Sistema Dinâmico de Economia de Energia em RTOS

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Orientador: Prof. Dr. Carlos Henrique V. Moraes

Co-orientador: Prof. Dr. Rodrigo Maximiano A. Almeida

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- Objetivos
- Revisão Bibliográfica
- Desenvolvimento
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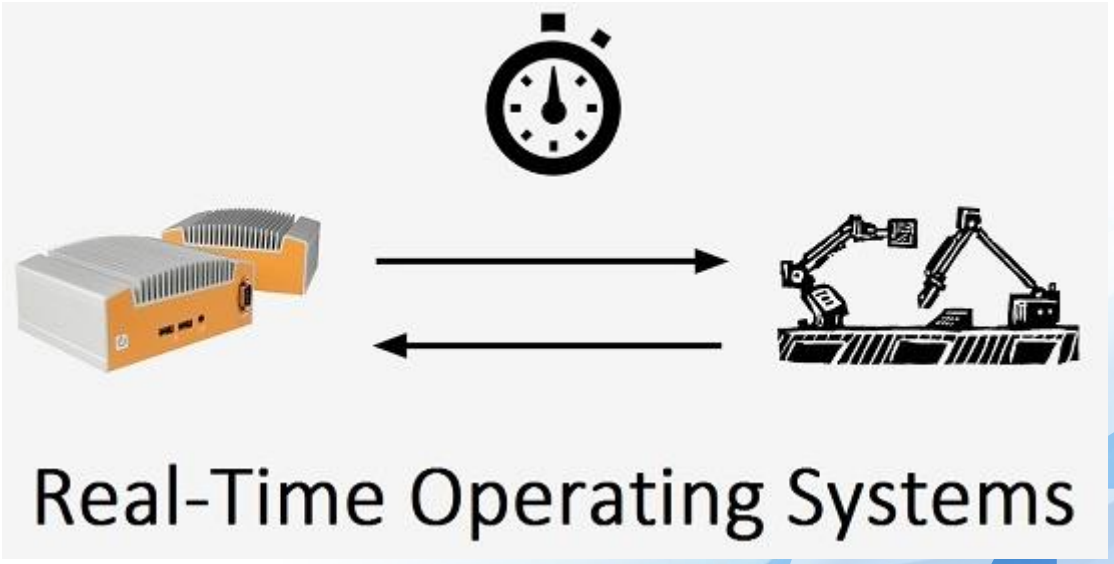
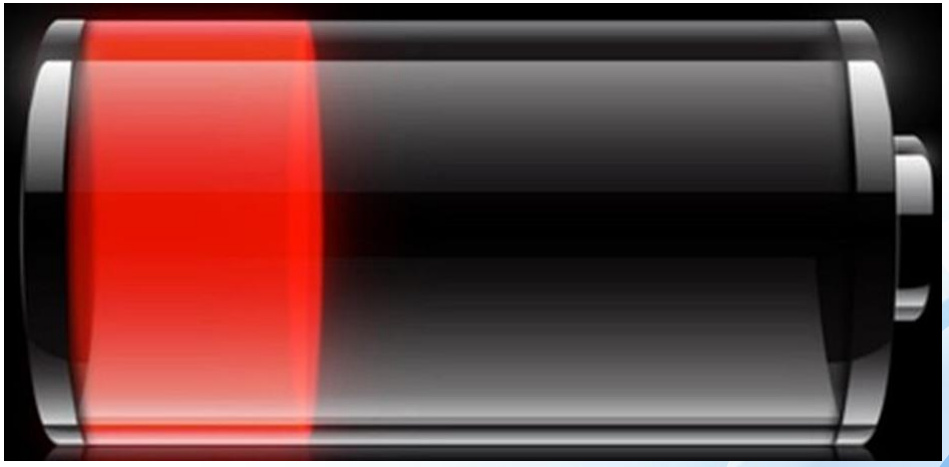
- Conclusão

