

# TPS23861 VDD Power Solutions

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## ABSTRACT

TPS23861 is an IEEE 802.3at compliant PSE controller integrated with analog circuits, digital circuits and an embedded processor. The VPWR pin supplies power to the internal analog circuits while the VDD pin supplies power for the digital circuits and internal processor. In most applications, an extra 3.3 V power is required for VDD. This paper introduces some VDD power supply solutions and design considerations in different solution environment.

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## 1 Introduction

TPS23861 is an IEEE 802.3at compliant PSE controller integrated with analog circuits, digital circuits and an embedded processor. The VDD (3.3 V) pin supplies power for internal digital circuits and processor. In most applications, PSE power and system power are designed isolated regarding safety considerations. This paper introduces different VDD power supply solutions and considerations for different applications.

In Electrical Characteristics Table of TPS23861 datasheet ([SLUSBX9](#)), VDD current is 5 mA (typical) and 6 mA (maximum). When designing power supply for VDD with different solutions approaches, we need to take the power consumption as a key consideration.

**Table 1.  $I_{VDD}$  Specification in TPS23861 Datasheet**

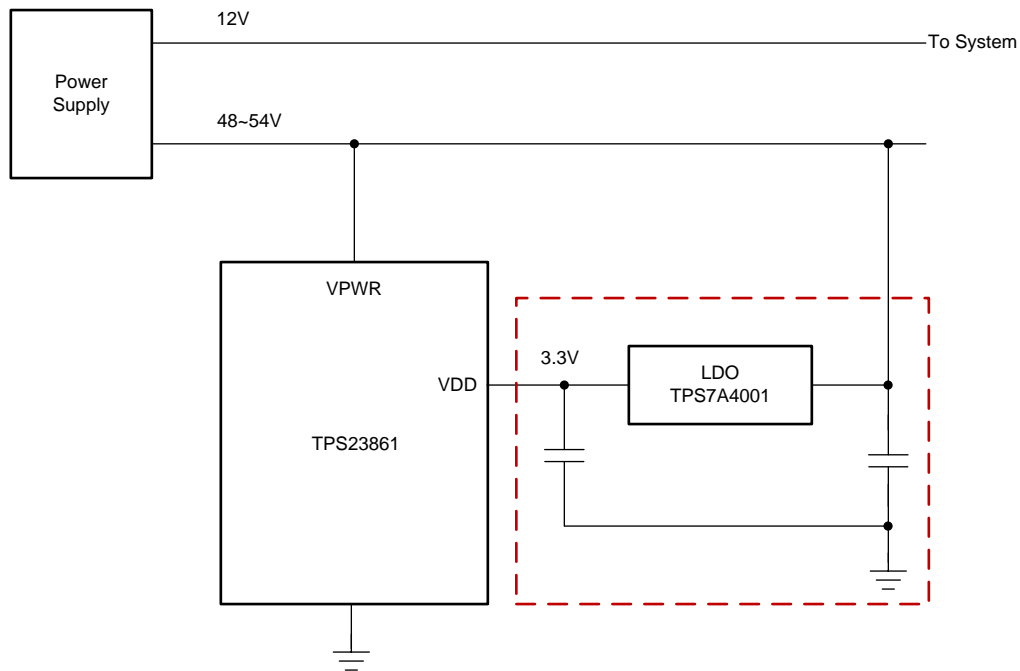
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>INPUT SUPPLY VPWR</b>						
$I_{VPWR}$	VPWR current consumption	$V_{VPWR} = 57\text{ V}$		3.5	7	mA
$V_{UVLOPW\_F}$	VPWR UVLO falling threshold	Internal oscillator stops operating	14.5		17.5	V
$V_{PUV\_F}$	VPWR Undervoltage falling threshold	$V_{PUV}$ for port de-assertion	25	26.5	28	V
$V_{UVLOPW\_R}$	VPWR UVLO rising threshold		15.5		18.5	V
<b>INPUT SUPPLY VDD</b>						
$I_{VDD}$	VDD current consumption			5	6	mA
$V_{UVDD\_F}$	VDD UVLO falling threshold	For port turn off	2	2.2	2.4	V
$V_{UVDD\_R}$	VDD UVLO rising threshold		2.4	2.6	2.8	V
$V_{UVDD\_HYS}$	Hysteresis VDD UVLO			0.4		V

## 2 VDD Power Design in Isolated PSE System

In most PSE systems like Ethernet Switch and Network Video Recorder (NVR), isolation is a common system requirement. In these applications, VPWR (normally 48 V ~ 54 V) for PSE and 12 V for system are supplied with adapters. Since VPWR is isolated from 12 V, power supply for VDD should be generated from VPWR.

