Design Guide: TIPA-020007

Power Supply Proof-of-Concept Design for AMD® Versal™ AI Edge Series Gen 2

Description

This proof-of-concept power design demonstrates how the required power rails for the 2VE3858 device can be powered by TI regulator integrated circuits (ICs). This design methodology aligns with the AMD® standard for minimizing consolidated power supply rails. See the AMD Power Design Manager (PDM) tool page for all available power consolidation options. For any application, use the PDM that was implemented when estimating power.

Resources

TIPA-020007	Design Folder
LM74910-Q1	Product Folder
LP8764-Q1	Product Folder
TPS62893-Q1	Product Folder
TPS6594-Q1	Product Folder

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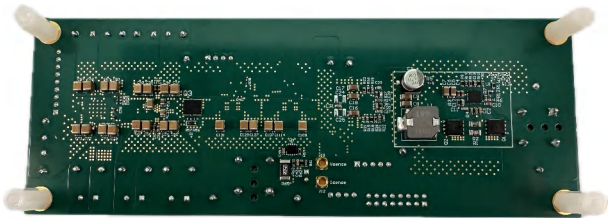
Features

- Details the design considerations and power tree design needed to support the 2VE3858 device
- Can be used as a foundation for designing the power tree for other devices of the AMD Versal™ AI Edge Series Gen 2 and AMD Versal Prime Series Gen 2 series with small modifications
- Power sequencing for 2VE3858 rails are controlled with power management IC (PMIC) TPS6594-Q1
- The GPIO output on the TPS6594-Q1 device can be used to control the TPS6594-Q1, LP8764-Q1, and TPS62893-Q1 devices for power sequencing

Applications

- Autonomous driving module
- In-cabin monitoring ECU
- Front camera
- Mirror replacement, camera mirror system
- Surround view system ECU



1 System Description

The original power source for this system can be either a battery or a power supply that is typically between 8Vin to 18Vin and capable of delivering about 150W of power.

The power source is fed to an optional front-end protection (FEP) sub-circuit, controlled by the LM74910-Q1 integrated circuit (IC), that acts as a programmable electronic safety switch with numerous safety features.

Following the FEP there is a buck converter, referred to as the 5V pre-regulator, that generates a well-regulated 5V voltage level from a higher voltage input. This 5V rail supplies the main point-of-load (POL) converters that regulate the voltages needed for the rails of the 2VE3858 device.

Two TPS62893-Q1 regulator ICs are used in a dual-phase configuration to supply the main core rail. The TPS6594-Q1 and LP8764-Q1 power management ICs (PMICs) are utilized for the other rails.

There is also a multirail voltage supervisor IC that monitors and communicates if all of the rails are within the respective acceptable voltage levels. Additionally, the multirail voltage supervisor IC is included for functional safety purposes.

2 Power Design Parameters

Table 2-1 displays the power rail specifications for each rail of the 2VE3858 including the voltages and tolerances, load currents, and sequence order for each rail. This reference design is designed to meet all the *AI Edge Series* power delivery specifications.

Table 2-1. 2VE3858 Device Power Rail Specifications

SEQUENCE	RAIL NAME	VOLTAGE (V)	DC TOLERANCE	AC TRANSIENT MARGIN	STEP LOAD (%)	CURRENT (A)
2	VCC_MIPI, VCC_LPD, VCC_FPD, VCC_USB2, VCC_PAUX, VCC_USB3, VCC_RAM, VCC_SOC, VCC_IO, VCC_MMD, VCC_AIE, VCCINT	0.8	±1%	±17mV	33	92
3	VCCAUX, VCCAUX_PLL, VCCAUX_LPD, VCCAUX_SMON	1.5	±1%	±2%	100	6
4	VGTYP_AVCC, VGTYP_MMI_AVCC	0.92	±1%	±2%	70	5
5	VGTYP_AVCCAUX, VGTYP_MMI_AVCCAUX	1.5	±1%	±2%	70	0.2
6	VGTYP_AVTT, VGTYP_MMI_AVTT	1.2	±1%	±2%	70	5
1	VCCIO_PAUX, VCCREG_USB2, VCCIO_USB3, VCCO_HDIO, VCCIO_MIPI, VCCO_PSIO	1.8	±1%	±2%	100	4.3
1	VCCO_PSIO, VCCO_HDIO, VCCIO_USB2	3.3	±1%	+2/-4%	100	3.8

Figure 2-1 shows the 2VE3858 device power tree.

