The STPMIC2L BOM details

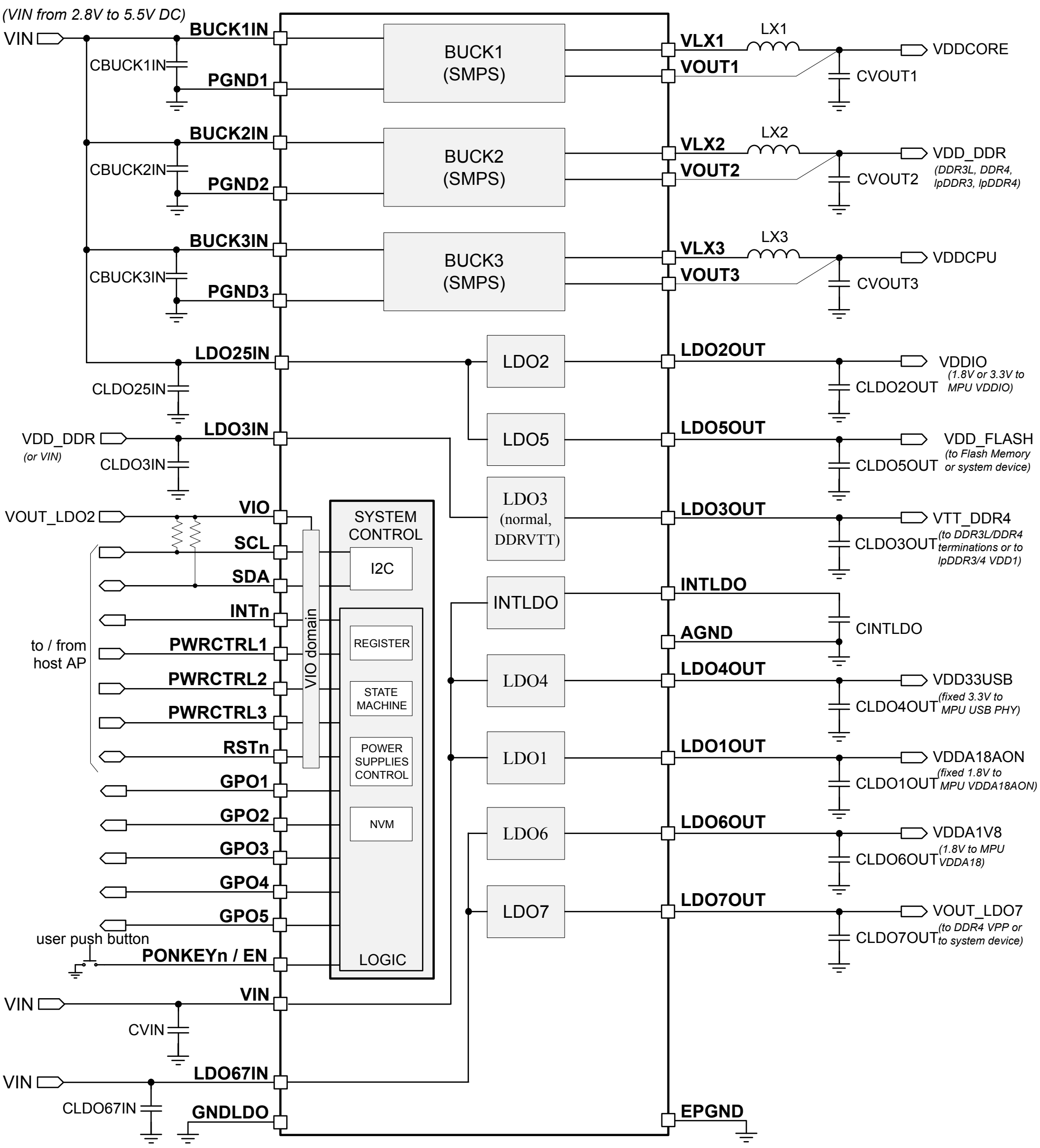
Introduction

STPMIC2L passive external components

This AN is intended to guide the customer in the selection of the external passive components for the BUCK and LDO regulators of the STPMIC2L device.