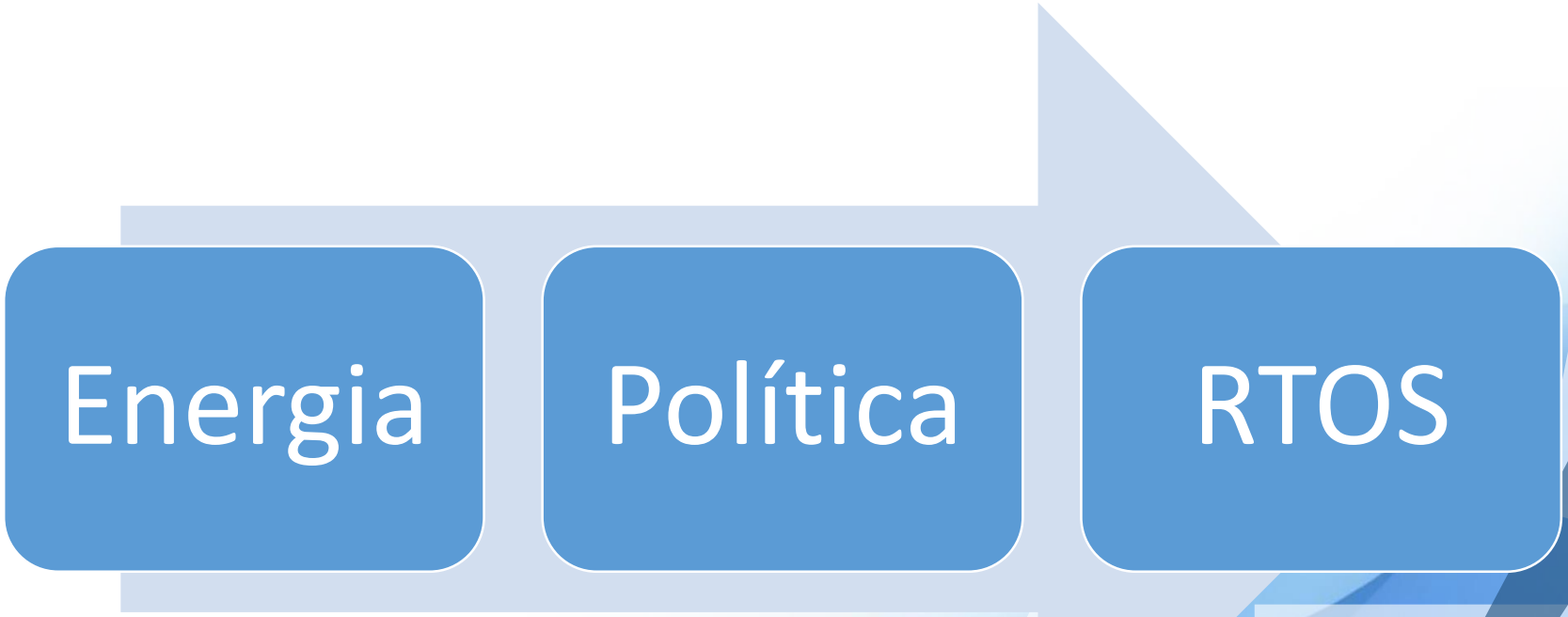
Introdução



Introdução

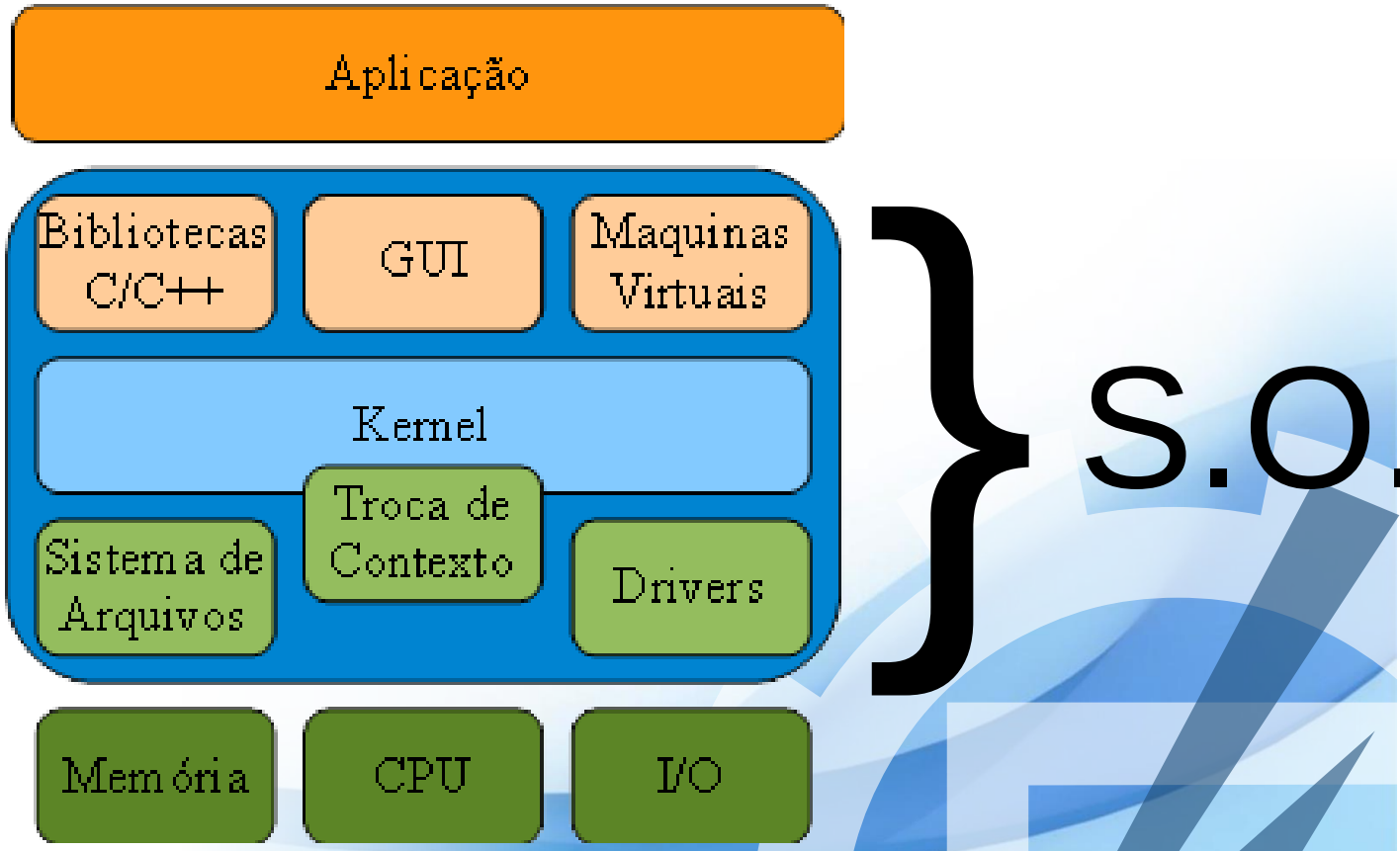


Objetivos

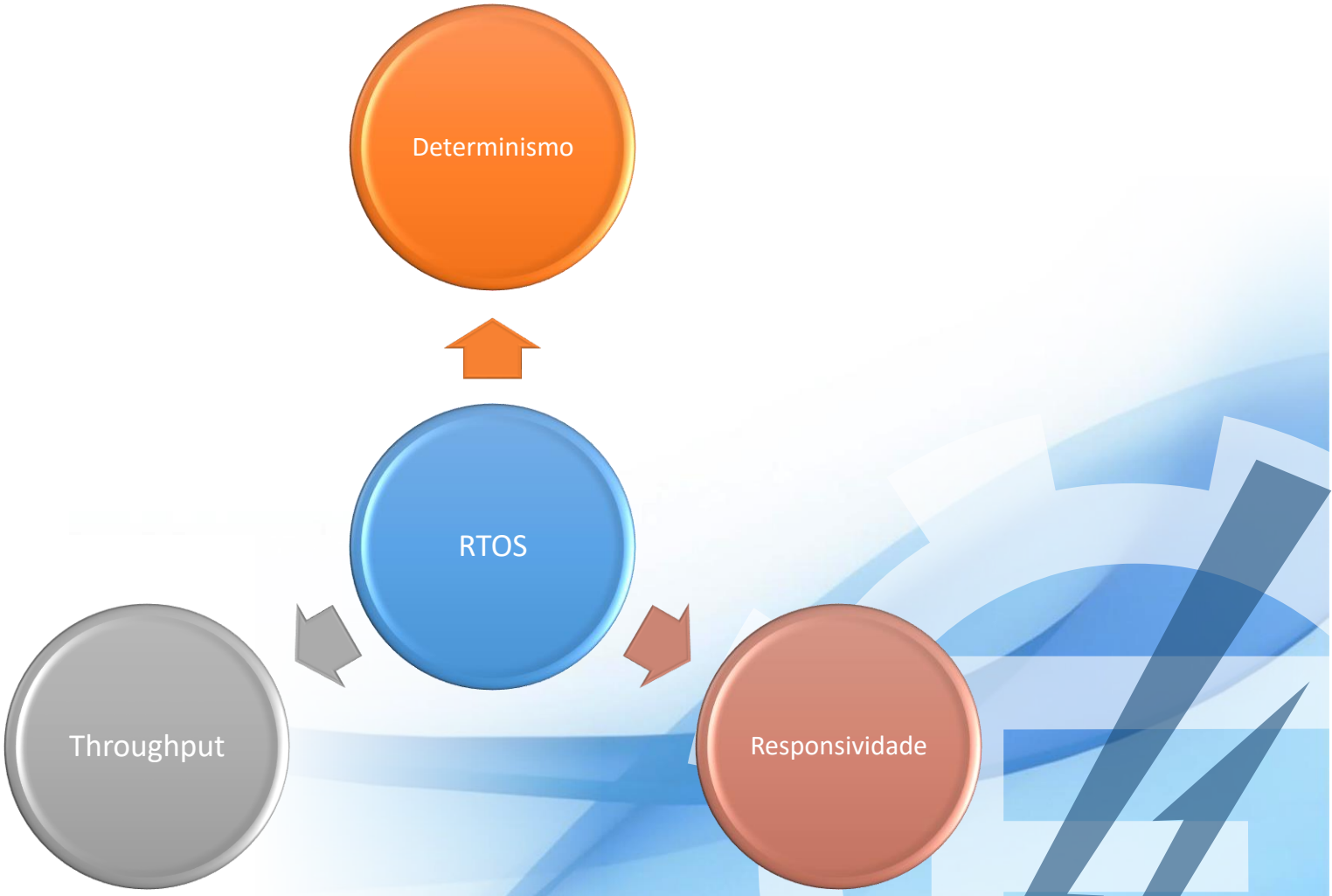


Fundamentação

