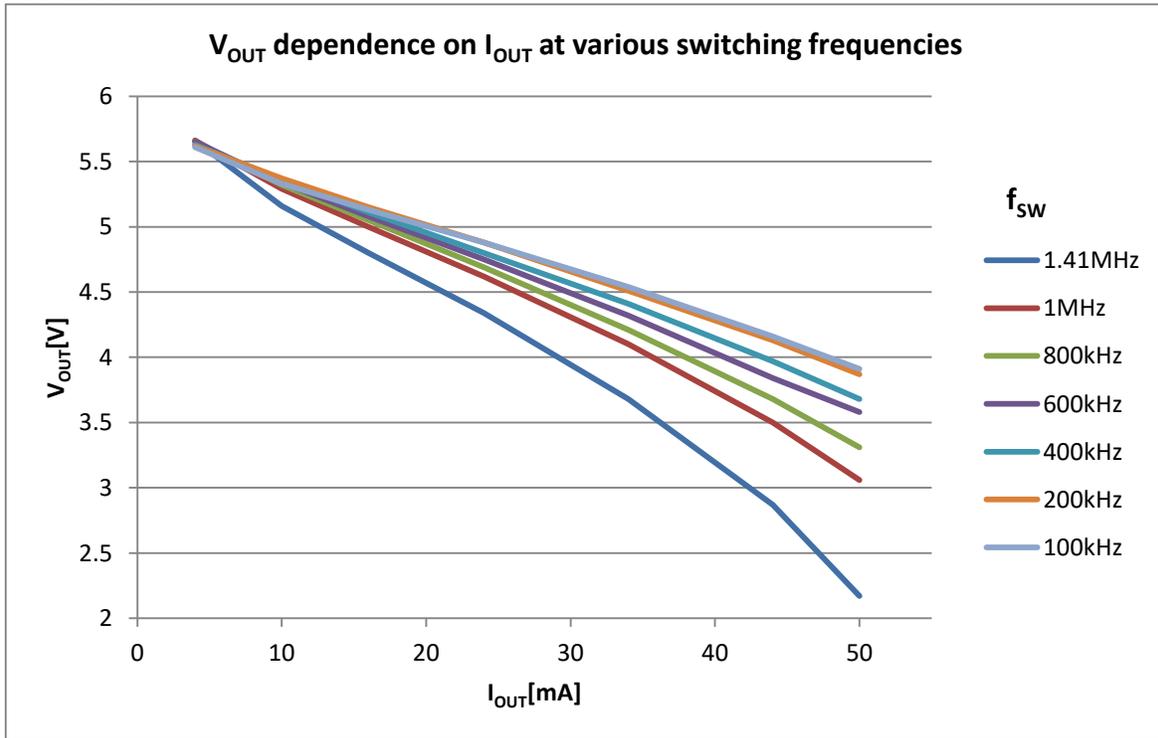
- Regulated bench power supply
- Oscilloscope
- Electronic load
- Multimeters

1.3 Considerations

Push-pull switching frequency considerations have been done in order to find the best efficiency. Optimal frequency balances the use of transformer at higher voltages and switching losses.

Load regulation graph (below) shows dependency of output voltage on load current for different various frequencies.

With regard to transformer saturation at highest input voltage compromise frequency of around 300kHz was selected.