A typical application schematic is shown in the figure below:

Figure 1. STPMIC2L typical application schematic



1 Buck converters

The STPMIC2L is provided with three buck converters optimized to supply circuits with high current consumption and comply with fast transient response requirements. The input supply range of all buck converters is from 2.8 V to 5.5 V, and they feature soft-start and DVS ramp for system power optimization.

The switching frequency of the converters is typically 2 MHz in a steady-state CCM condition.

The output voltage of BUCK1 is selectable between:

- 0.5 V and 1.5 V with 10 mV steps in the low-voltage range (LV range);

- 1.5 V and 4.2 V with 100 mV steps in the high-voltage range (HV range).

The output voltage of BUCK2 and BUCK 3 is selectable between 0.5 V and 1.5 V with 10 mV steps.

In detail:

Table 1. BUCK converters general description

Regulator	Output voltage (V)	Programming step (mV)	Rated output current (mA)	Application use (typical MCU application)
BUCK1	0.5 - 1.5 in LV mode 1.5 - 4.2 in HV mode	10 (0.5V-1.5V) 100 (1.5V-4.2V)	2000, 1500, 1000, 500	BUCK1 = VDDCORE
BUCK2	0.5 – 1.5	10	2000, 1500, 1000, 500	BUCK2 = VDDQ
BUCK3	0.5 – 1.5	10	2000, 1500, 1000, 500	BUCK3 = VDDCPU

The following sections describe the recommended values of the inductors and output capacitors that have been defined for STPMIC2LA and B to meet the expected performance for STM32MP2x MPUs, such as output voltage ripple and load transient response under all operating conditions (DCM, CCM and temperature).

Table 2. STPMIC2LA/B BUCK converters description

Regulator	Input voltage max (V)	Default output voltage (V)	Rated output current (A)	OCP threshold I_{BCKLIM} (A)	Typical MPU application
BUCK1	5.5	0.82	1.5	2.8	VDDCORE
BUCK2		-	-	-	
BUCK3		0.8	2	3.3	VDDCPU / VDDGPU

Note: For battery applications (with STPMIC2LB), the maximum input voltage could be reduced to 4.2 V (maximum battery voltage) to optimize I_L ripple computation. Nevertheless, this will not significantly change the I_{Lmax}.

1.1 Inductor selection for buck converters

The inductors must be rated for their DC resistance and saturation current. The DC resistance of the inductance directly influences the efficiency of the DC-DC converter. For this reason, an inductor with the lowest possible DC resistance should be selected to achieve higher efficiency.

Equation 1. Peak-to-peak inductor current (CCM mode)

$$\Delta I_L = \frac{(Vinmax - Vout)^{*} D_{max}}{L\,x\,f} = Vout^{*}\frac{1-\frac{Vout}{Vinmax}}{L\,x\,f} \quad (1)$$

Equation 2. Maximum inductor current (CCM mode)

$$I_{Lmax} = I_{out\_max} + \frac{\Delta I_L}{2} \quad (2)$$

Eq. (1) and Eq. (2) show how to calculate the maximum inductor current under static load conditions.

The saturation current of the inductor must therefore be rated higher than the maximum inductor current as calculated using Eq. (2). This is necessary because the inductor current rises above the calculated value during heavy-load transients.

Where:

- D_{MAX} = maximum duty cycle
- f = Switching frequency (2 MHz typical in CCM mode)
- L = Inductor value
- ΔI_L = Peak-to-peak inductor ripple current
- I_{LMAX} = Maximum inductor current

The highest inductor current occurs at maximum V_{IN}

For BUCK1, BUCK2 and BUCK3, a 0.68 µH output inductor must be used.

