Application Report
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Powering the AM1806, AM1808, and the AM1810 with the TPS650061

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ABSTRACT

This document details the design considerations of a power solution for the AM1806 and AM1808 (AM1806/08/10) low-power application processor 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 AM1806/08/10 requires at least three different voltage rails with specific sequencing and reset requirements. The TPS6500061 is a highly integrated power solution that can provide the 1.2 V, 1.8 V and 3.3 V rails and $\overline{\text{RESET}}$signal required by the AM1806/08/10. 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 AM1806/08/10. Power requirements, illustrated schematic, operation waveforms, performance data and bill of materials are detailed.

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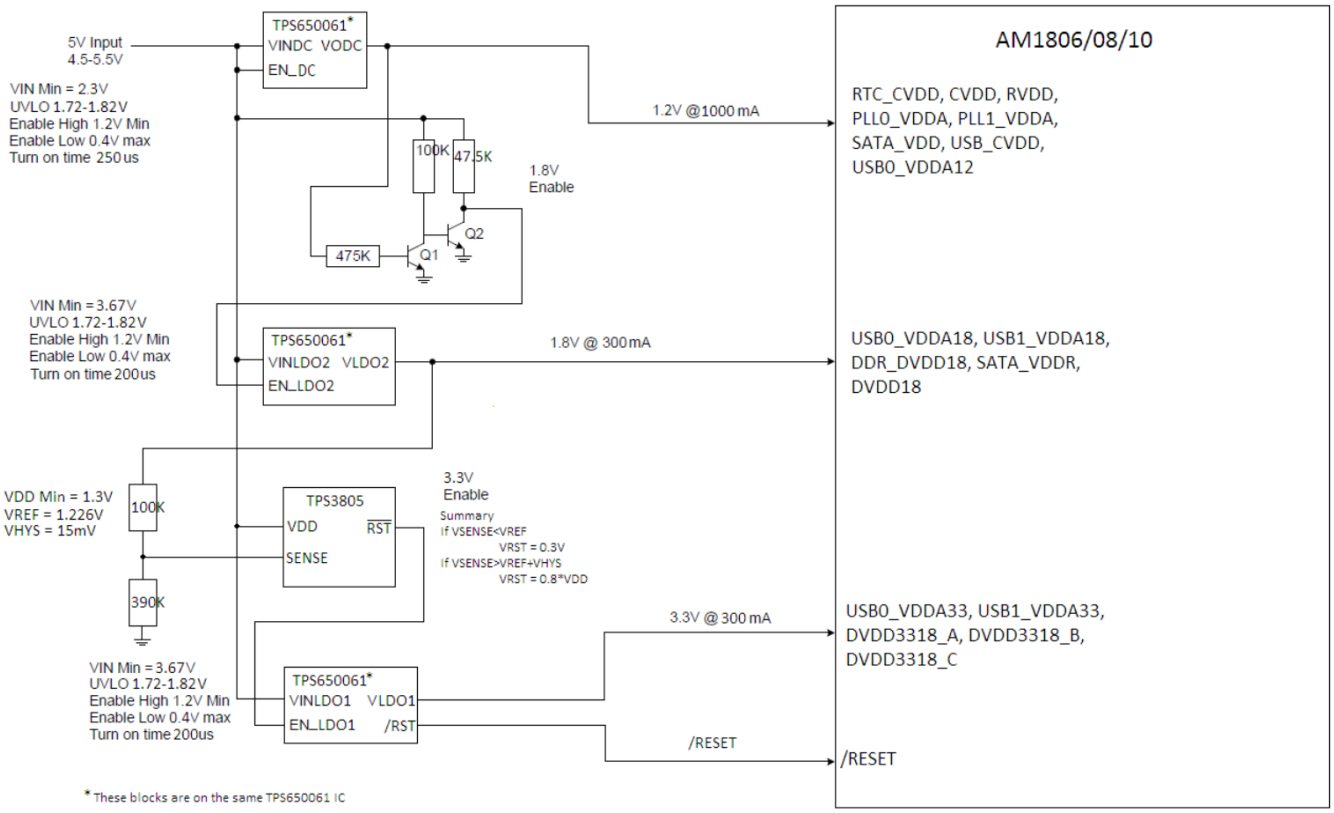

Figure 1. TPS3805, TPS650061, and AM1806/08/10 Block Diagram

1 Power Requirements

The AM1806/08/10 power requirements are listed in Table 1.