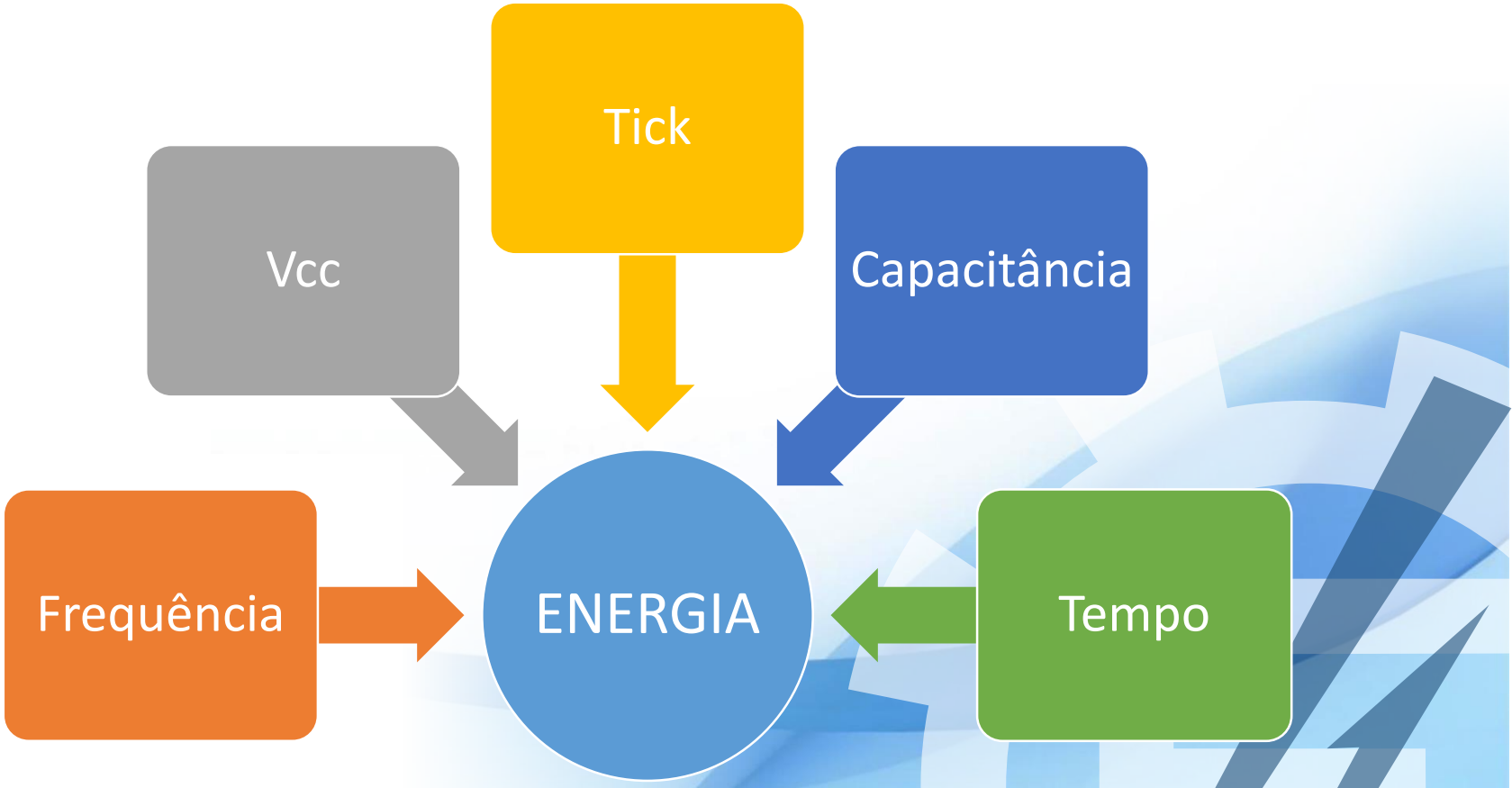
Sistemas Operacionais



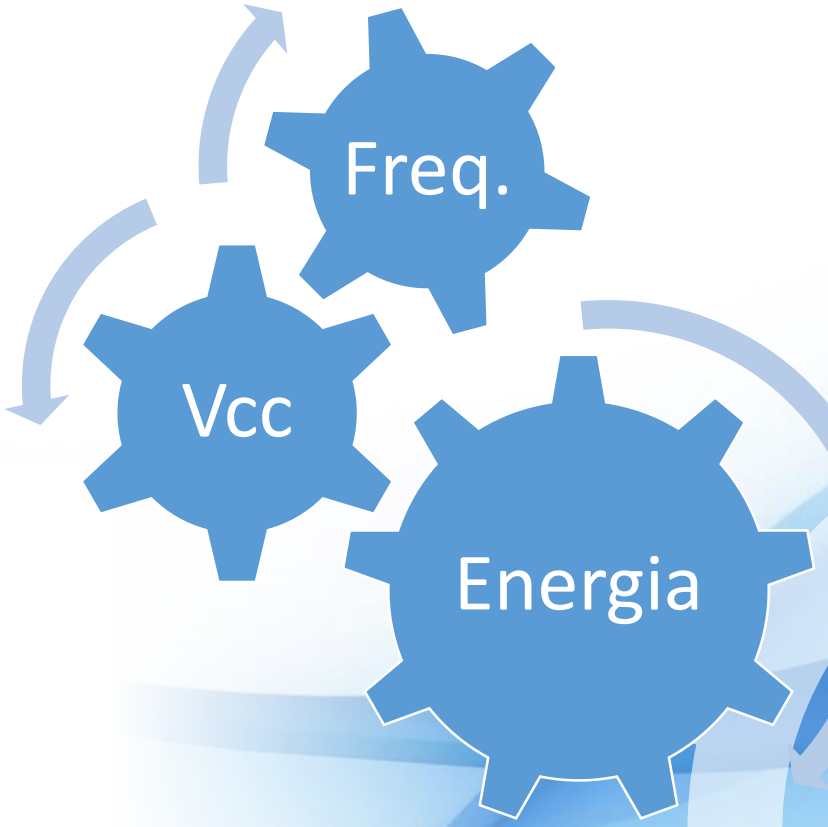
RTOS



Consumo de energia em Sistemas Embarcados

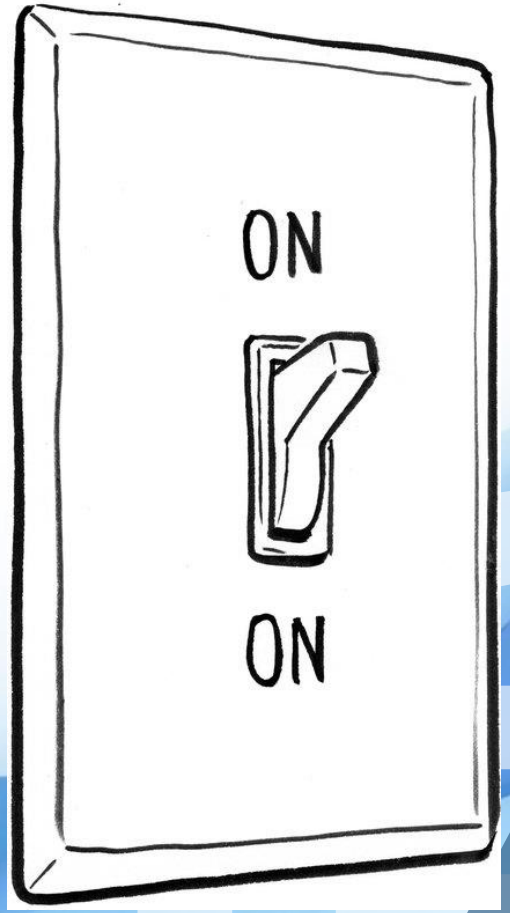