Table 3. Buck converters - inductor parameters

Regulator	Typical MPU application	Input voltage max	Default output voltage	Rated output current	OCP threshold	Switching frequency (CCM mode)	Recommended output coil	Peak-to-peak inductor current (CCM mode)	Maximum inductor current (CCM mode)
		(V)	(V)	(A)	I_{BCKLIM} (A)	(MHz)	(µH)	ΔI_L (A)	I_{Lmax} (A)
BUCK1	VDDCPU	5.5	0.82	1.5	2.8	2	0.68	0.51	1.75
BUCK2	VDDCORE		-	-	-	-	-	-	-
BUCK3	VDDGPU		0.8	2	3.3	2	0.68	0.50	2.25

The following inductor part numbers were chosen in the final application:

Table 4. **Buck converters - recommended inductors**

BUCK	Component	Vendor	Part number	(1) Value [µH]	Size	(2) DCR [mΩ]	(3) Isat [A]
BUCK1	LX1	Murata	DFE252012F-R68M	0.68	1008	25	5.4
BUCK2	LX2	Murata	DFE201610E-R68M	0.68	0806	36	4.3
BUCK3	LX3	Murata	DFE252012F-R68M	0.68	1008	25	5.4

1. *The inductance value should not be lower than -50% when the peak current on the inductor reaches the OCP threshold ($I_{BUCKLIM}$) in case of an overload or short-circuit. In fact, if the inductance value is too low, if I_L is very close to $I_{BUCKLIM}$ (i.e. the inductor is near saturation), I_L will increase faster than the OCP circuitry loop is able to detect, causing the destruction of the high-side MOS.*
2. *Selecting inductors with similar DCR values will help to limit power efficiency losses and also reduce self-heating of the coils.*
3. *Please refer to the inductor's datasheet for the Isat value specification*

Different PN can be used compared to Table 4, provided that the same characteristics (value, DCR) are maintained and that the saturation current is higher than the maximum expected inductor peak current ($I_{BUCKLIM}$) indicated in the datasheet.

The inductor package size should be small enough to allow good PCB placement around the STPMIC2L (not too far from the STPMIC2L on PCB).

Shielded inductors are recommended to reduce possible electromagnetic interference.

1.2 Output capacitor selection for buck converters

Table 5 shows the recommended output capacitor part numbers.

Table 5. **Buck converters - recommended output capacitors**

BUCK	Component	Vendor	Part number	Value [µF]	DC voltage [V]	Size	ESR [mΩ] @ f=2MHz, T=25°C (for 1 cap.)
BUCK1	CVOUT1	Murata	GRM188R60J226MEA0D	4x22	6.3	0603	6
BUCK2	CVOUT2	Murata	GRM188R60J226MEA0D	3x22	6.3	0603	6
BUCK3	CVOUT3	Murata	GRM188R60J226MEA0D	4x22	6.3	0603	6

The X5R capacitors are suitable if the temperature does not exceed +85°C (a combination of PCB temperature plus self-heating). If there is a need to work at temperatures higher than +85°C, X7R ceramic capacitors with similar characteristics to those of the X5R should be used.

Table 6 shows the recommended output capacitance ranges to meet the ripple and dynamic performance requirements of the buck converters to satisfy the power needs of STM32MP2x microprocessors.

Table 6. **Output capacitance range of buck converters and maximum ESR**

BUCK	Component	Output capacitance			(1) Max ESR [mΩ]
		(2) MIN effective [µF]	TYP [µF]	MAX [µF]	
BUCK1	CVOUT1	34.8	4x22	106	2
BUCK2	CVOUT2	23.2	3x22	106	3
BUCK3	CVOUT3	34.8	4x22	106	2

1. *Using multiple output capacitors in parallel instead of one helps reduce the ESR value, improving electrical dynamic performance such as ripple and load transient response.*
2. *The MIN effective capacitance is obtained considering all the derating factors that can affect the recommended capacitors shown in Table 5, such as: nominal tolerance, worst case operating temperature, the highest voltage DC bias for each buck converter, and aging.*

1.3 Input capacitor selection for buck converters

The table below shows the minimum values of the input capacitors required to stabilize the input voltage of the buck converters, which can be affected by the input peak current due to the DC-DC switching activity.