Table 1. AM1806/08/10 Power Requirements

RAIL NAME	VOLTAGE (V)	Imax (mA)	TOLERANCE
RTC_CVDD	1.2	1	–25%, +10%
CVDD	1.2	375	–9.75%, +10%
RVDD, PLL0_VDDA, PLL1_VDDA, SATA_VDD, USB_CVDD, USB0_VDDA12	1.2	200	–5%, +10%
USB0_VDDA18, USB1_VDDA18, DDR_DVDD18, SATA_VDDR, DVDD18	1.8	180	±5%
USB0_VDDA33, USB1_VDDA33	3.3	24	±5%
DVDD3318_A, DVDD3318_B, DVDD3318_C	1.8/3.3	50/90	±5%

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 AM1806/08/10 power-on requirements, the 1.2V rail must power on first, then the 1.8V rail, and lastly, the 3.3 V rail. After all 3 rails are up, the RESET may be released. To ensure this power up sequence, the 1.2V enable is connected to VIN and the output is connected to EN_LDO2 through two transistors. The output of LDO2, VLDO2, is connected to the sense input of an SVS that has its $\overline{\text{RESET}}$output connected to EN_LDO1. To ensure that the TPS650061 doesn't assert its reset until all three supplies are up, $\overline{\text{RST}}$ is pulled up to VLDO2, $\overline{\text{MR}}$ is pulled up to VODC, and RSTSNS is connected to VLDO1 with a resistor divider. The proper connections for this power-on sequencing are shown in Figure 2.

Notice the following considerations in selecting components for the circuit:

- The resistor divider on RSTSNS is such that if VLDO1 goes below 3.3 V – 5% (3.125 V), reset becomes active (opens).
  - Because $\overline{\text{RST}}$ is pulled-up to VLDO2 and /MR is pulled up to VODC, it will only go high if VODC, VLDO1, and VLDO2 are all present.
- The RSTSNS pin may be connected to an external RC network to set the deglitch timing for triggering a reset when the RSTSNS pull-up voltage falls below the set threshold.

Per the excerpt from the AM1806/08/10 datasheet, the device should be powered-on in the following order:

1. RTC (RTC_CVDD) may be powered from an external device (such as a battery) prior to all other supplies being applied or powered-up at the same time as CVDD. If the RTC is not used, RTC_CVD should be connected to CVDD. RTC_CVDD should not be left unpowered while CVDD is powered.
2. Core logic supplies:

   (a) CVDD core logic supply

   (b) Other 1.2V logic supplies (RVDD, PLL0_VDDA, PLL1_VDDA, USB_CVDD). If voltage scaling is not used on the device, groups 2a) and 2b) can be controlled from the same power supply and powered up together.
3. All 1.8V IO supplies (DVDD18, DDR_DVDD18, USB0_VDDA18) and any of the LVCMOS IO supply groups used at 1.8V nominal (DVDD3318_A, DVDDA3318_B, or DVDD3318_C).
4. All analog 3.3V PHY supplies (USB0_VDDA33; this is not required if USB0 is not used) and any of the LVCMOS IO supply groups used at 3.3V nominal (DVDDA3318_A, DVDDA3318_B, or DVDDA3318_C).

There is no specific required voltage ramp rate for any of the supplies as long as the LVCMOS supplies operated at 3.3V (DVDDA3318_A, DVDDA3318_B, or DVDDA3318_C) never exceed STATIC 1.8V supplies by more than 2 volts. $\overline{\text{RESET}}$ must be maintained active until all power supplies have reached their nominal values.