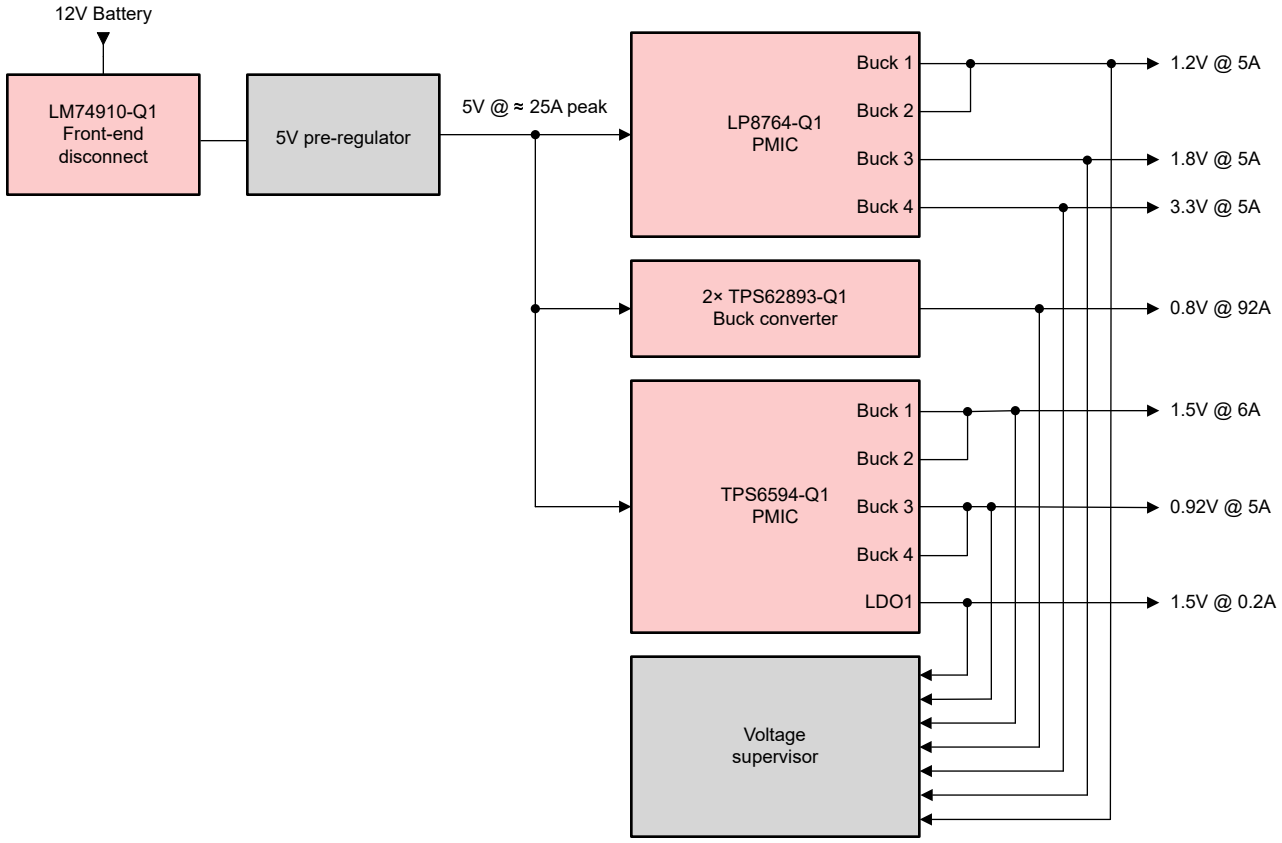


Figure 2-1. 2VE3858 Device Minimum Rails Configuration Power Tree

3 Sequencing

3.1 Start-Up

Figure 3-1 and Figure 3-2 show the start-up timing of the power rails

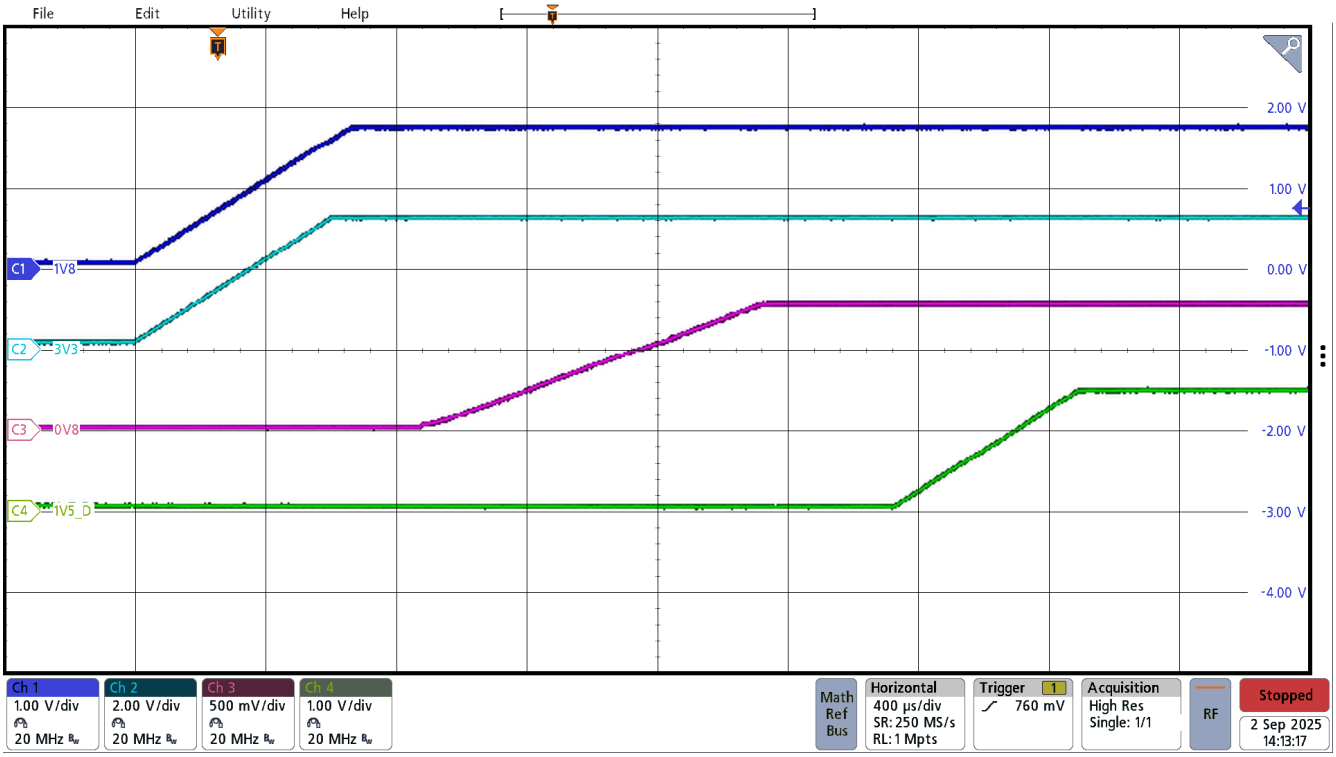