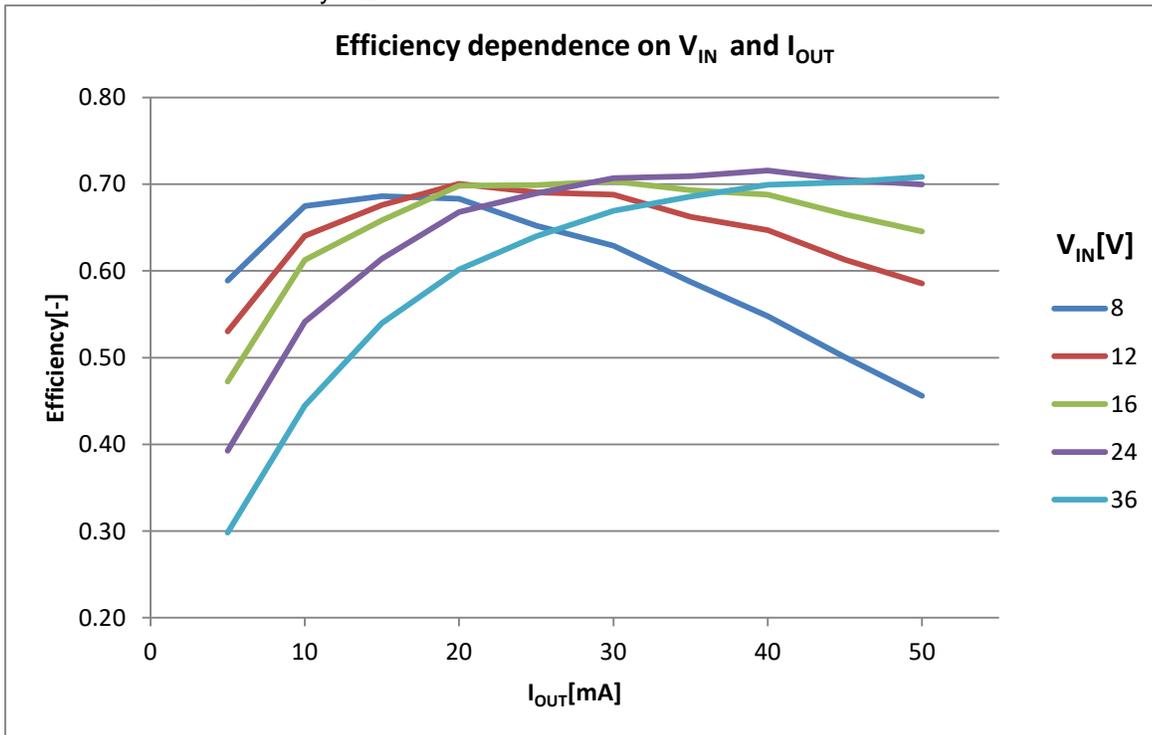


2 Testing and Results

2.1 Efficiency Graphs

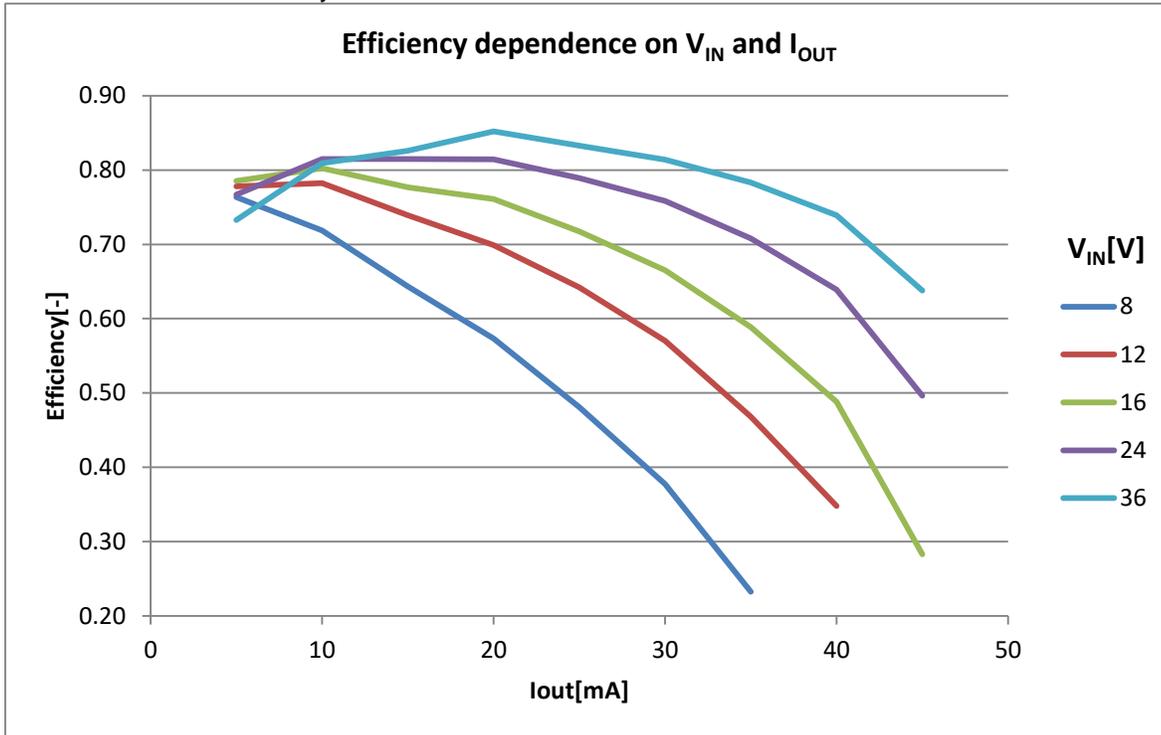
2.1.1 Topology A (Push-Pull)

