

# **Powering the TMS320DM335 and TMS320DM355 with the TPS650061**

*Daniel Acevedo*
*Battery Power Applications*

## **ABSTRACT**

This document details the design considerations of a low-cost power solution for the TMS320DM335 and TMS320DM355 (DM335/55) low-power application processors with a TPS650061, three-rail Power Management Unit (PMU) or Power Management IC (PMIC).

Portable application solution size demands a high level of integration and the DM335/55 require at least three different voltage rails with specific sequencing and reset requirements. The TPS650061 is a highly integrated low-cost power solution that can provide the 1.3 V, 1.8 V and 3.3 V rails and **RESET** signal required by the DM335/55. The TPS650061 has a single step-down converter, two low dropout regulators and a voltage supervisor.

Included in this document is a power solution for the DM335/55. Power requirements, illustrated schematic, operation waveforms and bill of materials are included.

## **Contents**

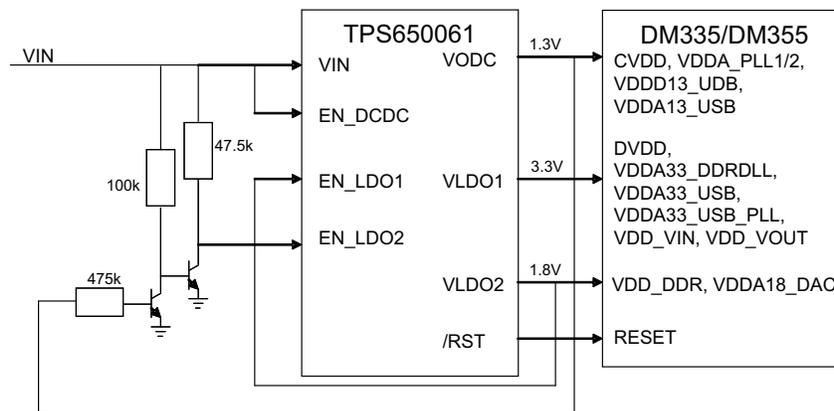
1	Power Requirements .....	2
	1.1 Power-On Sequence .....	2
	1.2 Power-Off Sequence .....	3
	1.3 Power Solution .....	3
2	Schematic, Waveforms, and Bill of Materials .....	4
	2.1 Schematic .....	4
	2.2 Waveforms .....	5
	2.3 Bill of Materials .....	6
3	Conclusion .....	6
4	References .....	6

## **List of Figures**

1	TPS650061 and DM335/55 Simplified Block Diagram .....	2
2	TPS650061 Schematic Diagram .....	4
3	TPS650061 Power-Up, Ch. 1 - VIN, Ch. 2 - 1.3V Rail, Ch. 3 - 1.8V Rail, Ch. 4 - 3.3V Rail.....	5
4	TPS650061 Power-Up and <b>RESET</b> , Ch. 1 - <b>RESET</b> , Ch. 2 - 1.3V Rail, Ch. 3 - 1.8V Rail, Ch. 4 - 3.3V Rail .....	5
5	TPS650061 Power-Off Sequence, Ch. 1 - <b>RESET</b> , Ch. 2 - 1.3V Rail, Ch. 3 - 1.8V Rail, Ch. 4 - 3.3V Rail .....	5

## **List of Tables**

1	DM335/55 Power Requirements .....	2
2	Bill of Materials .....	6


**Figure 1. TPS650061 and DM335/55 Simplified Block Diagram**

## 1 Power Requirements

The DM335/55 power requirements are listed in [Table 1](#).

**Table 1. DM335/55 Power Requirements**

Rail Name	Voltage (V)	I <sub>max</sub> (mA)	Tolerance	Power-On	Power-Off
CVDD, VDDA_PLL1, VDDA_PLL2, VDDD13_USB, VDDA13_USB	1.3	210	±5%	1 <sup>st</sup>	2 <sup>nd</sup>
VDD_DDR, VDDA18_DAC	1.8	30	±5%	2 <sup>nd</sup>	1 <sup>st</sup>
DVDD, VDDA33_DDRDLL, VDDA33_USB, VDDA33_USB_PLL, VDD_VIN, VDD_VOUT	3.3	95	±5%	2 <sup>nd</sup>	1 <sup>st</sup>

The TPS650061 meets these power requirements with its single step-down converter, two low dropout regulators and voltage supervisor.

### 1.1 Power-On Sequence

To meet the DM335/55 power-on requirements, the 1.3V rail must power on first, then both the 1.8V rail and the 3.3V. After all 3 rails are powered on RESET may be released.

The power-on sequence is described in the following text from the DM335/355 datasheet.