Dynamic Voltage-Frequency Scaling

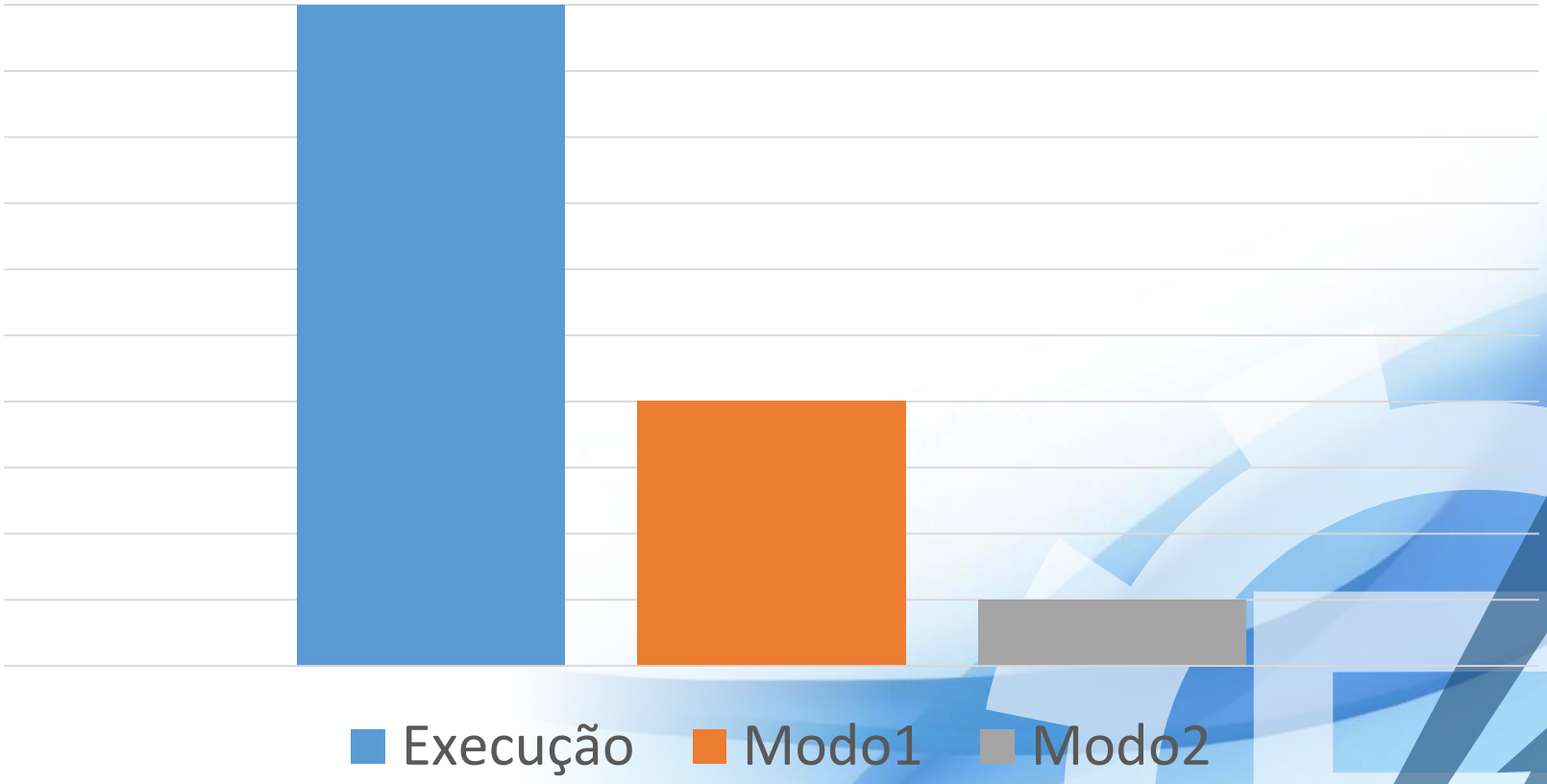


Dynamic Power Management

Problemas para desenvolver uma política de economia