- I_{OUT} between positive output and GND.
- Maximum efficiency: 72%



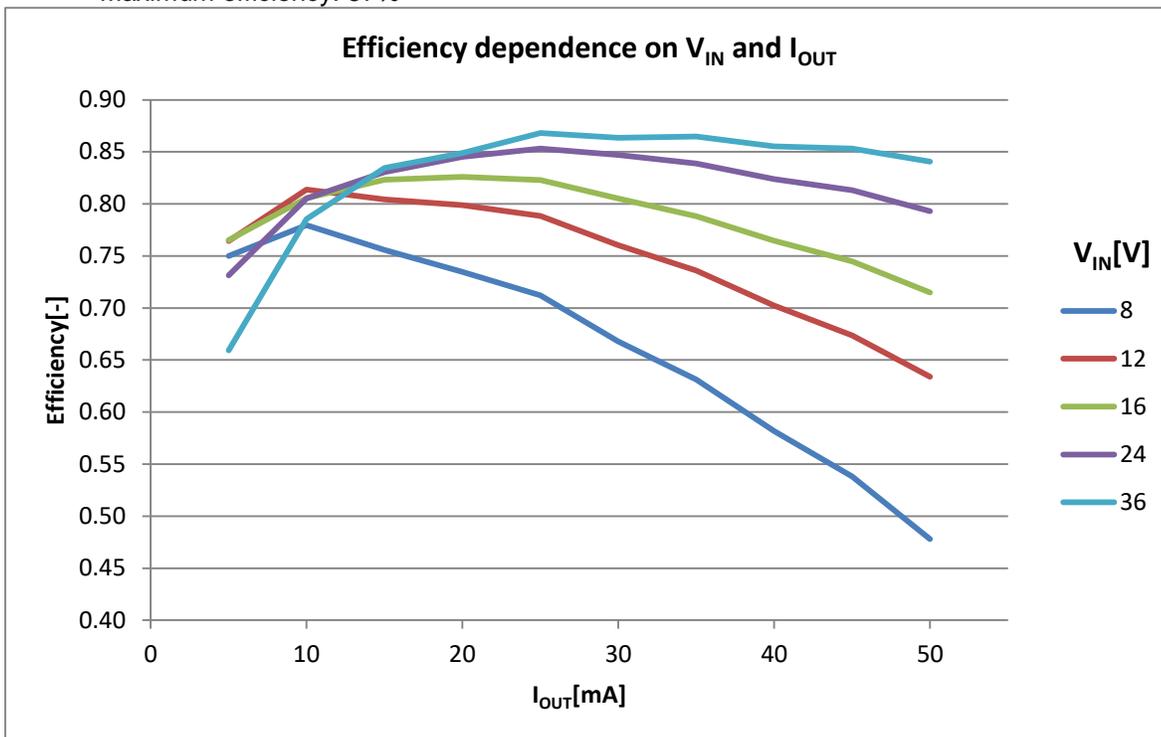
2.1.2 Topology B (Single-ended Charge-pump)

