User's Guide
SNVU631–August 2018

# Power Supply Design for NXP i.MX 8 Using the LP875640-Q1 and LP8733-Q1

This document details the design considerations of a power management unit solution for the NXP i.MX 8 processor using the LP875640-Q1 option of the LP87564-Q1 power management IC and the LP873300-Q1 option of the LP8733-Q1 power management IC (PMIC).

The LP875640-Q1 and LP873300-Q1 have an input range from 2.5 to 5.5 V. The LP876540-Q1 has 4 buck converters, and the LP873300-Q1 has 2 buck converters and 2 low-dropout (LDO) regulators.

**Contents**



**List of Figures**



**List of Tables**



## Trademarks



## 1 Introduction

This application note provides a reference power solution for the i.MX 8 family of application processors, as well as memory and external peripherals in the system. This power solution assumes an input voltage of 3.8 V to 5 V. If the system input voltage is higher, for example a car battery, use a buck converter as a pre-regulator to generate a supply voltage between 3.8 and 5 V. The LP875640-Q1 and LP873300-Q1 are $I^2C$ configurable, so the default voltage and sequence can be configured for each platform by an on-board microcontroller.

## 2 Power Solution

Figure 1 shows an example block diagram of two LP875640-Q1 devices, an LP873300-Q1 device, and an i.MX 8 processor. Since both LP875640-Q1 devices have the same $I^2C$ address, use a switch such as SN74LVC1G3157-Q1 on the SDA line. The microcontroller can control the select signal of the switch to control which device it is communicating with.

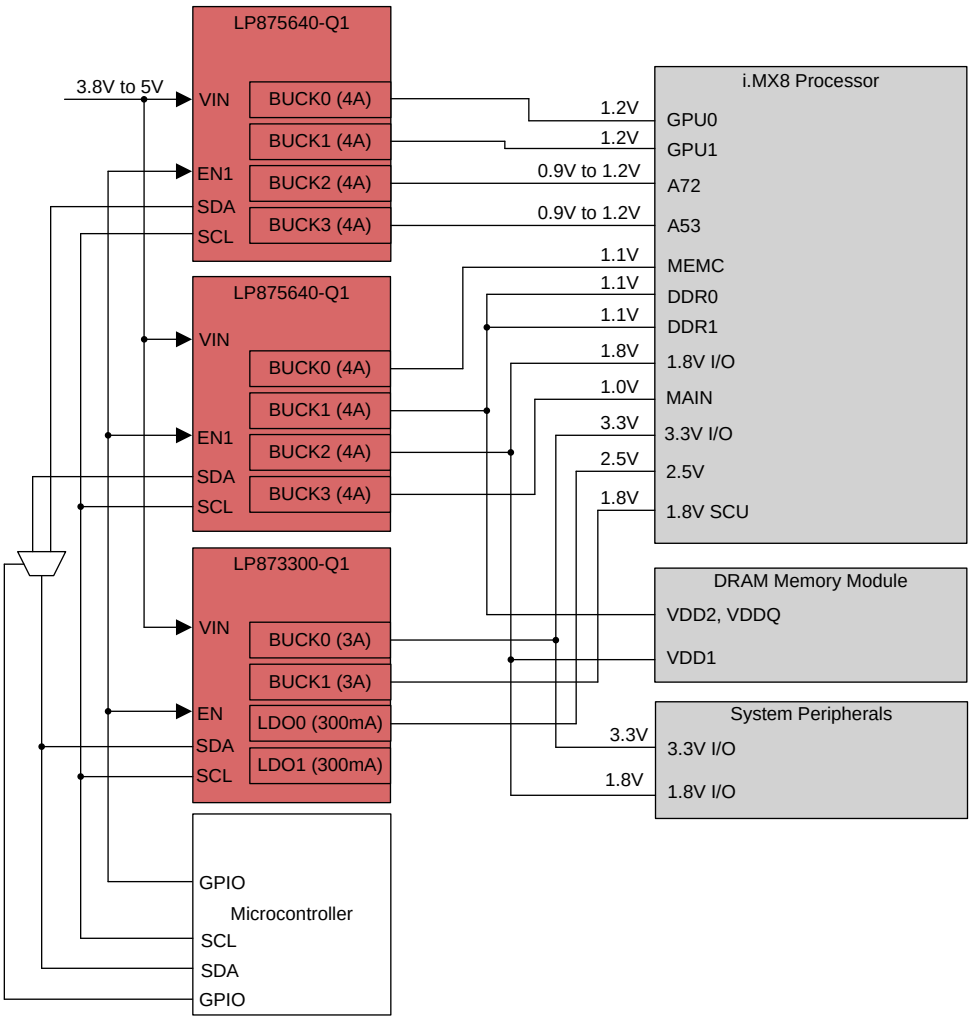


**Figure 1. LP875640-Q1 Power Solution Block Diagram**

The power solution fulfills all the power requirements with ten buck regulators and one LDO regulator. There is also an additional LDO to support any system loads up to 300 mA. To support a wide variety of different system configurations, the default state of the LP875640-Q1 and LP873300-Q1 has all regulators disabled. The microcontroller should configure the default voltage, sequence, and other settings through $I^2C$ before enabling the PMICs. After the PMICs are supplied, the recommended sequence of $I^2C$ configuration is:

1. Output voltage values
2. Current limit
3. Clock synchronization (if used)
4. PGOOD settings
5. Interrupt settings
6. Power sequence settings
7. EN_PIN_CTRL bits
8. BUCKx_EN and LDOx_EN bits

After the devices are configured, the microcontroller can set the EN pins high to enable the PMICs with the new configuration. The *LP8756x-Q1 Configuration Guide* and *LP8733-Q1 and LP8732-Q1 Configuration Guide* explain the configuration process in more detail. If dynamic voltage scaling (DVS) is required, $I^2C$ can be used to set the output voltages during system operation using the BUCKx_VOUT registers.