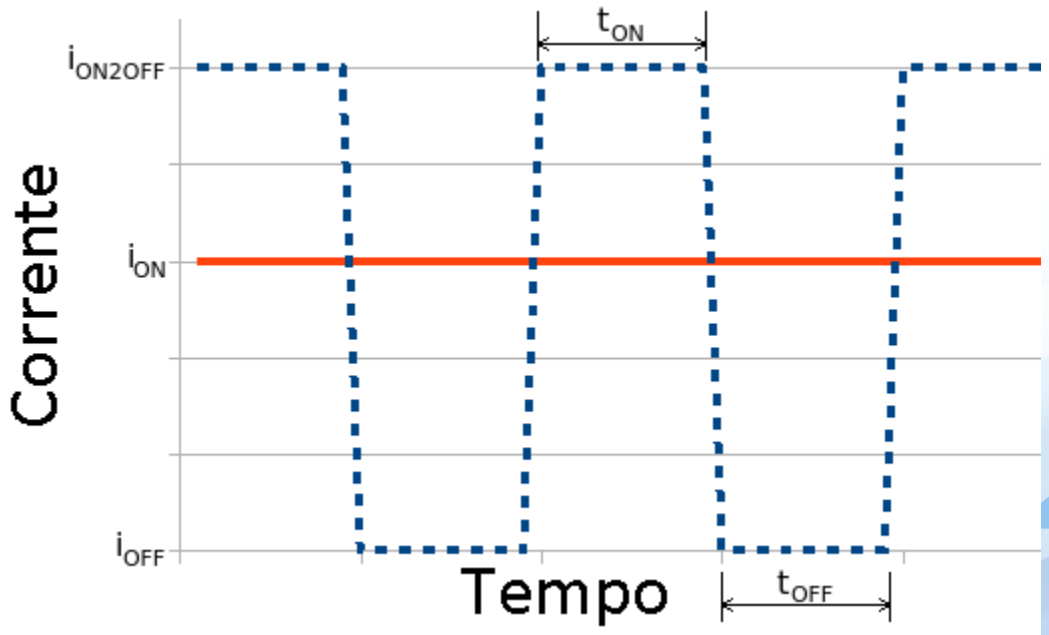


Modos de energia do microcontrolador

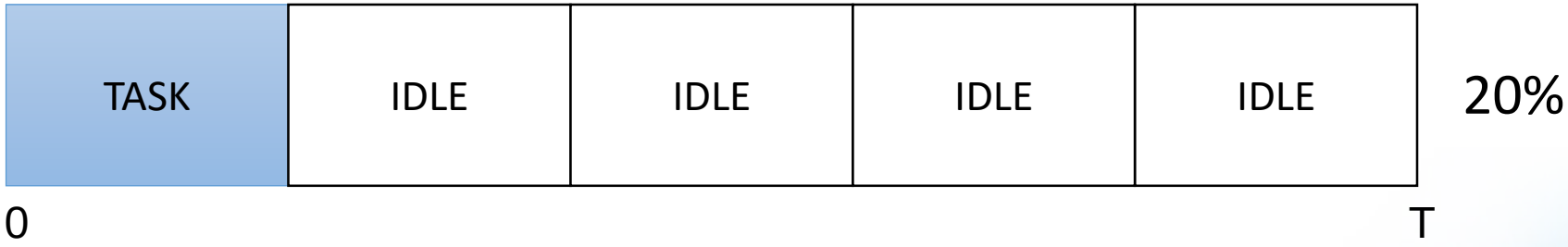


Metodologia

Análise de Consumo



Carga de Processamento (C%)