According to different system design and cost considerations, three VDD power solutions are proposed.

## 2.1 High Voltage LDO



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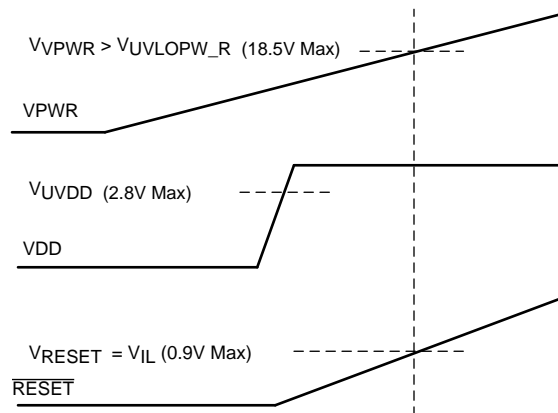
**Figure 1. VDD Power with High Voltage LDO in Isolated System**

The simplest VDD power solution comes with a high voltage LDO. The maximum power loss on LDO is calculated in [Equation 1](#).

$$P_{\text{loss}} = (V_{\text{VPWR}(\text{MAX})} - V_{\text{VDD}}) \times I_{\text{VDD}(\text{MAX})} = 0.304 \text{ W} \quad (1)$$

Due to 0.304 W maximum power consumption on LDO, proper thermal consideration is required in real board design, and one LDO is not suggested to supply power to  $\geq 2$  pieces of TPS23861.

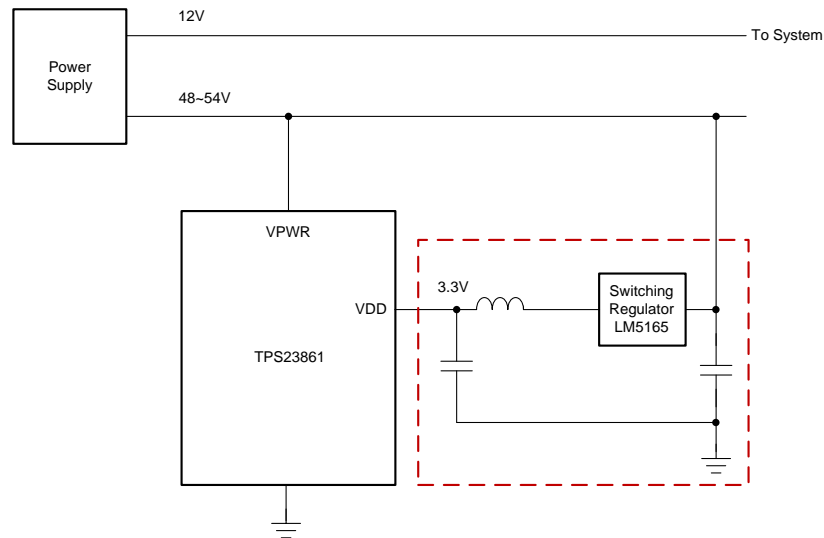
Considering TPS23861 power on sequence requirement as shown in [Figure 2](#), a high voltage LDO with adjustable UVLO is recommended.



**Figure 2. TPS23861 Power On Sequence**

## 2.2 Switching Regulator

If efficiency and thermal are key considerations, a switching regulator is recommended. Compared with LDO, switching regulator has better efficiency and higher current capability to feed multiple TPS23861 devices. Therefore, it is a good fit for Switch and NVR end equipment which has higher port count (>4 ports).



