The STPMIC1L BOM details

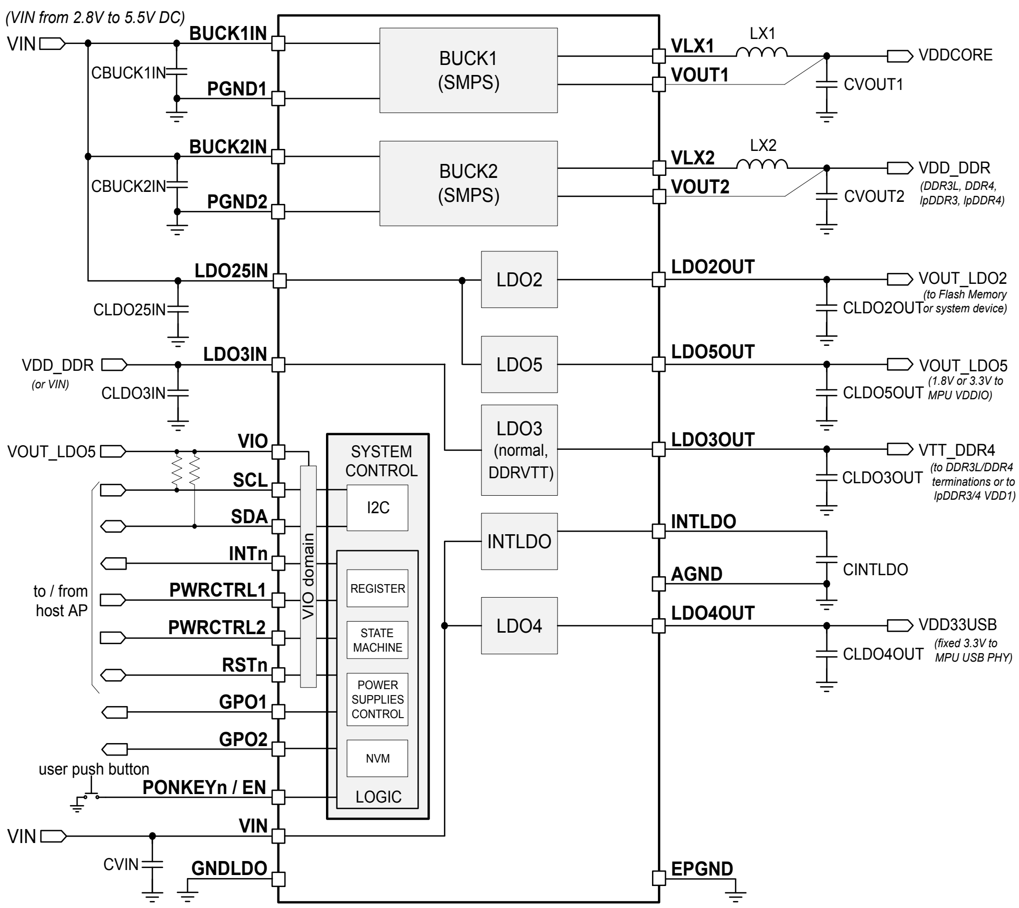
Introduction

STPMIC1L 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 STPMIC1L device.

A typical application schematic is shown in the figure below.

Figure 1. **STPMIC1L typical application schematic**



1 Buck converters

The STPMIC1L is provided with two buck converters optimized to supply circuits with high current consumption and comply with fast transient response requirements. The input supply of all buck converters ranges 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 is selectable between 0.5 V and 1.5 V with 10 mV steps.

In details:

Table 1. BUCK converters general description

Regulator	Output voltage (V)	Programming step (mV)	Rated output current (mA)	Application use (typical MCU MPU application)
BUCK1	LV: 0.5 V to 1.5 V	10	2000, 1500, 1000, 500	VDDCORE/VDDCPU
	HV: 1.5 V to 4.2 V	100		
BUCK2	0.5 V to 1.5 V	10	2000, 1500, 1000, 500	VDDQ_DDR (DDR3L, DDR4, lpDDR3, lpDDR4)/ VDDCPU

The following sections show the recommended values of the inductors and output capacitors that have been defined for STPMIC1LA and B to achieve the expected performance for STM32MP13/15s MPUs, such as the output voltage ripple and the load transient response under all operating conditions (DCM, CCM and temperature).