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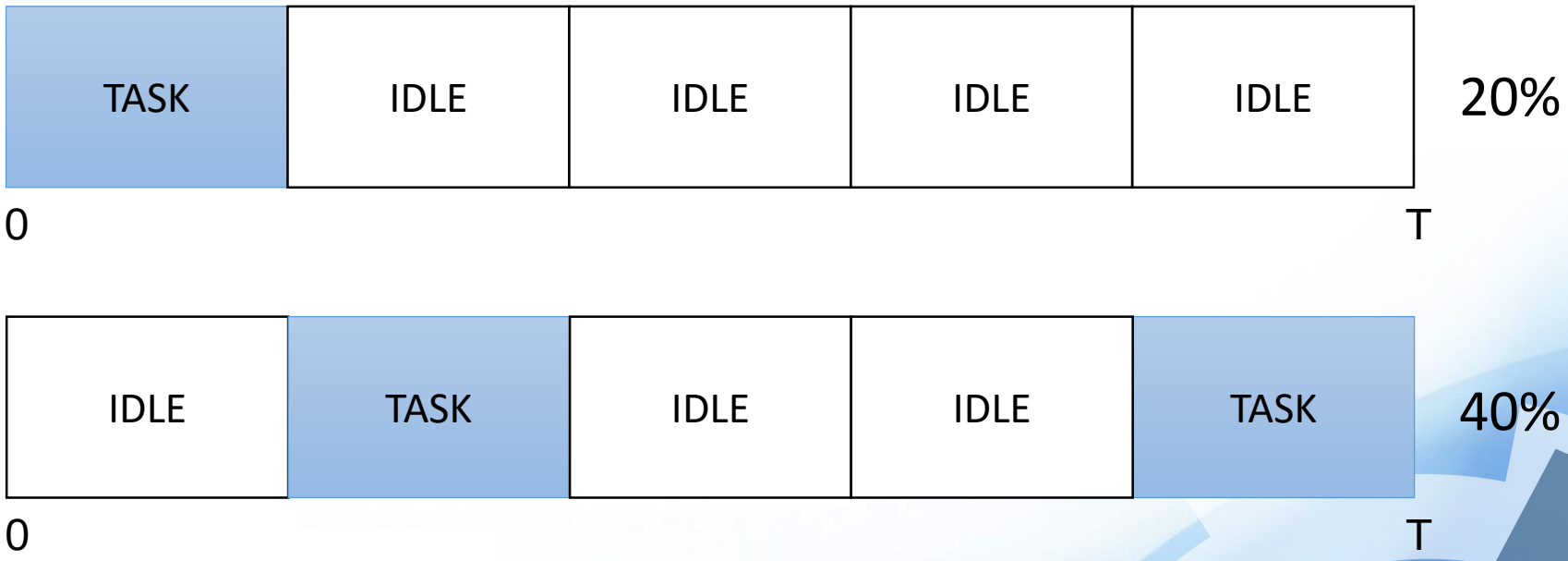
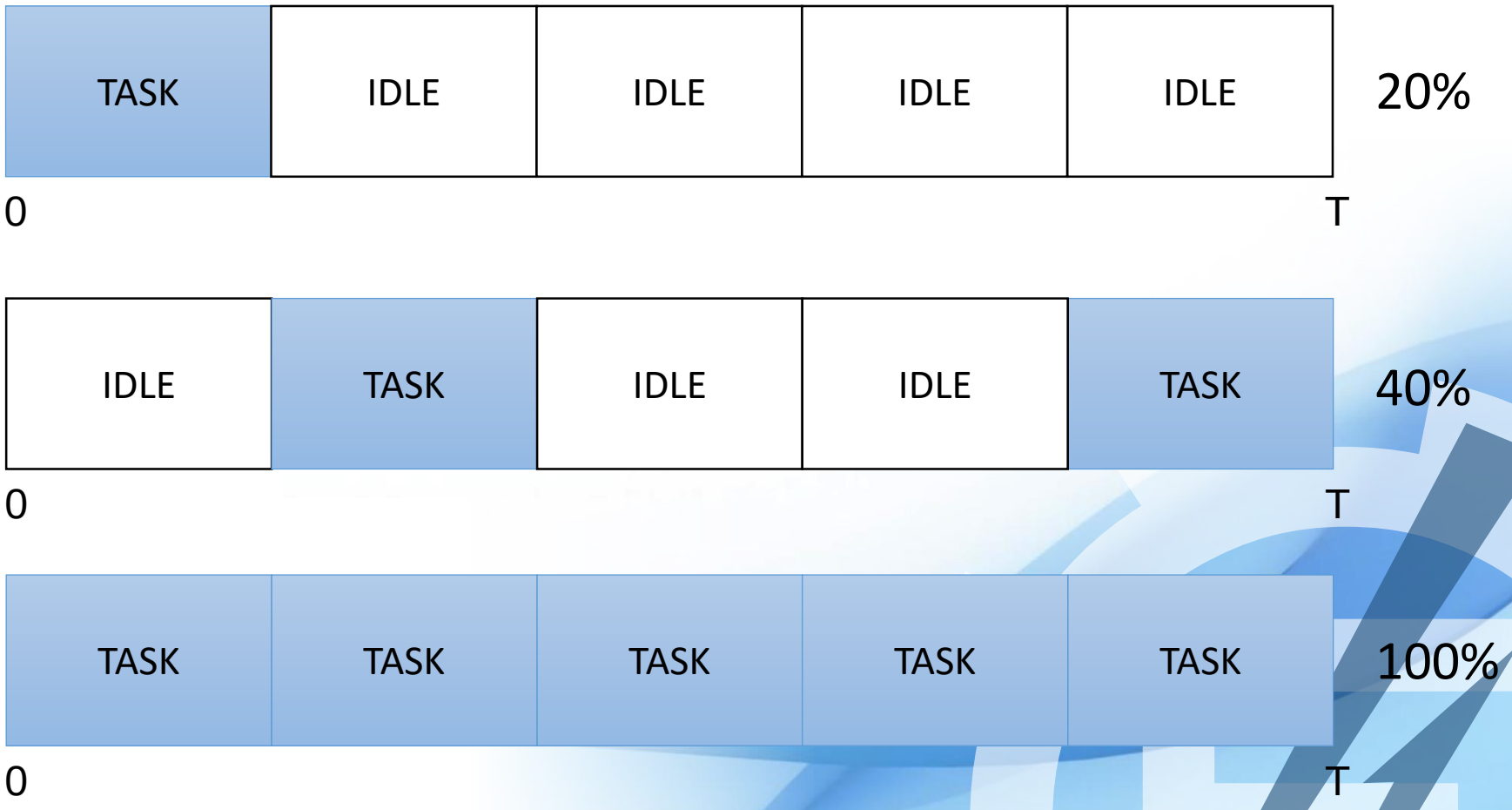