Figure 3-1. 2VE3858 Device POL Rails Start-Up Sequence 1

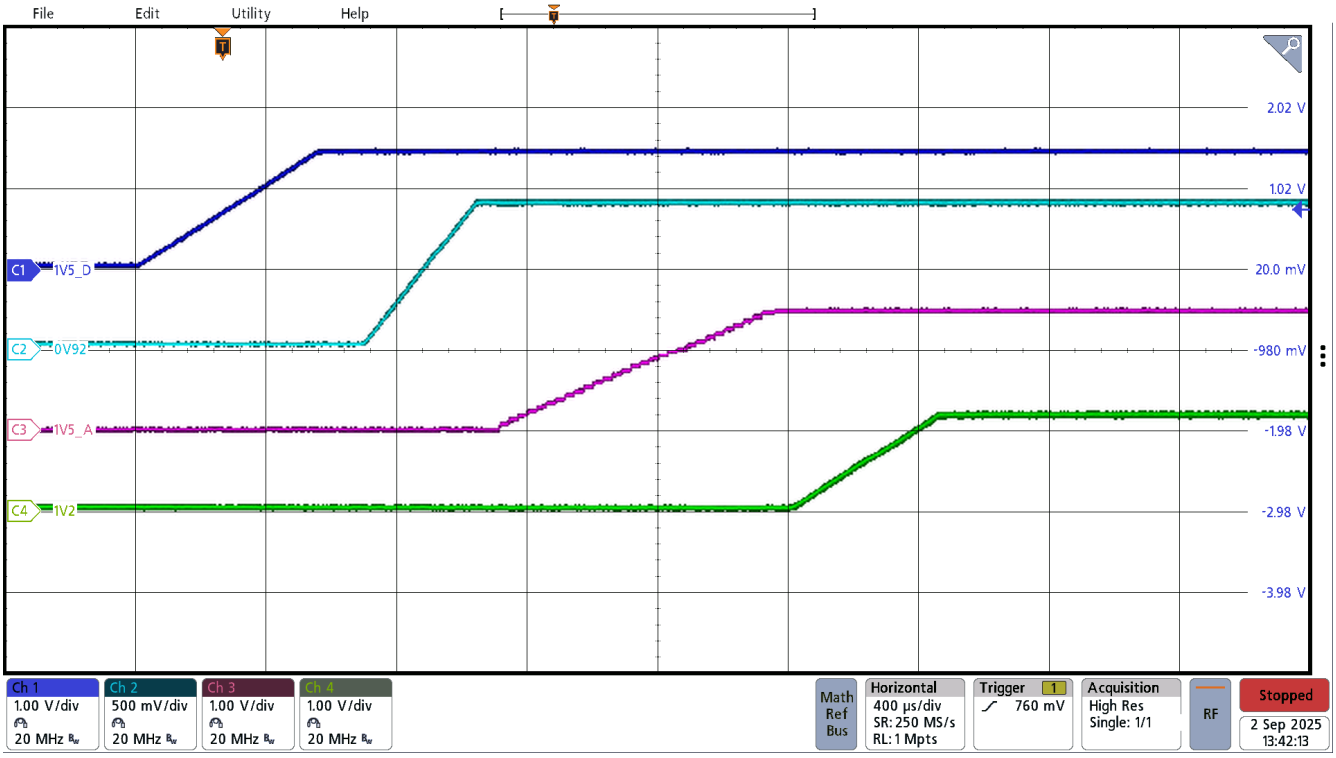


Figure 3-2. 2VE3858 Device POL Rails Start-Up Sequence 2

3.2 Shutdown

Figure 3-3 and Figure 3-4 show shutdown timing of the power rails.