Table 2. STPMIC1LA/B/D BUCK converters description

Regulator	STPMIC1L version	Input voltage max. (V)	Default output voltage (V)	Rated output current (A)	OCP threshold I_{BCKLIM} (A)	Typical MPU application
BUCK1	STPMIC1LA STPMIC1LB (1)	5.5	1.22 (2)	1.5	2.8	VDDCORE/VDDCPU
BUCK2	STPMIC1LA STPMIC1LB (1)		1.2	1	2.1	VDDQ_DDR/ VDDCPU
BUCK1	STPMIC1LD (3)	5.5	1.25	1	2.1	VDDCORE/VDDCPU
BUCK2	STPMIC1LD (3)		1.25	1	2.1	VDDQ_DDR/ VDDCPU

1. *For battery applications (with STPMIC1LB), the max. input voltage could be reduced to 4.2 V (maximum battery voltage) to optimize I_L ripple computation. Nevertheless, this will not change the I_{Lmax} significantly.*
2. *Default STM32MP15 VDDCORE at 1.22 V (bootloader adapts VDDCORE at 1.25 V for STM32MP13)*
3. *The STPMIC1LD version covers the compatibility with the STM32MP13 in overdrive setup. A dedicated GPO is used to power ON an external buck converter (the ST1S31) with the proper rank to supply the DDR3L memory.*

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 DC resistance should be selected to achieve a 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 then must be rated higher than the maximum inductor current as calculated with 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 and BUCK2, a 1 µH output inductor must be used.

Table 3. Buck converters - inductors 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)	$I_{BUCKLIM}$(A)	(MHz)	(µH)	ΔI_L (A)	I_{Lmax} (A)
BUCK1	VDDCORE VDDCPU	5.5	1.22	1.5	2.8	2	1	0.48	1.74
BUCK2	VDDQ_DDR		1.2	1	2.1	2	1	0.47	1.23

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	Samsung	CIGT201610LH1R0MNE	1	0806	57	3.6
BUCK2	LX2	Samsung	CIGT201610LH1R0MNE	1	0806	57	3.6

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 the I_L is very close to $I_{BUCKLIM}$ (i.e. the inductor is close to saturation), the 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 to reduce the 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, but keeping the same characteristic (value, DCR) and selecting the saturation current higher than the maximum expected inductor peak current (IBUCKLIM) indicated in the datasheet.

The inductors' package size should be small enough to allow good PCB placement around the STPMIC1L (not too far from the STPMIC1L on PCB)

Shielded inductors are recommended to reduce possible electromagnetic interferences

1.2 Output capacitor selection for buck converter

Table 5 shows the recommended output capacitor part numbers.

Table 5. Buck converters - recommended output capacitors

BUCK	Mode	Component	Vendor	Part number	Value [µF]	DC voltage [V]	Size	ESR [mΩ] @ f = 2 MHz, T = 25°C (for 1 cap.)
BUCK1	LV range	CVOUT1	Murata	GRM188R60J226MEA0D	2x22	6.3	0603	6
	HV range		Murata	GRM21BR61A226ME51L	2x22	10	0805	5
BUCK2	-	CVOUT2	Murata	GRM188R60J226MEA0D	2x22	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 total recommended output capacitance ranges to meet the ripple and dynamic performance requirements of the buck converters to satisfy the power needs of STM32MP1x microprocessors.

Table 6. Output capacitance range of buck converters and max ESR

BUCK	Mode	Component	Output capacitance			(1) Max ESR [mΩ]
			(2) Min. effective [µF]	Typ. [µF]	Max. [µF]	
BUCK1	LV range	CVOUT1	12	2x22	55	3.6
	HV range		12	2x22	55	3
BUCK2	-	CVOUT2	12	2x22	55	3.6

1. *Using multiple output capacitors in parallel instead of one will help to 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, and the highest voltage DC bias for each buck converter and aging.*

1.3 Input capacitor selection for buck converters

The table below shows the input capacitor value 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 [µF]	DC voltage [V]	(1) Size	Dielectric
BUCK1	CBUCK1IN	Murata	GRM188R61A106ME69D	10	10	0603	X5R
BUCK2	CBUCK2IN	Murata	GRM188R61A106ME69D	10	10	0603	X5R

1. *For each buck converter, we recommend not adding an additional input capacitor. The 10 µF / 0603 capacitor 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 provide better filtering on the input pins and limit ringing effects, on the other hand, it would be necessary to place such capacitors further away from the input pins of the STPMIC1L, thus significantly increasing the parasitic inductance values between the VIN and GND pins.*

2 LDO regulators

The STPMIC1L is provided with 4 LDOs, listed below in detail:

- LDO2 and LDO5 are general-purpose LDOs, suitable for supplying MPU application peripherals.
- LDO3 has two different operating modes:
  - Normal mode: used as general-purpose LDO
  - Sink-source mode: for DDR3, DDR3L, DDR4 memory termination
- LDO4 is a fixed 3.3 V regulator designed to supply a 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)
LDO2	0.9 V to 4.0 V	100	400/200/100/50	VDDIO
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
LDO5	0.9 V to 4.0 V	100	400/200/100/50	General purpose (VDD_FLASHeMMC, DDR4 VPP, SD card, LCD camera)

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]
LDO2	CLDO2OUT	2	4.7	10
LDO3 (normal mode)	CLDO3OUT	2	4.7	10
LDO3 (sink-source mode)	CLDO3OUT	6	10	15
LDO4	CLDO4OUT	2	4.7	10
LDO5	CLDO5OUT	2	4.7	10
INTLDO	CINTLDO	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 10, such as: nominal tolerance, worst-case operating temperature, the highest voltage DC bias for each LDO and aging.*

Table 10 shows the recommended part numbers.