Table 7. Buck converters – recommended input capacitors

BUCK	Component	Vendor	Part number	Value [µH]	DC voltage [V]	(1) Size	Dielectric
BUCK1, BUCK2, BUCK3	CBUCK1,2,3 _IN	Murata	GRM188R61A106ME69D	10	10	0603	X5R

1. *For each buck converter, it is recommended to use a minimum 10 µF ceramic input capacitor. The 0603 size is suggested as the best compromise between capacitance value and component placement on the PCB. In fact, while larger value and dimension capacitors would help to have better filtering on the input pins, thereby limiting ringing effects, on the other hand, it would be necessary to place such capacitors further away from the input pins of the PMIC25, significantly increasing the parasitic inductance values between the VIN and GND pins.*

2 LDO regulators

The STPMIC2L is provided with seven LDOs, listed below in detail:

- LDO1 is a fixed 1.8 V low drop regulator, typically used to supply the VDDA18 MPU application domain. LDO1 is the first IP which needs to be powered on, before any other power domain.
- LDO2, LDO5, LDO6 and LDO7 are general purpose LDOs suitable for supplying MPU application peripherals. All these LDOs are provided with bypass mode function.
- LDO3 has two different operating modes:
  - Normal mode: used as a general-purpose LDO
  - Sink-source mode: for DDR3, DDR3L, DDR4 memory termination
- LDO4 is a fixed 3.3 V regulator designed to supply 3V3 USB PHY circuit.

Table 8. LDO general description

Regulator	Output voltage (V)	Programming step (mV)	Rated output current (mA)	Application use (typical MCU application)
LDO1	1.8	-	20	VDDA18AON
LDO2, LDO5, LDO6, LDO7	0.9 V to 4.0 V	100	400/200/100/50	General purpose (eMMC, DDR4 VPP, SD card, LCD camera)
LDO3 normal mode	0.9 V to 4.0 V	100	120	General purpose/lpDDR VDD1
LDO3 sink-source mode	$\frac{V_{OUT2}}{2}$	-	+/-120 (rms) +/-230 (peak)	DDR3L/DDR4 terminations (VTT)
LDO4	3.3	-	40	VDD33USB VDD33UCPD

2.1 Output capacitor selection for LDOs

The output capacitor is essential to maintain the stability of a linear voltage regulator. It stores charge to manage sudden changes in load current, thereby reducing output voltage ripple and noise. Additionally, it creates a pole with the LDO's output impedance, which can influence the phase margin and the overall stability of the regulator. The value and the ESR of the output capacitor can greatly affect the transient response and the stability of the LDO.

The table below shows the minimum effective output capacitance that must be guaranteed for each LDO.

Table 9. Output capacitance range of LDOs

LDO	Component	Output capacitance		
		(1) MIN effective [µF]	TYP [µF]	MAX [µF]
LDO1	CLDO1OUT	2	4.7	10
LDO2	CLDO2OUT	2	4.7	10
LDO3 (normal mode)	CLDO3OUT	2	4.7	15
LDO3 (sink-source mode)	CLDO3OUT	6	10	15
LDO4	CLDO4OUT	2	4.7	10
LDO5	CLDO5OUT	2	4.7	10

LDO	Component	Output capacitance		
		[1] MIN effective [µF]	TYP [µF]	MAX [µF]
LDO6	CLDO6OUT	2	4.7	10
LDO7	CLDO7OUT	2	4.7	10

1. *The MIN effective capacitance is obtained considering all the derating factors that can affect the recommended capacitors shown in Table 8, such as: nominal tolerance, worst-case operating temperature, and the highest voltage DC bias for each LDO.*

Ceramic capacitors with X5R dielectric were chosen as best compromise to achieve low ESR values.

Table 9 shows the recommended part numbers.