It is mentioned in the AM1806 Silicon Errata that the DVDD18 voltage rail can pull up to 2.7 V when using dual-voltage IOs at 3.3 V. To address this potential issue, workaround (1a) from the errata is implemented. This workaround asserts that maintaining sufficient bulk capacitance on the DVDD18 supply will ensure that it is not pulled up to 2.7 V. The capacitor value selected was calculated using the equation $I = C \times (dV/dt)$, where dV/dt is the ramp rate of the DVDD3318_x supply (around 280 µs) and I is the maximum leakage current into the DVDD18 supply (140 mA). The calculation gives a capacitance value of 11.88 µF, so the nearest valued available capacitor (22 µF) was chosen and connected to the 1.8 V output rail.

1.2 Power-Off Sequence

For the AM1806/08/10, the power supplies can be powered off in any order as long as the LVCMOS supplies operated at 3.3V (DVDDA3318_A, DVDDA3318_B, or DVDDA3318_C) never exceed STATIC 1.8V supplies by more than 2 volts. There is no specific required voltage ramp down rate for any of the supplies (except as required to meet the above mentioned voltage condition).

To meet the power-off requirement, this design utilizes the TPS3805 voltage supervisor and a resistor divider to detect the voltage of the 1.8V rail. The TPS3805 has a threshold voltage of 1.226V, so using a resistor divider of R1 = 100kΩ and R2 = 390kΩ will result in a trip voltage of 1.54V. This setup should ensure that the 3.3V rail never exceeds the 1.8V rail by more than 2 volts. Note that if the LVCMOS IO supply groups are used at 1.8V instead of 3.3V, the TPS3805 would not be needed.

2 Schematic

This is the schematic of the power solution for the AM1806/08/10.