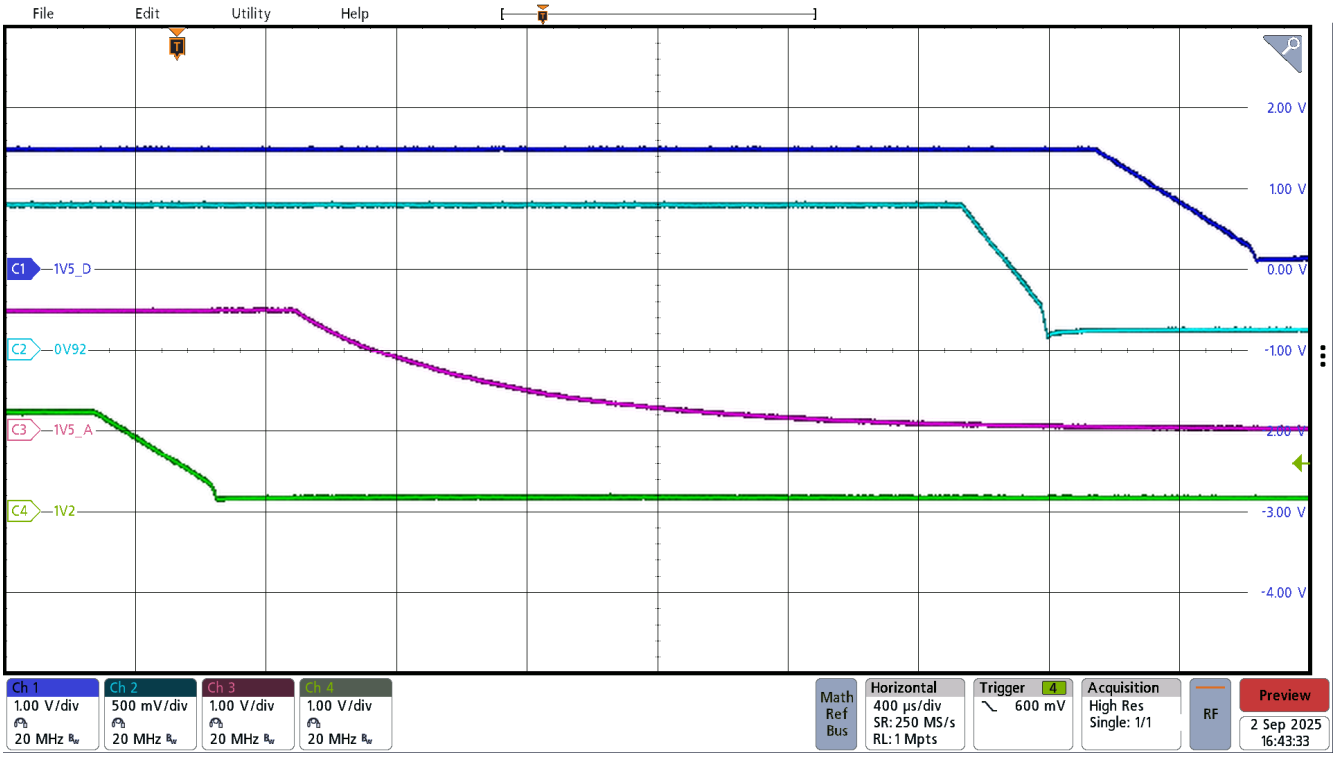


Figure 3-3. 2VE3858 Device POL Rails Shutdown Sequence 1

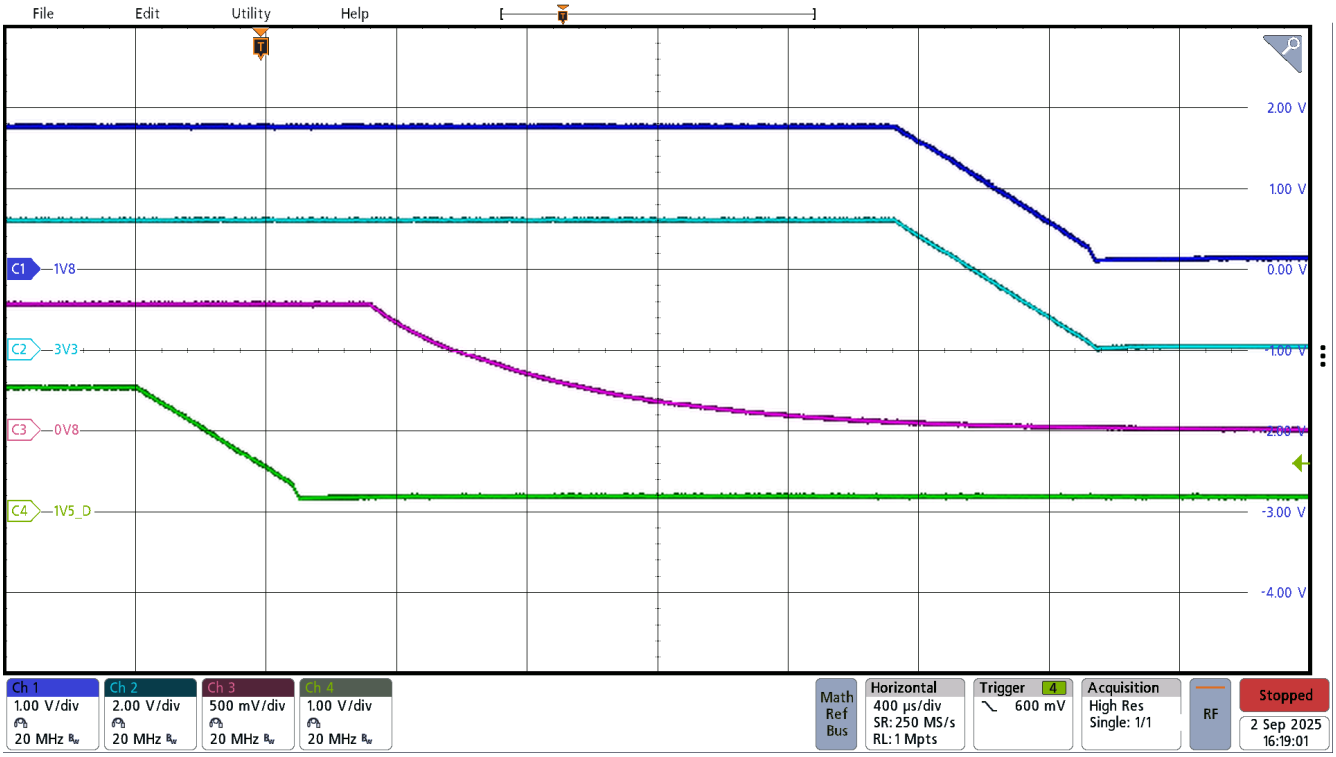


Figure 3-4. 2VE3858 Device POL Rails Shutdown Sequence 2

4 Schematics

Figure 4-1 shows the LM74910-Q1 schematic with critical components. For guidance on layout, see the data sheets and EVM user guides for the particular devices.