Per the excerpt from the DM335/55 datasheet, the device should be powered-on in the following order:

- Power on 1.3 V: CVDD, VDDA\_PLL1/2, VDDD13\_USB, VDDA13\_USB
- Power on 1.8 V: VDD\_DDR, VDDA18\_DAC
- Power on 3.3 V: DVDD, VDDA33\_DDRDLL, VDDA33\_USB, VDDA33\_USB\_PLL, VDD\_VIN, VDD\_VOUT

You may power-on the 1.8 V and 3.3 V power supplies simultaneously

## 1.2 Power-Off Sequence

The DM335/55 power-down requirements state that the 1.8 V and 3.3 V supplies should power off together, before the 1.3 V supply as describe in the DM335/355 datasheet excerpt below:

1. Power off 3.3 V: DVDD, VDDA33\_DDRDLL, VDDA33\_USB, VDDA33\_USB\_PLL, VDD\_VIN, VDD\_VOUT
2. Power off 1.8 V: VDD\_DDR, VDDA18\_DAC
3. Power off 1.3 V: CVDD, VDDA\_PLL1/2, VDDD13\_USB, VDDA13\_USB

You may power-off the 1.8 V and 3.3 V power supplies simultaneously.

Power-off the 1.8V/3.3V supply before or within 10usec of power-off of the 1.3 V supply

## 1.3 Power Solution

To best achieve this power up/down sequence and minimize cost, two 2N222 transistors are used in conjunction with the TPS650061.

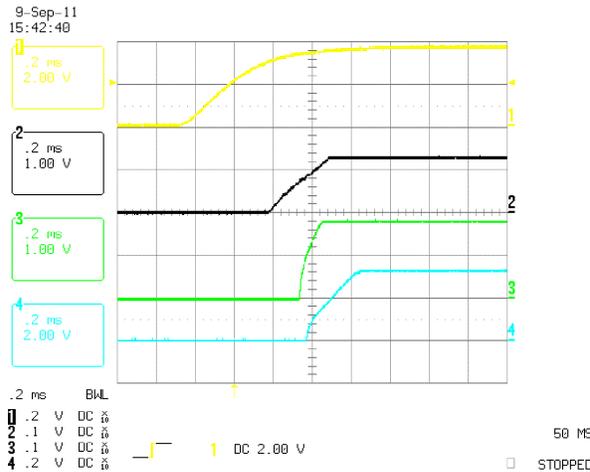
- The enable for the 1.3V supply (EN\_DCDC) is connected to VIN.
- The output, VODC, is connected to the base of an NPN transistor, Q1. The collector of Q1 has a 100 k $\Omega$  pull-up to VIN; the emitter is connected to ground.
- The collector of Q1 is also connected to the base of another NPN transistor, Q2. The collector of Q2 has a 47.5k pull-up to VIN; the emitter is connected to ground
- The collector of Q2 is also connected to the enable of the 1.8 V supply (EN\_LDO2).
- The 1.8 V supply (VLDO2) is connected to the enable of the 3.3 V supply (EN\_LDO1).
- When VIN is applied, it will turn on the 1.3 V supply (VODC) and Q2; keeping EN\_VLDO2 tied to ground.
- VODC will then turn on Q1 which will turn-off Q2 and enable VLDO2 when EN\_LDO2 gets pulled-up to VIN.
- VLDO2 will enable VLDO1.
- During power-off, the 3.3 V rail ramps down with VIN as VIN nears VOUT, then the 1.8 V rail, then the 1.3 V rail.
- A resistor divider connects RSTSNS to VLDO1, the  $\overline{MR}$  pin is connected to VODC and the pin  $\overline{RST}$  is pulled up to VLDO2. This will assert the reset to 1.8 V only when all three supplies are up.
- Additionally, to add deglitch time to the  $\overline{RESET}$ , a capacitor (C5) can be added in parallel with the top resistor of the RTSNS divider.

The proper connections for the power-on/off sequence are shown in [Figure 1](#).