Carga de Processamento (C%)



Política Dinâmica Proposta

$$i_{LPM} = C\,\% \cdot i_{ON2OFF} + \left(1 - C\,\%\right) \cdot i_{OFF}$$

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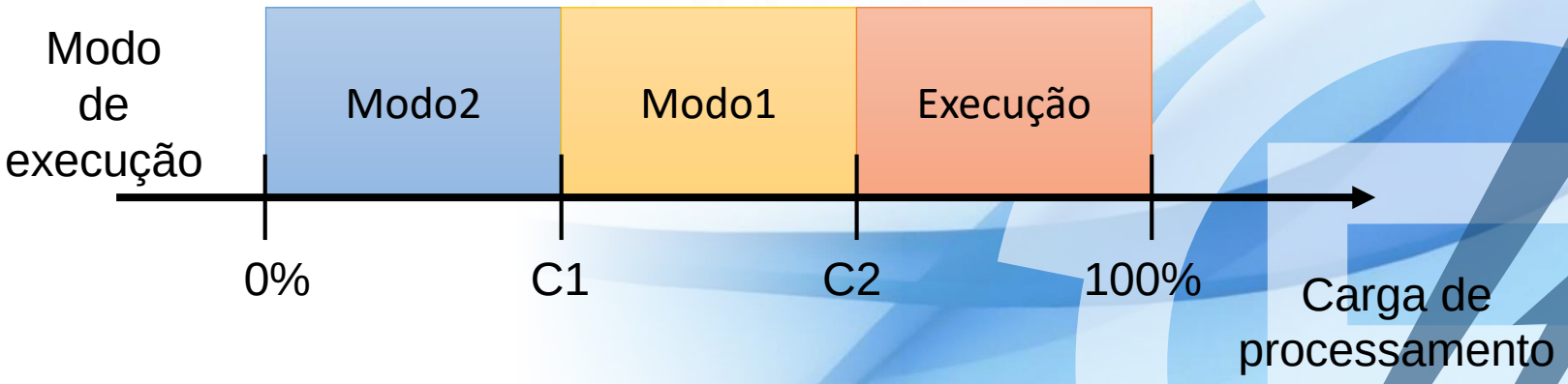
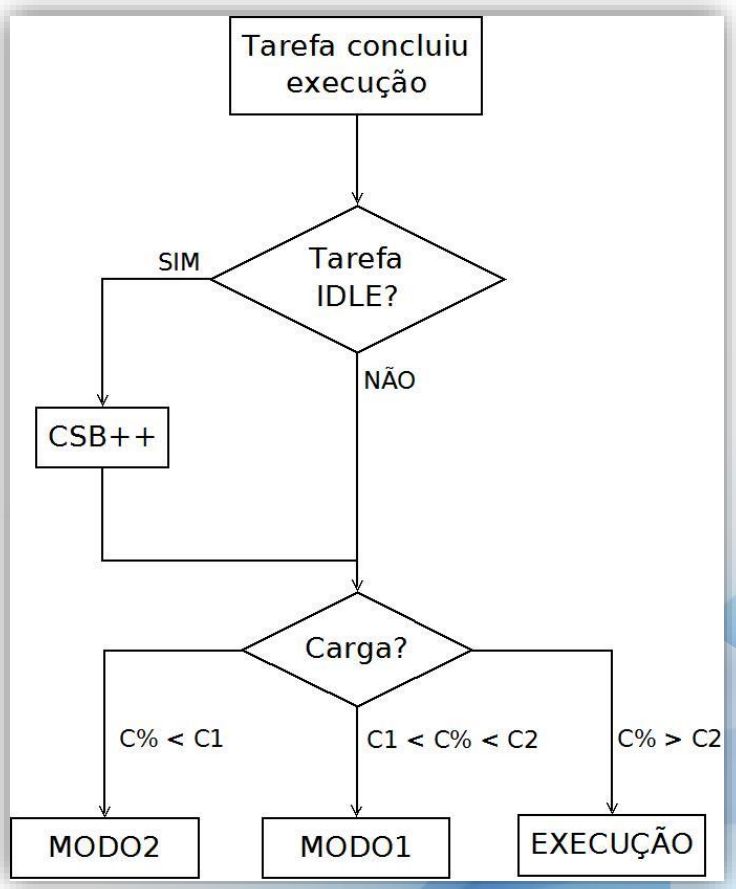