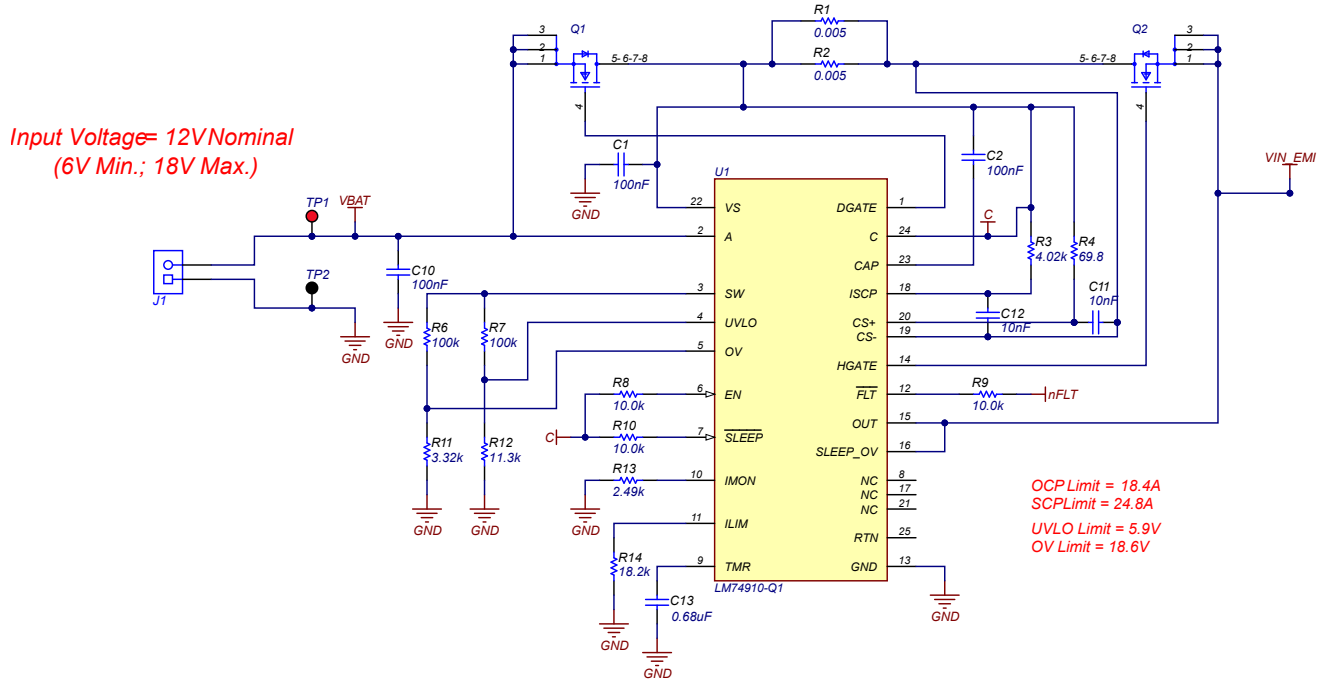


Figure 4-1. LM74910-Q1 Front-End Protection Schematic

Figure 4-2 shows the dual-phase TPS62893-Q1 schematic with critical components. For guidance on layout, see the data sheets and EVM user guides for the particular devices.