- Maximum efficiency: 85%



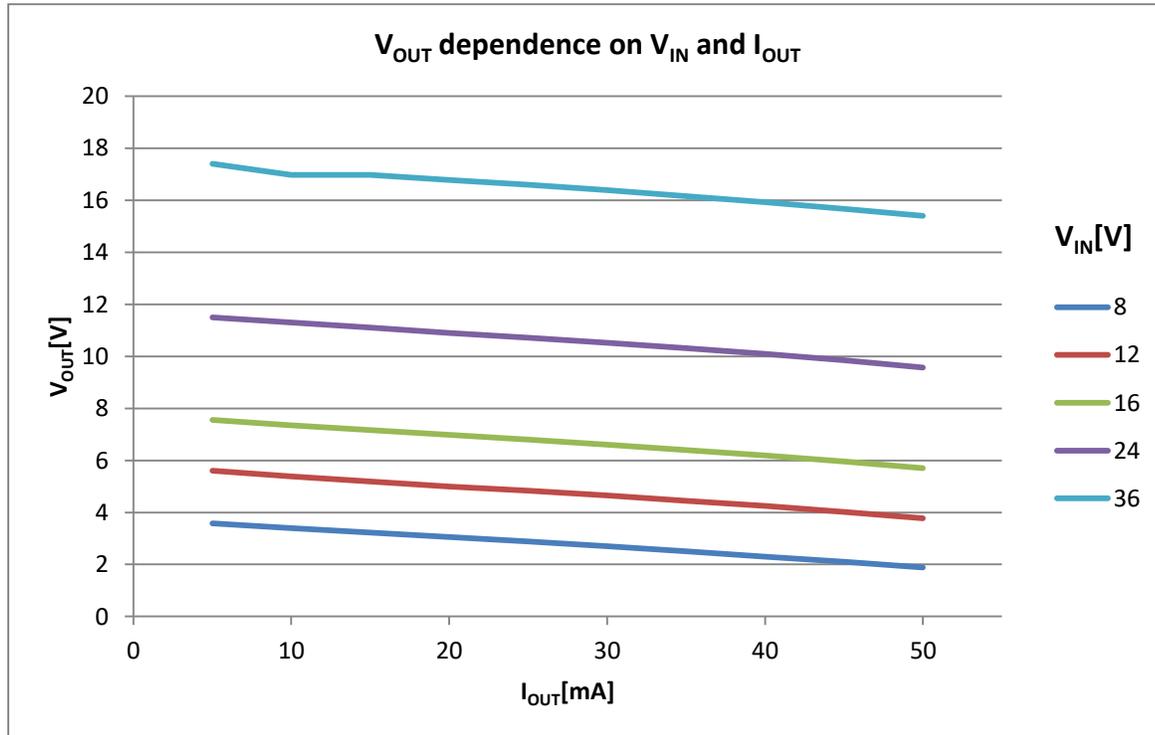
2.1.3 Topology C (Differential Charge-pump)