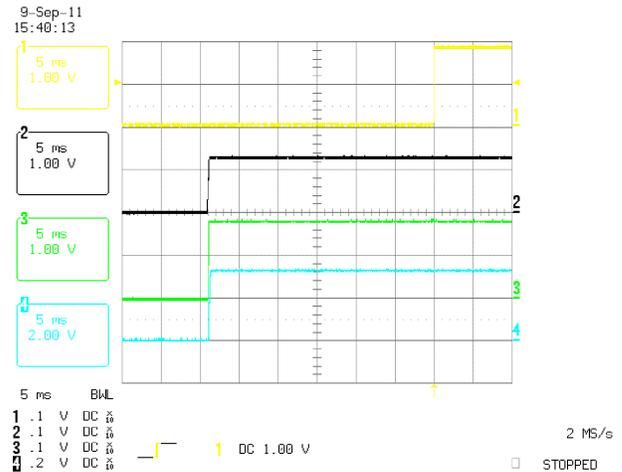


## 2.2 Waveforms

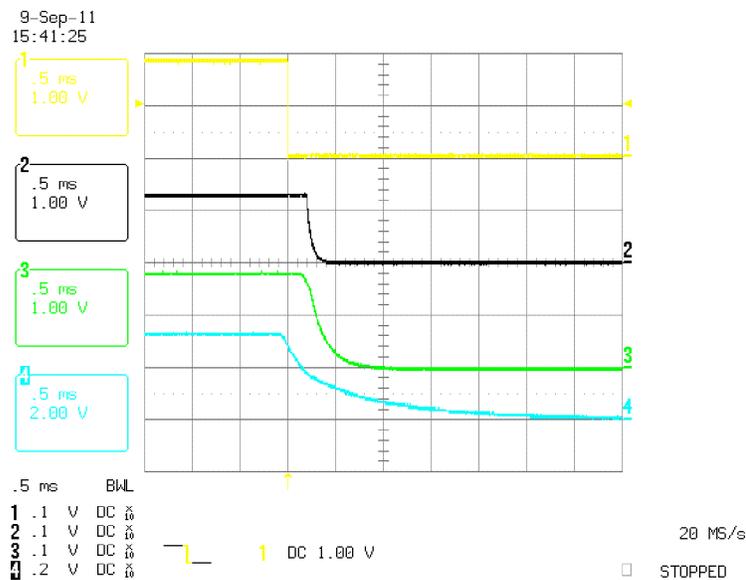
The following waveforms demonstrate the startup and power down sequence of the TPS650061 as required by the DM335/55. **Figure 3**, shows the TPS650061 power on sequence of 1.3V then 1.8 V and 3.3 V. **Figure 4** shows the reset pin, RST, being released after the voltage on RSTNS rises above the threshold and after the reset recovery time,  $t_{RST}$ , is exceeded. **Figure 5** shows the power down sequence, 3.3 V and 1.8 V then the 1.3 V supply. For the following tests, the 1.3V supply had a 200mA load, the 1.8V supply had a 95mA load and the 3.3V supply had a 30mA load.



**Figure 3. TPS650061 Power-Up, Ch. 1 - VIN, Ch. 2 - 1.3V Rail, Ch. 3 - 1.8V Rail, Ch. 4 - 3.3V Rail**



**Figure 4. TPS650061 Power-Up and RESET, Ch. 1 - RESET, Ch. 2 - 1.3V Rail, Ch. 3 - 1.8V Rail, Ch. 4 - 3.3V Rail**



**Figure 5. TPS650061 Power-Off Sequence, Ch. 1 - RESET, Ch. 2 - 1.3V Rail, Ch. 3 - 1.8V Rail, Ch. 4 - 3.3V Rail**

## 2.3 Bill of Materials

The bill of materials is displayed in [Table 2](#).

**Table 2. Bill of Materials**

Count	RefDes	Value	Description	Size	Part Number	MFR
4	C1, C6, C8, C9	10uF	Capacitor, Ceramic, 10V, X5R, 10%,	0805	Std	Std
2	C2, C3	2.2uF	Capacitor, Ceramic, 10V, X5R, 10%	0603	Std	Std
1	C4	0.1uF	Capacitor, Ceramic, 16V, X7R, 10%	0603	Std	Std
1	C7	22pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	Std	Std
1	L1	2.2uH	Inductor, SMT, 2.0A, 110milliohm	0.118 x 0.118 inch	LPS3015-222ML	Coilcraft
2	Q1, Q2	2N2222	Transistor, NPN, 40V	SOT-23	2N2222	Std
2	R2, R9	47.5k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R3	976k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
2	R5, R7	475k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R4	232K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R6	402k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R8	100k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	U1	TPS650061RUK	IC, 2.25 MHz Step Down Converter with Dual LDOs and SVS	QFN	TPS650061RUK	TI

## 3 Conclusion

The TPS650061 provides a low cost, comprehensive power solution for the DM335/55. A 1.3 V rail (capable of supplying 1 A) is powered on followed by a 1.8 V rail (300 mA) then a 3.3 V rail (300 mA). Once all three supplies have reached regulation, **RESET** goes high (i.e. rises to its pull-up voltage). For power-down, the 1.8 V and 3.3 V turn off before the 1.3 V rail. This meets the power requirements of the DM335/55.

## 4 References

1. TPS650061 Datasheet ([SLVS810B](#))
2. DM335 Datasheet ([SPRS528](#))
3. DM355 Datasheet ([SPRS463](#))
4. 5Vin DM355 Power using LDO's ([SLVR331B](#))

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Mobile Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

TI E2E Community Home Page

[e2e.ti.com](http://e2e.ti.com)

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2012, Texas Instruments Incorporated