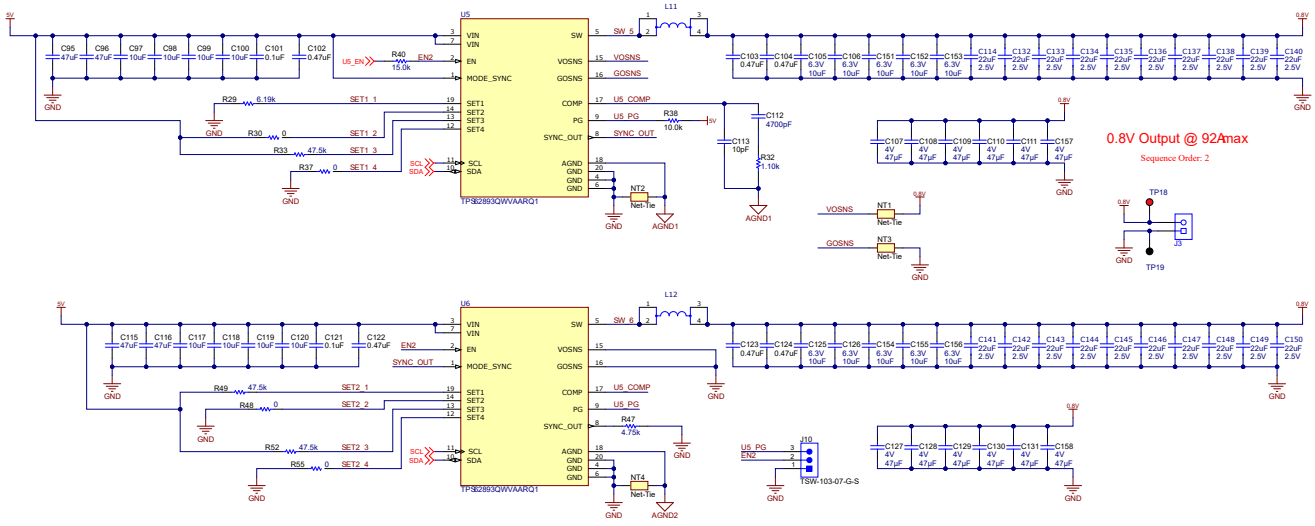


Figure 4-2. TPS62893-Q1 Core Rail Schematic

Figure 4-3 shows the TPS6594-Q1 schematic with critical components. For guidance on layout, see the data sheets and EVM user guides for the particular devices.

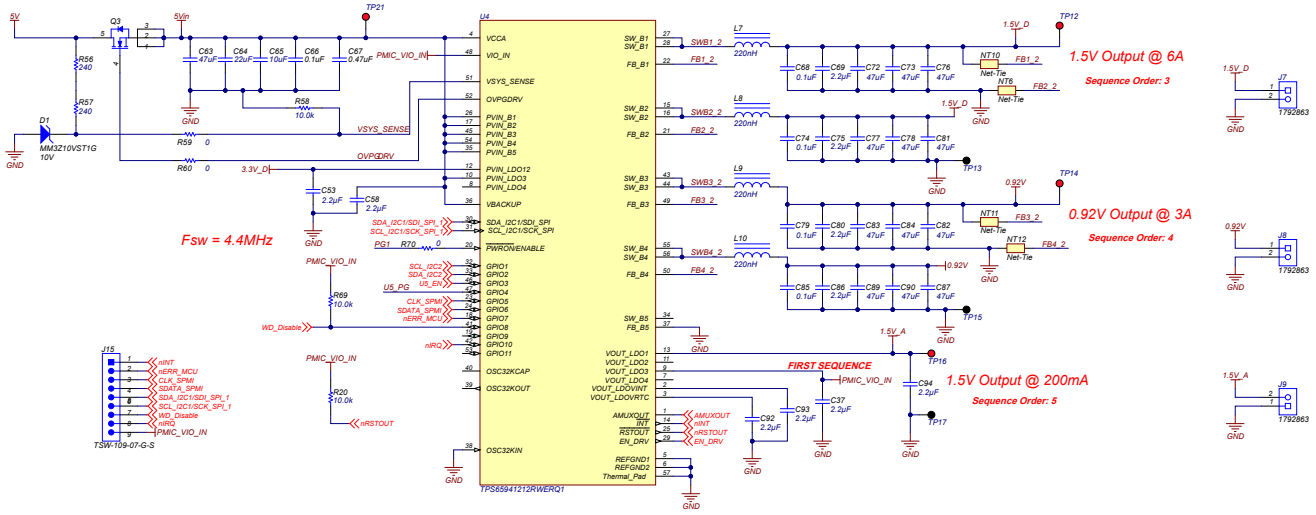


Figure 4-3. TPS6594-Q1 Multiple Peripheral Rails Schematic

Figure 4-4 shows the LP8764-Q1 schematic with critical components. For guidance on layout, see the data sheets and EVM user guides for the particular devices.