Table 10. Recommended output capacitors

LDO	Component	Vendor	Part number	Value [µF]	DC voltage [V]	Size	ESR [mΩ] @ f=1MHz, T=25°C
LDO1	CLDO1OUT	Murata	GRM155R60J475ME47D	4.7	6.3	0402	6
LDO2	CLDO2OUT	Murata	GRM155R60J475ME47D	4.7	6.3	0402	6
[1] LDO3 (normal mode)	CLDO3OUT	Murata	GRM155R60J106ME05D	10	6.3	0402	6
			GRM155R60J475ME47D	4.7	6.3	0402	6
[1] LDO3 (sink-source mode)	CLDO3OUT	Murata	GRM155R60J106ME05D	10	6.3	0402	6
LDO4	CLDO4OUT	Murata	GRM155R60J475ME47D	4.7	6.3	0402	6
LDO5	CLDO5OUT	Murata	GRM155R60J475ME47D	4.7	6.3	0402	6
LDO6	CLDO6OUT	Murata	GRM155R60J475ME47D	4.7	6.3	0402	6
LDO7	CLDO7OUT	Murata	GRM155R60J475ME47D	4.7	6.3	0402	6

1. *It is recommended to use a 10µF/6.3V capacitor for LDO3 operating in both normal and sink-source mode.*

2.2 Input capacitor selection for LDOs

The main function of an input capacitor in an LDO is to supply high-frequency current that cannot be obtained from the power source because of the inductance in the power supply line. It aids in minimizing the ripple voltage from the power supply and stops the LDO from oscillating by offering a low-impedance path to ground for high-frequency noise. The value of the input capacitor is determined by the LDO's input impedance and the highest input ripple voltage that the application can handle.

The table below shows the recommended input capacitor for each LDO.

Table 11. recommended input capacitors

LDO	Component	Vendor	Part number	Value [µF]	DC voltage [V]	Size
LDO2, LDO5	CLDO2,5IN	Murata	GRM155R61E105KA12D	1	25	0402
LDO3	CLO3IN	Murata	GRM155R60J106ME05D	10	6.3	0402
LDO1, LDO4	CVIN	Murata	GRM155R60J475ME47D	4.7	6.3	0402
LDO6, LDO7	CLDO67IN	Murata	GRM155R61E105KA12D	1	25	0402

3 Recommended BOM

The table below summarizes all suggested BOM part numbers also used on the STPMIC2L evaluation board (STEVAL-PMIC2LKV1).

Table 12. STPMIC2L recommended BOM list

Component	Manufacturer	Part number	Value	Size
CVIN, CLDO1,2,3,4,5,6,7_OUT, CINTLDO	Murata	GRM155R60J475ME47D	4.7µF 6.3V	0402
CBUCK1,2,3_IN		GRM188R61A106ME69D	10µF 10V	0603
CVOUT1, CVOUT3		GRM188R60J226MEA0D	4 x 22µF 6.3V	0603
CVOUT2			3 x 22µF 6.3V	
CLDO25IN, CLDO67IN		GRM155R61E105KA12D	1µF 25V	0402
CLDO3IN, CLDO3OUT		GRM155R60J106ME05D	10µF 6.3V	0402
LX1, LX3		DFE201610E-R68M=P2	0.68µH	0806
LX2		DFE252012F-R68M=P2	0.68µH	1008

Note: *All the recommended part numbers are X5R guaranteed with T_{amb} ≤ 85°C. Consider using X7R or better dielectric capacitors if the whole application operates in an environment with T_{amb} > 85 °C.*

Table 13 shows the alternative STPMIC2L part numbers that can be used in an environment with T_{amb} > 85°C.

Table 13. Alternative X7R capacitor part numbers

Component	Manufacturer	Part number	Value	Size
CVIN, CLDO1,2,3,4,5,6,7_OUT, CINTLDO	Murata	GRM21BR71A475ME51	4.7µF 10V	0805
CBUCK1,2,3_IN		GRM21BR71A106MA73	10µF 10V	0805
CVOUT1, CVOUT3		GRM31CR70J226ME19	4 x 22µF 6.3V	1206
CVOUT2			3 x 22µF 6.3V	
CLDO25IN, CLDO67IN		GRM219R71E105KA88	1µF 25V	0805
CLDO3IN, CLDO3OUT		GRM21BR70J106MA73	10µF 6.3V	0805

Revision history

Table 14. Document revision history

Date	Version	Changes
20-Jan-2026	1	Initial release.

Contents

List of tables

List of figures