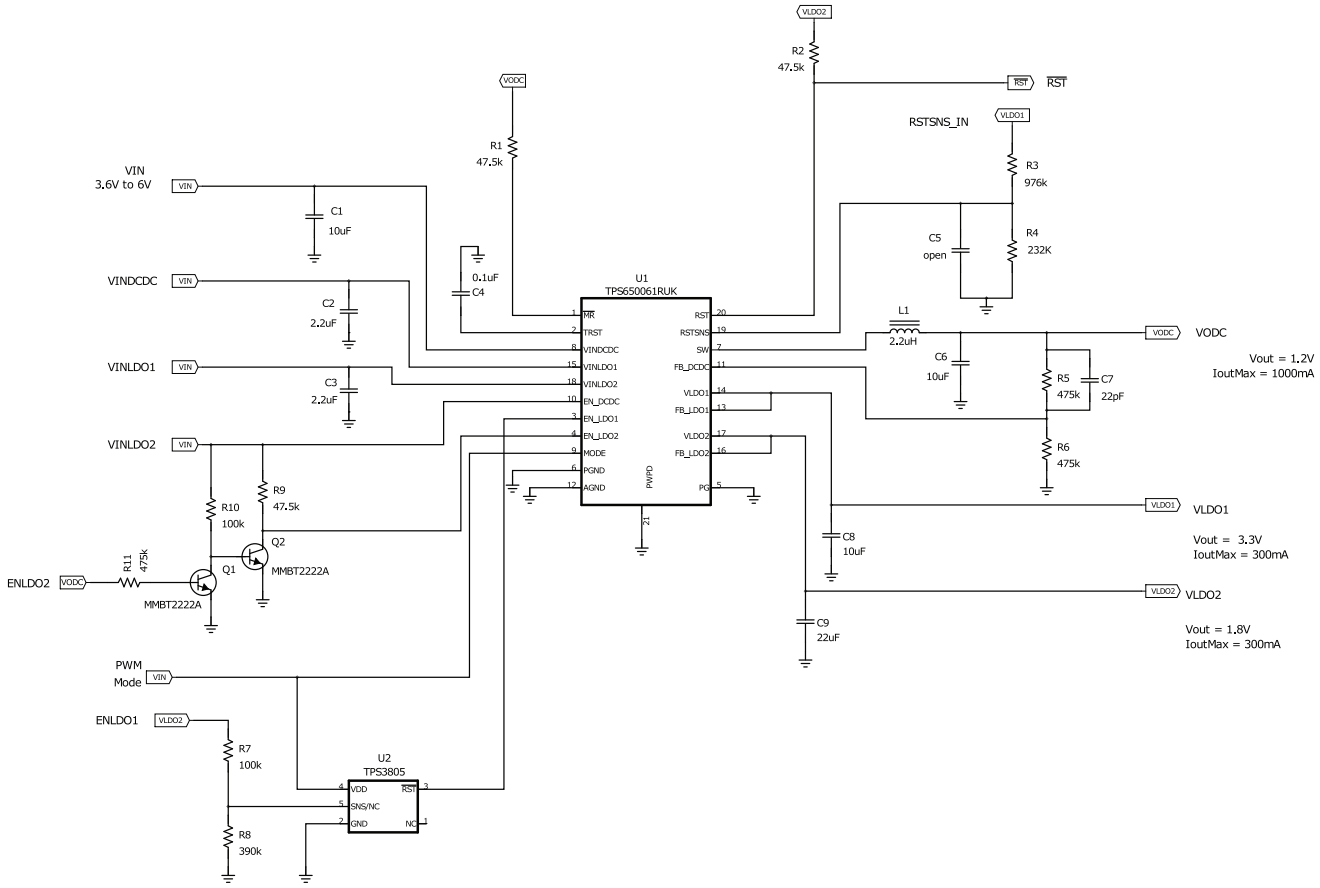

Figure 2. TPS650061 Schematic Diagram

3 Waveforms

The following waveforms demonstrate the startup sequence and the reset of the TPS650061 as required by the AM1806/08/10.

Figure 3 shows the TPS650061 power on sequence of 1.2V then 1.8V then 3.3 V. Figure 4 shows the reset pin, $\overline{RST}$, being released after the voltage on RSTSNS rises above the threshold and after the reset recovery time, t_{RST}, is exceeded. Figure 5 shows the power down sequence where the 3.3V rail never exceeds the 1.8V rail by more than 2 volts.