- Maximum efficiency: 87%

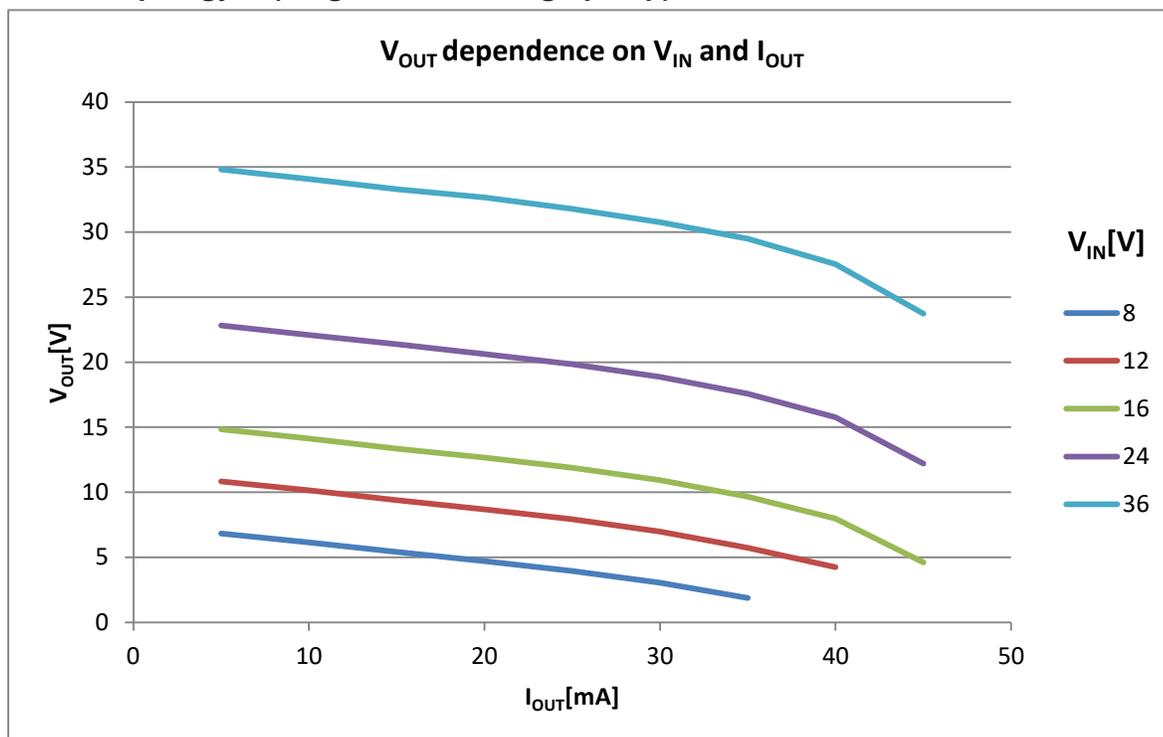


2.2 Load regulation Graphs

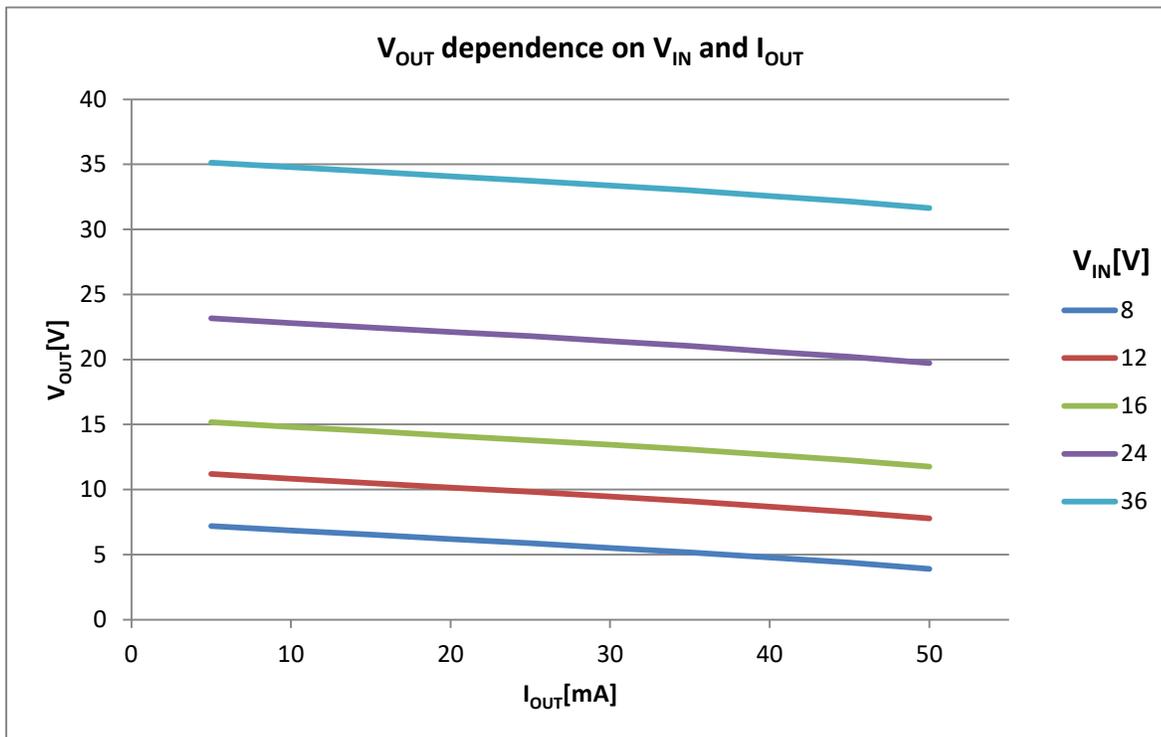
2.2.1 Topology A (Push-Pull)