## 3 Recommended External Components

See Table 1 for the recommended external components to use in this solution with the LP875640-Q1 and LP873300-Q1. Note that the buck input capacitors, output capacitors, output inductors, and VANA supply capacitors apply to the LP875640-Q1 and LP873300-Q1 devices. It also shows the total solution size including the PMIC devices and the external components

**Table 1. Bill of Materials**

| SYSTEM COMPONENT | COUNT | VALUE | SIZE | PART NUMBER | MANUFACTURER | BOARD SIZE(1) |
|---|---|---|---|---|---|---|
| PMIC | 2 | - | 4.5 x 4 mm | LP875640RNFRQ1 | TI | 55 $mm^2$ |
| PMIC | 1 | - | 5 x 5 mm | LP873300RHDRQ1 | TI | 36 $mm^2$ |
| SDA switch | 1 | - | 2.1 x 2 mm | 1P1G3157QDCKRQ1 | TI | 9.3 $mm^2$ |
| Buck input capacitor | 10 | 10 µF | 0805 | GCM21BR71A106KE22 | Murata | 67.5 $mm^2$ |
| Buck output inductor | 10 | 0.47 µH | 1008 | DFE252012PD-R47M | Murata | 105 $mm^2$ |
| Buck output capacitor | 10 | 22 µF | 1206 | GCM31CR71A226KE02 | Murata | 109.2 $mm^2$ |
| VANA supply capacitor | 3 | 100 nF | 0402 | GCM155R71C104KA55 | Murata | 9 $mm^2$ |
| LDO input capacitor | 1 | 2.2 µF | 0603 | GCM188R70J225KE22 | Murata | 4.7 $mm^2$ |
| LDO output capacitor | 1 | 1 µF | 0603 | GCM188R71C105KA64 | Murata | 4.7 $mm^2$ |
| TOTAL | 39 | - | - | - | - | 400.4 $mm^2$ |

(1) Assuming 1 mm keep-out around each component, and multiplying by component count

# 4 Measurements

Test data can be found in the Application Curves section of the *LP8756x-Q1 16-A Buck Converter with Integrated Switches Datasheet* and *LP8733xx-Q1 Dual High-Current Buck Converter and Dual Linear Regulator Datasheet*. This test data includes start-up and shutdown waveforms, output voltage ripple, and load transient response.

The following efficiency curves show the efficiency for each of the converters at input voltages of 3.8 V and 5 V, at different output voltages, and across the range of output currents.

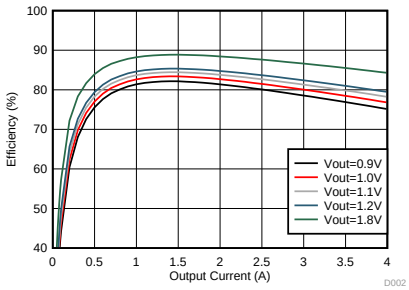


**Figure 2. LP875640-Q1 Efficiency at Vin = 5 V**

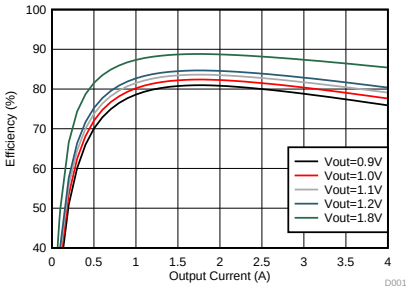


**Figure 3. LP875640-Q1 Efficiency at Vin = 3.8 V**

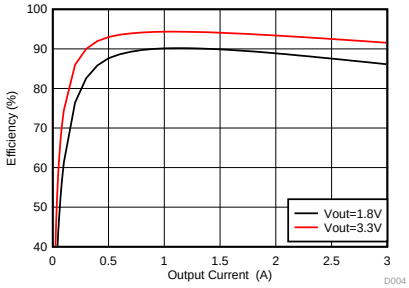


**Figure 4. LP873300-Q1 Efficiency at Vin = 5 V**

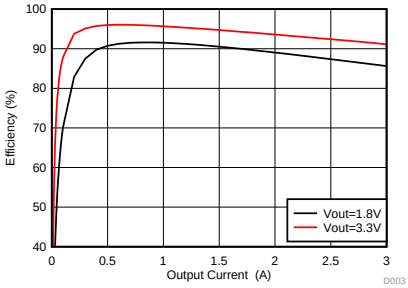


**Figure 5. LP873300-Q1 Efficiency at Vin = 3.8 V**

## 5 Conclusion

The LP875640-Q1 and LP873300-Q1 devices provide a flexible power solution for the i.MX 8 family of application processors. The example power solution can be configured through $I^2C$ to set the voltages, sequence, and other settings. This allows the same power solution to be used in multiple platforms with different requirements, such as different I/O voltages or different DDR memory types.

## 6 References

See these references for additional information:

1. Texas Instruments, *LP8756x-Q1 16-A Buck Converter With Integrated Switches* data sheet
2. Texas Instruments, *LP8733xx-Q1 Dual High-Current Buck Converter and Dual Linear Regulator Datasheet*
3. Texas Instruments, *LP8756x-Q1 Configuration Guide*
4. Texas Instruments, *LP8733-Q1 and LP8732-Q1 Configuration Guide*

## 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 (www.ti.com/legal/termsofsale.html) or other applicable terms available either on 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