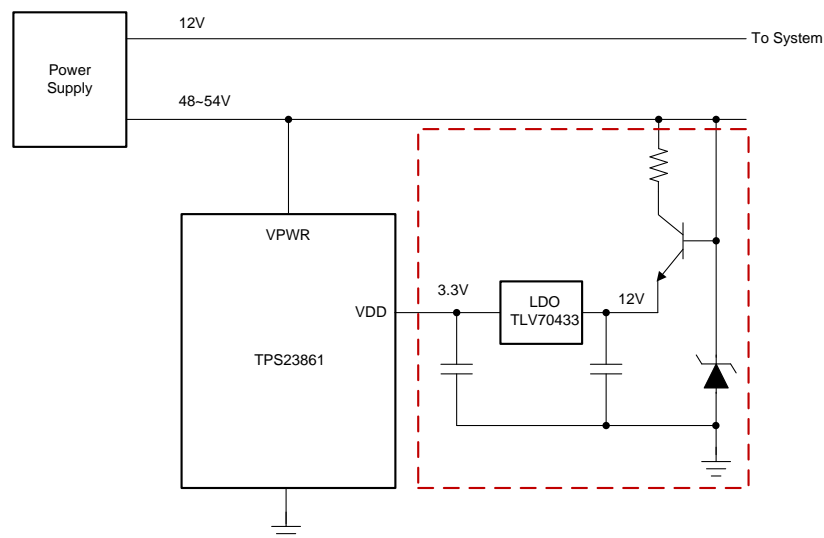
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**Figure 3. VDD Power with Switching Regulator in Isolated System**

It is good engineering practice to set switching regulator's EN/UVLO voltage above TPS23861 UVLO (18.5 V) in application design.

## 2.3 Discrete Solution

For some cost-sensitive products and applications, a simple discrete solution is proposed as shown in [Figure 4](#). A Zener diode and high voltage NPN transistor is used to replace the high voltage LDO with a low cost LDO.



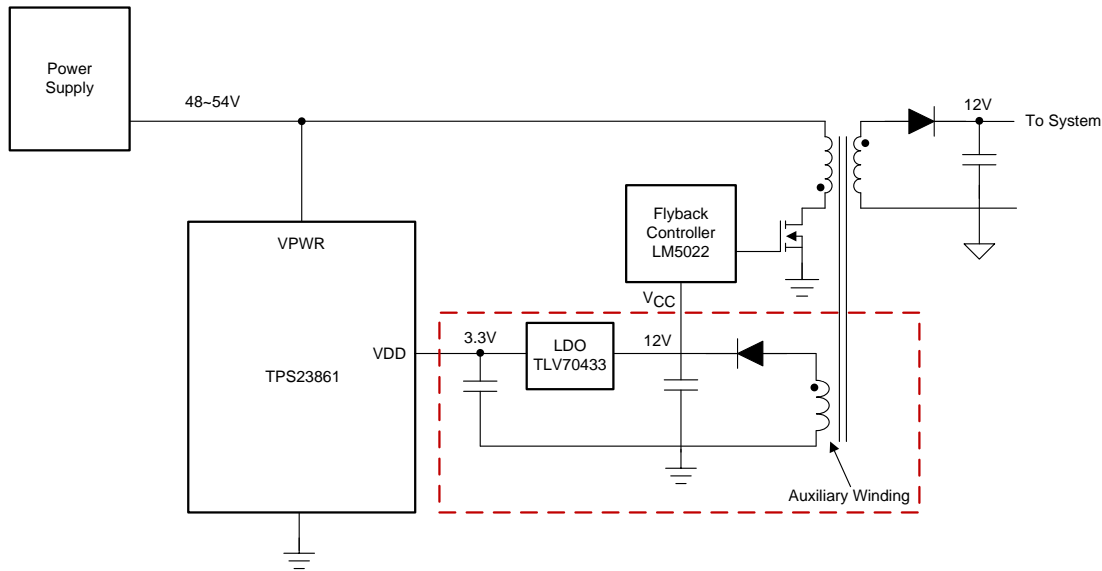
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**Figure 4. VDD Power with Discrete Solution in Isolated System**

For the NPN transistor, a SOT-223 package is recommended which has better thermal performance. In this design, the power consumption is shared by the collector resistor, NPN transistor and LDO. As a result, it has better efficiency with lower cost compared to the high LDO solution.

## 2.4 Auxiliary Winding Power

In some isolated applications with single-output adapter, a Flyback topology is used to generate isolated 12 V from 48 V. VDD can be supplied from 12 V through above three solutions. Normally in Flyback application, an auxiliary winding is used to generate 12 V for Flyback controller  $V_{CC}$  power. One optional selection is to generate 3.3 V with an LDO from auxiliary winding 12 V as shown in Figure 5. Since the  $I_{VDD}$  is 6 mA maximum, single wire auxiliary winding is able to power more than 2 TPS23861 devices. This solution is also widely used due to its low cost and good thermal performance.