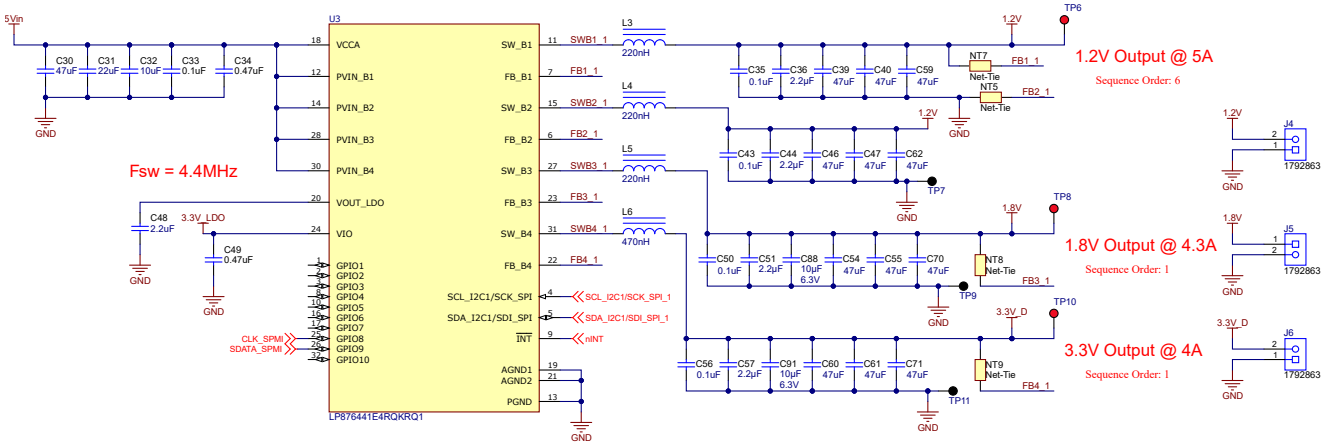


Figure 4-4. LP8764-Q1 Multiple Peripheral Rails Schematic

5 Front-End Protection

An LM74910-Q1 front-end protection (FEP) circuit is found at the main input of the circuit at the main power source connection. This FEP controller provides features such as:

- Reverse-polarity protection
- Programmable overcurrent protection (OCP) disconnect (through R1, R2, R4, and R16 component values)
- Programmable undervoltage disconnect protection and lockout protection (through R2 and R9 divider values)
- Programmable overvoltage disconnect protection and lockout protection (through R6 and R11 divider values)
- Programmable protection delay time and fault delay time (through C13, from the TMR pin to GND)
- Current monitoring (through R1, R2, R4, and R13 components values)

Other options are available for the front-end protection IC, aside from the LM74910-Q1. See also the *Texas Instruments* website and search in the *Ideal diode/ORing controllers* section for alternatives.

6 Multiple Peripheral Rail Buck Converter PMICs

The TPS6594-Q1 is a power management IC (PMIC) that has four flexible multiphase configurable buck regulators with an additional buck regulator and four LDOs. The TPS6594-Q1 device includes protection and diagnostic mechanisms such as voltage monitoring on the input supply, input overvoltage protection, voltage monitoring on all buck and LDO regulator outputs, register and interface CRC, current-limit, short-circuit protection, thermal pre-warning, and overtemperature shutdown.

The LP8764-Q1 is a power management IC (PMIC) which has four step-down DC/DC converter cores, that are configurable for five different phase configurations from one 4-phase output to four 1-phase outputs.

Both PMICs utilize a non-volatile memory (NVM) to control the default power sequences and default configurations, such as output voltage and GPIO configurations. The NVM is pre-programmed to allow start-up without external programming. Most static configurations, stored in the register map of the device, can be changed through SPI or I2C interfaces to configure the device to meet many different system needs. The NVM contains a bit-integrity-error detection feature (CRC) to stop the power-up sequence if an error is detected, preventing the system from starting in an unknown state.

7 Low-Voltage, High-Current, Core Rail Buck Converter

The TPS62893-Q1 is a synchronous step-down DC/DC converter with I2C interface and differential remote sense. The device can operate in stacked mode to deliver higher output currents or to spread the power dissipation across multiple devices. In stacked operation, the converter frequencies are synchronized, share a common compensation signal, and shift the phases to supply heavier loads. The I2C compatible interface offers several control, monitoring, and warning features including telemetry data of input voltage, output voltage, output current, and temperature. Four SET pins can be used to program default settings before start up.

8 Voltage Supervisor

A programmable voltage supervisor is included. The device contains numerous registers that can be programmed through I2C. Programmable parameters include, voltage threshold levels, hysteresis levels, and glitch immunity times.

9 Summary

This design, using the LM74910-Q1, TPS62893-Q1, TPS6594-Q1, and LP8764-Q1 ICs, provides the power requirements for the 2VE3858 device. The I2C control of the TPS6594-Q1 and LP8764-Q1 PMICs allow for a large amount of control and the ability to configure the system through a single serial communication line. It is possible to customize and optimize this power design based on the actual use case regarding current requirements, used peripherals, power sequencing, and so forth, for other devices of the AI Edge series.

10 Documentation Support

1. Texas Instruments, *LM74910-Q1: Automotive ideal diode with circuit breaker, 200-kHz ACS and under- and overvoltage protection* product page
2. Texas Instruments, *TPS62893-Q1: Automotive, 2.8V to 6V input 50A fast transient stackable synchronous buck converter with telemetry* product page
3. Texas Instruments, *TPS6594-Q1: Automotive 2.8-V to 5.5-V PMIC with five buck regulators and four low-dropout regulators* product page
4. Texas Instruments, *LP8764-Q1: 4 5-A/20-A multiphase buck converters PMIC for automotive SoCs* product page

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