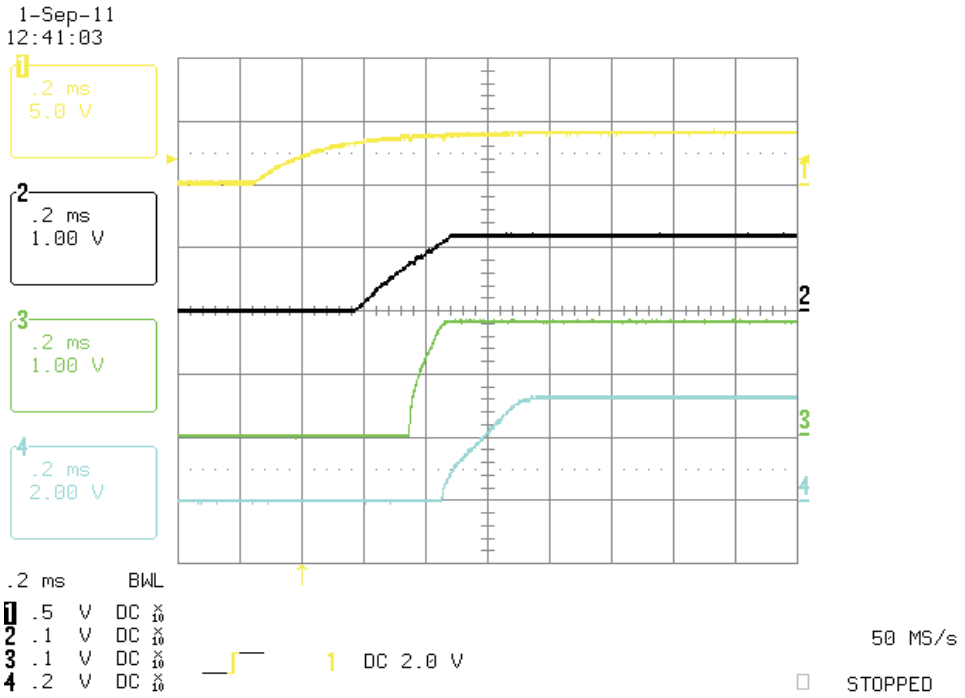

Figure 3. TPS650061 Power-On Ch1-Vin, Ch2-VODC, Ch3-VLDO2, Ch4-VLDO1

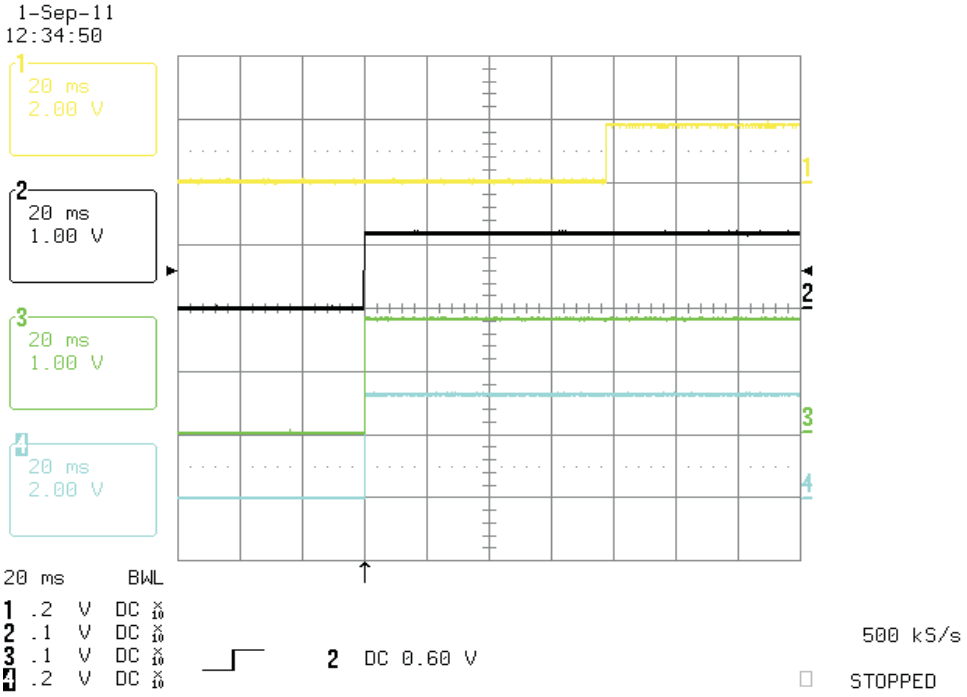

Figure 4. TPS650061 Power-On and /Reset Ch1-/RST, Ch2-VODC, Ch3-VLDO2, Ch4-VLDO1

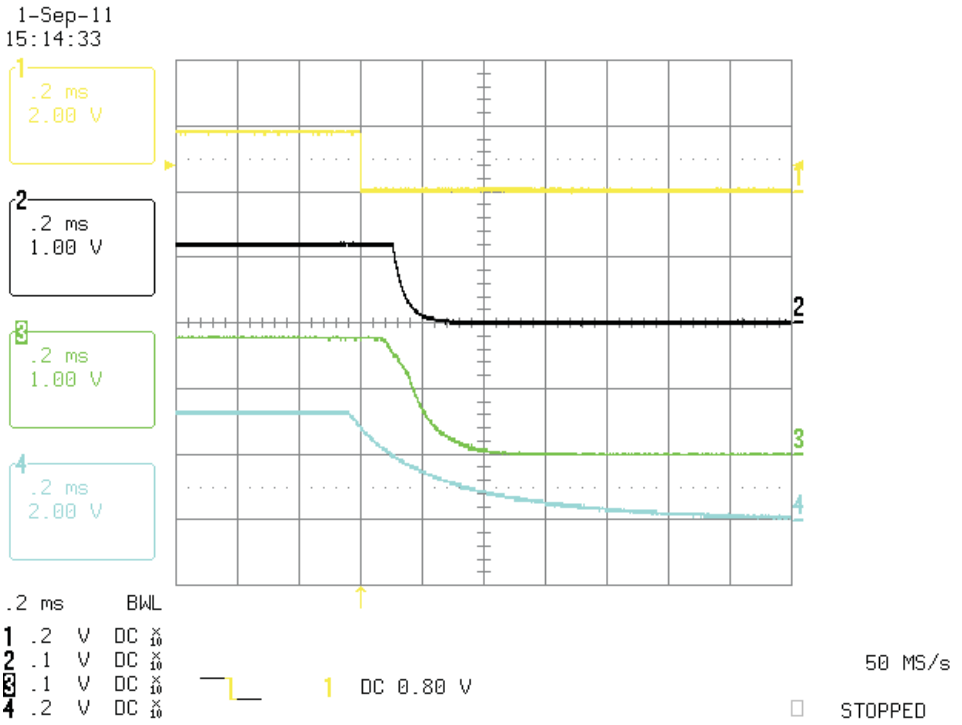

Figure 5. TPS650061 Power-Off Ch1–/RST, Ch2–VODC, Ch3–VLDO2, Ch4–VLDO1

4 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
3	C1, C6, C8	10 µF	Capacitor, Ceramic, 10 V, X5R, 10%	0805	Std	Std
1	C9	22 µF	Capacitor, Ceramic, 10 V, X5R, 10%	0805	Std	Std
2	C2, C3	2.2 µF	Capacitor, Ceramic, 10 V, X5R, 10%	0603	Std	Std
2	C4, C5	0.1 µF	Capacitor, Ceramic, 16 V, X7R, 10%	0603	Std	Std
1	C7	22 pF	Capacitor, Ceramic, 50 V, C0G, 5%	0603	Std	Std
1	L1	2.2 µF	Inductor, SMT, 2.0 A, 110 milliohm	0.118 x 0.118 inch	LPS3015-222ML	Coilcraft
3	R1, R2, R9	4.5 kΩ	Resistor, Chip, 1.16 W, 1%	0603	Std	Std
4	R3, R5 R6, R11	475 kΩ	Resistor, Chip, 1.16 W, 1%	0603	Std	Std
2	R7, R10	100 kΩ	Resistor, Chip, 1.16 W, 1%	0603	Std	Std