Table 10. Output capacitance range of LDOs

LDO	Component	Vendor	Part number	Value [μF]	DC voltage [V]	Size	ESR [mΩ] @ f=1MHz, T=25°C
LDO2	CLDO2OUT	Murata	GRM155R60J475ME47D	4.7	6.3	0402	6
LDO3 (normal mode)	CLDO3OUT	Murata	GRM155R60J475ME47D	4.7	6.3	0402	6
			GRM155R60J106ME05D	10	6.3	0402	6
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
INTLDO	CINTLDO	Murata	GRM155R60J475ME47D	4.7	6.3	0402	6

2.2 Input capacitor selection for LDOs

The main function of an input capacitor in a 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 input capacitor value 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	CLDO25IN	Murata	GRM155R61E105KA12D	1	25	0402
LDO3 (normal mode)	CLDO3IN	Murata	GRM155R61E105KA12D	1	25	0402
			GRM155R60J106ME05D	10	6.3	0402
LDO3 (sink-source mode)	CLDO3IN	Murata	GRM155R60J106ME05D	10	6.3	0402
LDO4	CVIN	Murata	GRM155R60J475ME47D	4.7	6.3	0402

3 Recommended BOM

The table below summarizes all suggested BOM part numbers also used on the STPMIC1L evaluation board (STEVAL-PMIC1LKV1).

Table 12. STPMIC1L recommended BOM list

Component	Manufacturer	Part number	Value	Size
CVIN, CLDO2OUT, CLOD4OUT, CLDO5OUT, CLDO3OUT (LDO3 in normal mode), CINTLDO	Murata	GRM155R60J475ME47D	4.7 µF 6.3 V	0402
CBUCK1IN, CBUCK2IN	Murata	GRM188R61A106ME69D	10 µF 10 V	0603
CVOUT1 (LV range)	Murata	GRM188R60J226MEA0D	2 x 22 µF 6.3 V	0603
CVOUT1 (HV range)	Murata	GRM21BR61A226ME51L	2 x 22 µF 10 V	0805
CVOUT2	Murata	GRM188R60J226MEA0D	2 x 22 µF 6.3 V	0603
CLDO25IN, CLDO3IN (LDO3 in normal mode)	Murata	GRM155R61E105KA12D	1 µF 25 V	0402
CLDO3IN, CLDO3OUT (LDO3 in sink-source mode)	Murata	GRM155R60J106ME05D	10 µF 6.3 V	0402
LX1, LX2	Samsung	CIGT201610LH1R0MNE	1 µH	0806

Note: *All recommended capacitor part numbers are X5R guaranteed with Tpcb ≤ 85°C. Consider using X7R or better dielectric capacitors if the whole application works in an environment with Tpcb > 85°C.*

Table 13 shows the alternative STPMIC1L part numbers that can be used in an environment with Tpcb > 85°C.

Table 13. Alternative X7R capacitor part numbers

Component	Manufacturer	Part number	Value	Size
CVIN, CLDO2OUT, CLOD4OUT, CLDO5OUT, CLDO3OUT (LDO3 in normal mode), CINTLDO	Murata	GRM21BR71A475ME51	4.7 µF 10 V	0805
CBUCK1IN, CBUCK2IN	Murata	GRM21BR71A106MA73	10 µF 10 V	0805
CVOUT1 (LV range)	Murata	GRM31CR70J226ME19	2 x 22 µF 6.3 V	1206
CVOUT1 (HV range)	Murata	GRM31CR71A226ME15	2 x 22 µF 10 V	1206
CVOUT2	Murata	GRM31CR70J226ME19	2 x 22 µF 6.3 V	1206
CLDO25IN, CLDO3IN (LDO3 in normal mode)	Murata	GRM219R71E105KA88	1 µF 25 V	0805
CLDO3IN, CLDO3OUT (LDO3 in sink-source mode)	Murata	GRM21BR70J106MA73	10 µF 6.3 V	0805

Revision history

Table 14. Document revision history

Date	Version	Changes
19-Dec-2025	1	Initial release.

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