2.2.2 Topology B (Single-ended Charge-pump)



2.2.3 Topology C (Differential Charge-pump)

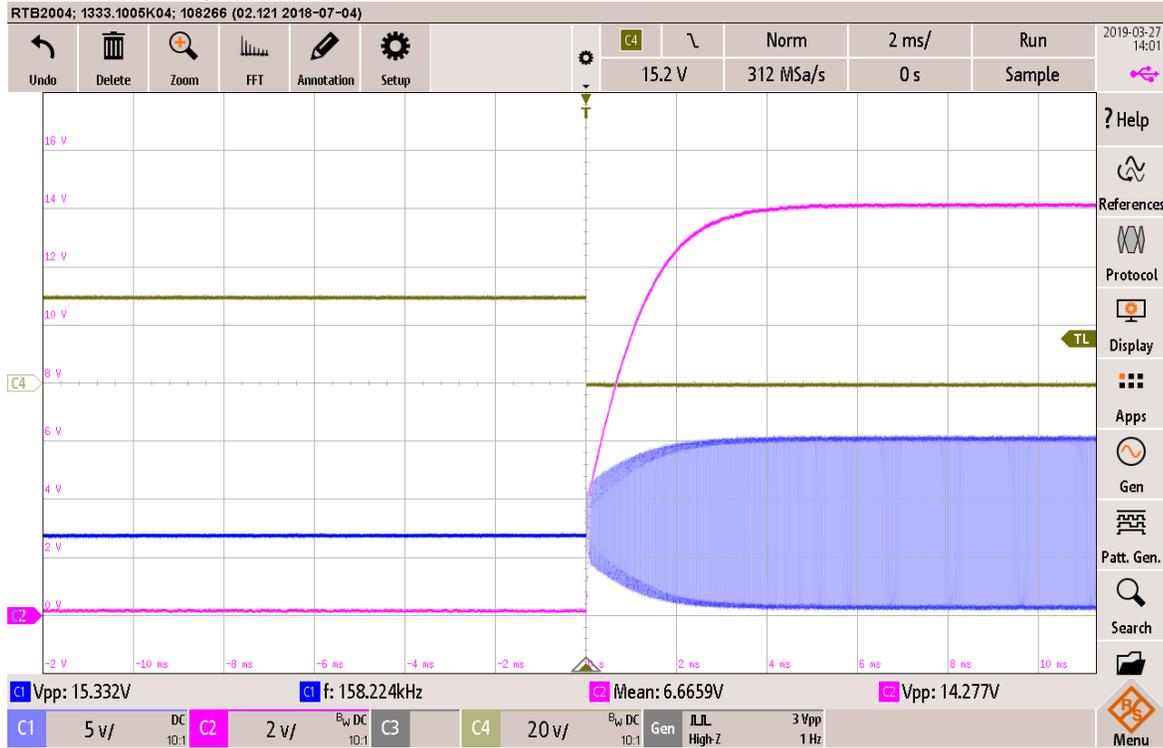


3 Waveforms

3.1 Start-up Sequence

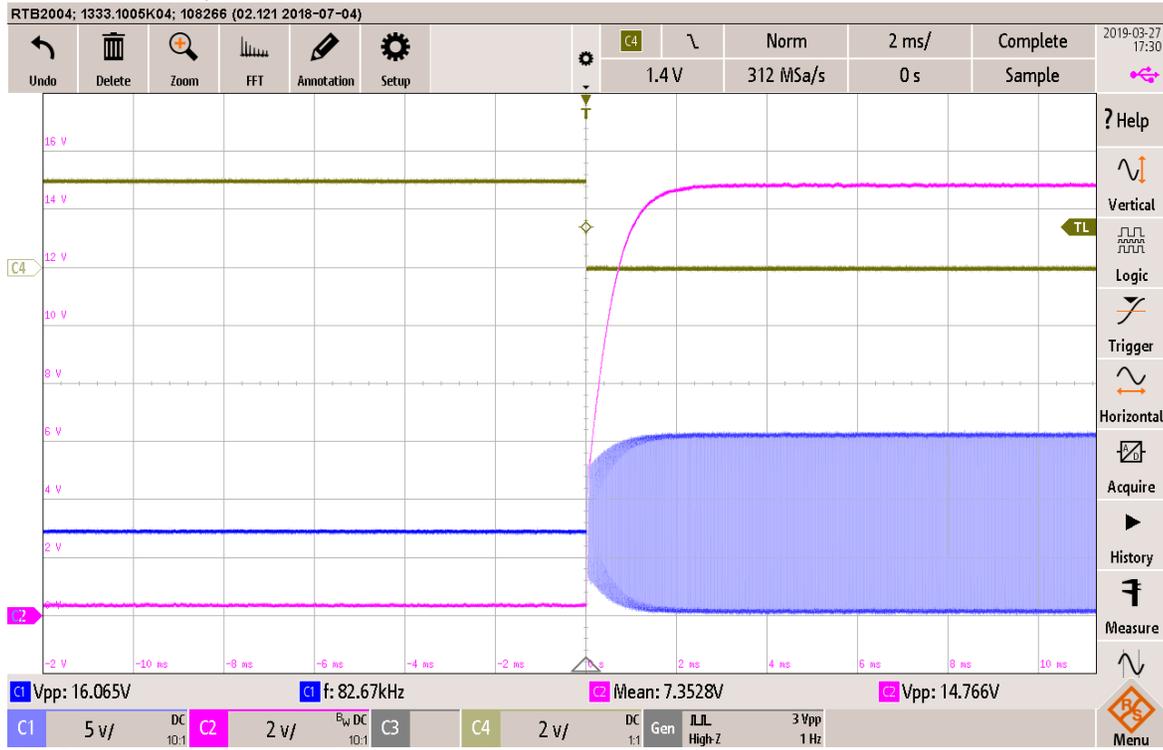
3.1.1 Topology B (Single-ended Charge-pump), output voltage limiter not populated