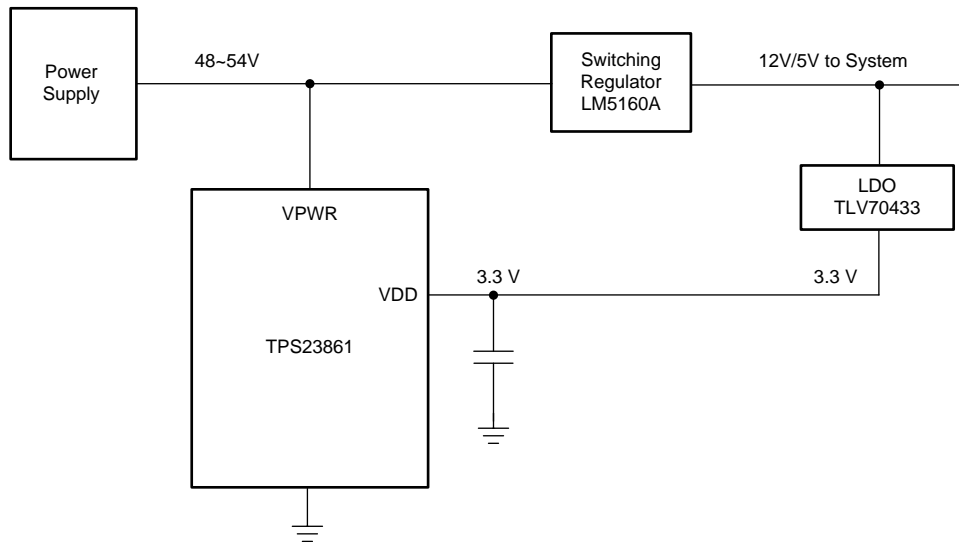


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Figure 5. VDD Power with Auxiliary Winding Power in Isolated System

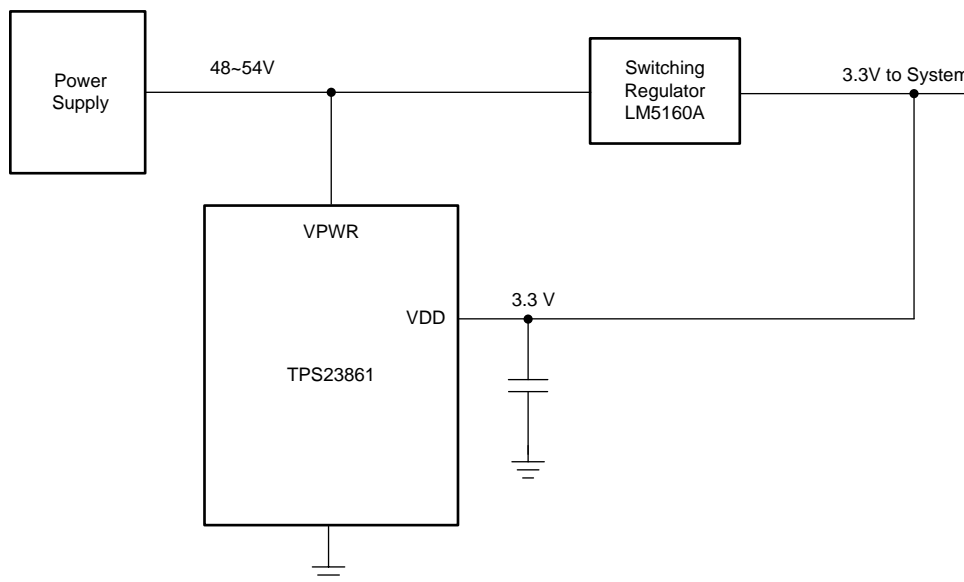
### 3 VDD Power Design in Non-isolated PSE System

We have seen some customer's system in which 48 V power rail and system power rail are non-isolated. Under this condition, usually 12 V / 5 V / 3.3 V is generated from 48 V and VDD can be connected directly with system 3.3 V.



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**Figure 6. VDD Power in Non-isolated System - 1**



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**Figure 7. VDD Power in Non-isolated System - 2**

#### 4 Conclusion

The VDD for the TPS23861 digital circuits and internal processor needs external power supply. In non-isolated system, VDD pin can be directly connected to system 3.3 V. While in isolated system, 3.3 V should be generated separately. Four methods have been discussed for different systems with corresponding design considerations.

#### 5 Reference

*TPS23861 IEEE 802.3at Quad Port Power-over-Ethernet PSE Controller*, [SLUSBX9](#)

*TPS23861 Power-On Considerations*, [SLVA723](#)

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