1	R4	255 kΩ	Resistor, Chip, 1.16 W, 1%	0603	Std	Std
1	R8	390 kΩ	Resistor, Chip, 1.16 W, 1%	0603	Std	Std
1	U1	TPS650061RUK	IC, 2.25 MHz Step Down Converter with Dual LDOs and SVS	QFN	TPS650061RUK	TI
1	U2	TPS3805	IC, Voltage Detector	SOP-5 (DCK)	TPS3805	TI
2	Q1, Q2	MMBT2222A	Transistor, NPN, High-Performance, 500 mA	SOT-23	MMBT2222A	Fairchild

5 Conclusion

The TPS650061 provides a low cost, comprehensive power solution for the AM1806/08/10. A 1.2 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 minimum regulation, $\overline{\text{RESET}}$goes high (I.e., rises to its pull-up voltage). This meets the power requirements of the AM1806/08/10.

6 References

1. TPS650061 Datasheet (SLVS810B)
2. AM1806 Datasheet (SPRS658C)
3. AM1808 Datasheet (SPRS653B)
4. AM1810 Datasheet (SPRS709A)
5. Powering Freon with TPS65070 Application Report (SLVA371A)
6. DM355 Reference Design (SLVR331B)
7. AM1806 Silicon Errata (SPRZ314B)

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