- $V_{in}=16V$, $I_{out}=10mA$



3.1.2 Topology C (Single-ended Charge-pump)

- $V_{in}=16V$, $I_{out}=10mA$

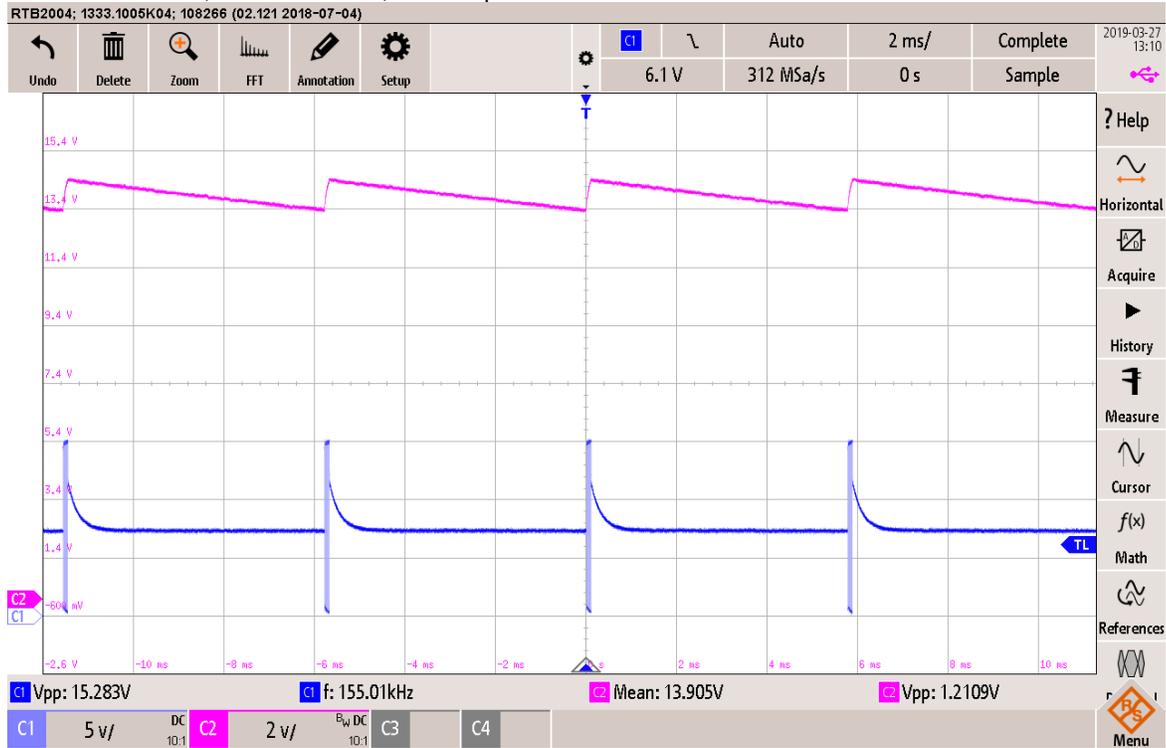


C1: Switch node, C2: Vout, C4: enable signal

3.2 Other

3.2.1 Topology B (Single-ended Charge-pump) output voltage limiter populated

- $V_{in}=16V$, $R_{load}=100k\Omega$, $I_{in}=180\mu A$



C1: Switch node, C2: Vout

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (<https://www.ti.com/legal/termsofsale.html>) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2021, Texas Instruments Incorporated