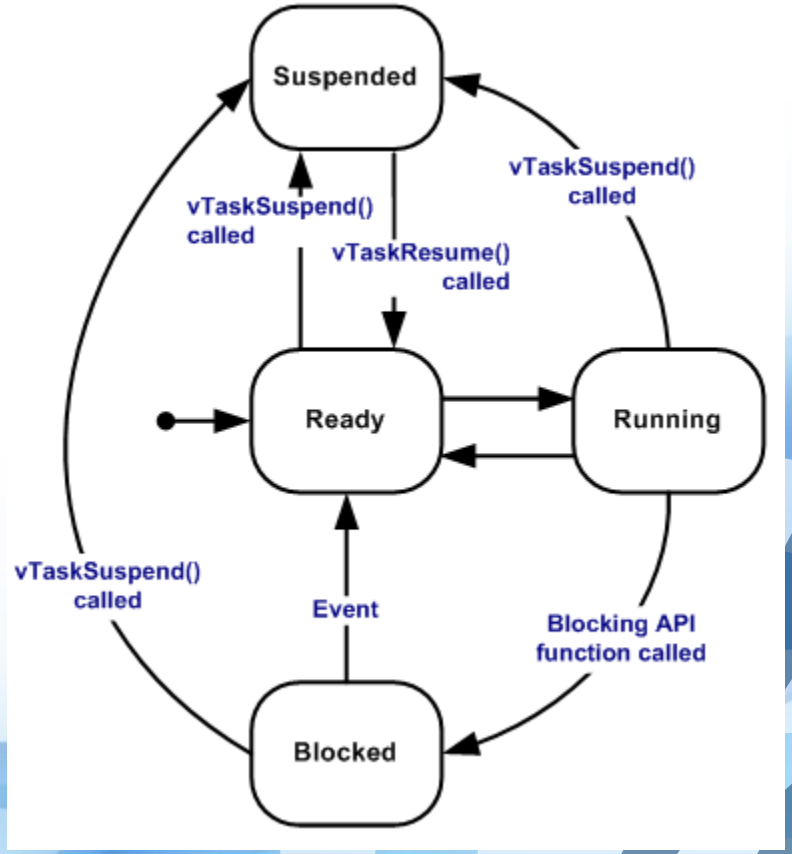
Implementação



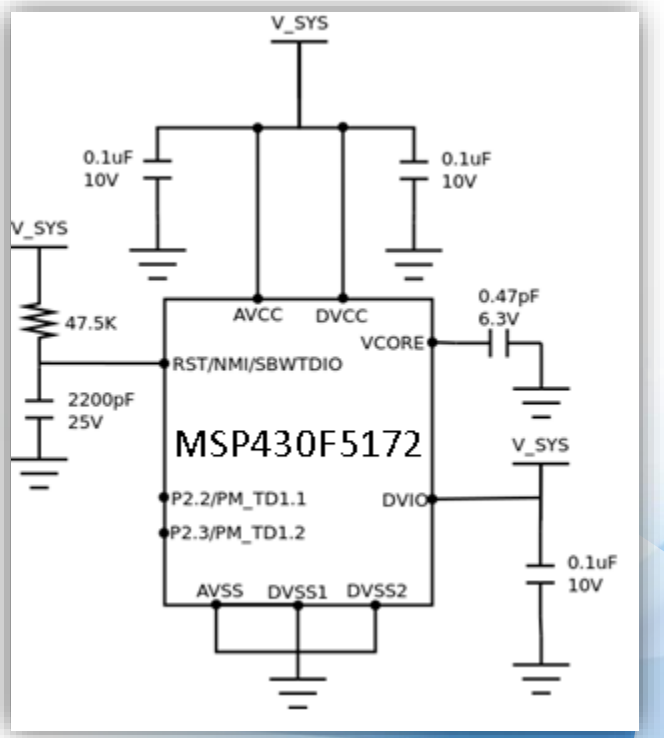
Desenvolvimento

FreeRTOS


free
RTOS


Suspended
vTaskSuspend()
called
vTaskResume()
called
vTaskSuspend()
called
Ready
Running
vTaskSuspend()
called
Event
Blocking API
function called
Blocked

Placas de Teste MSP430 e KL25Z



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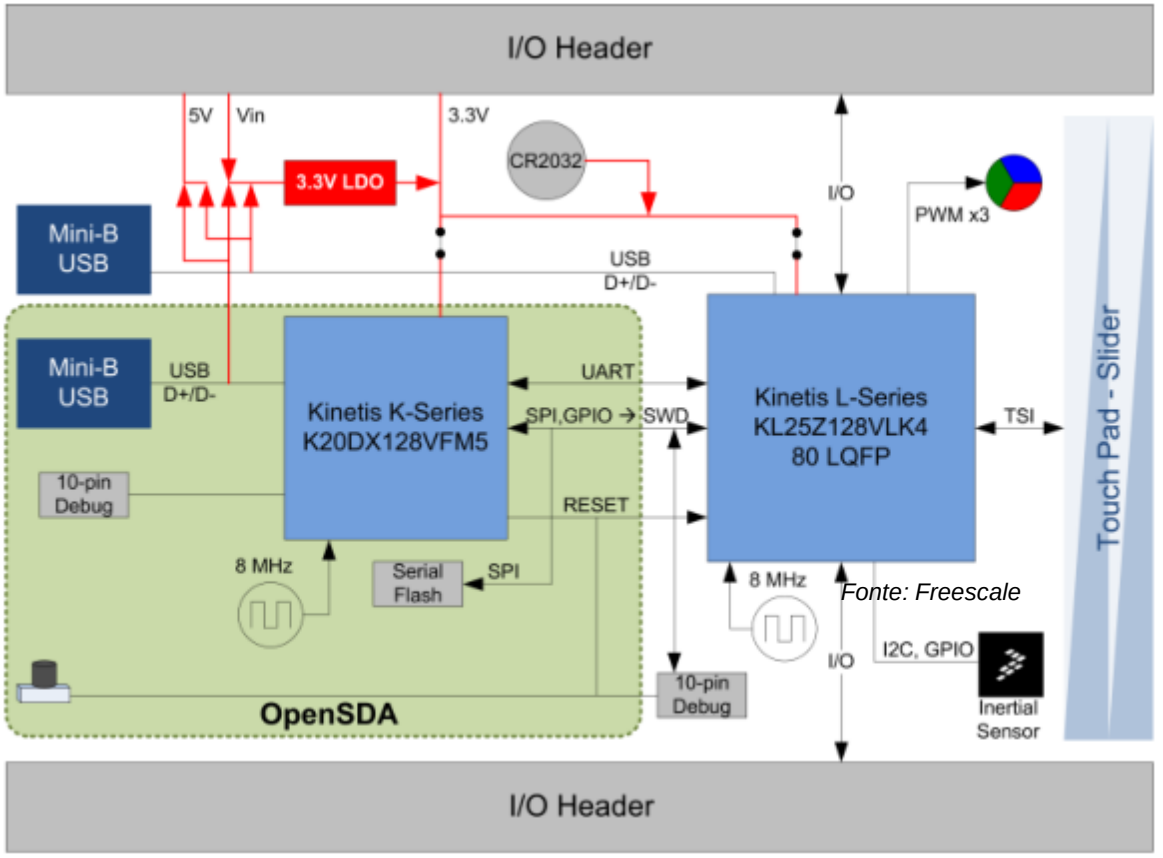
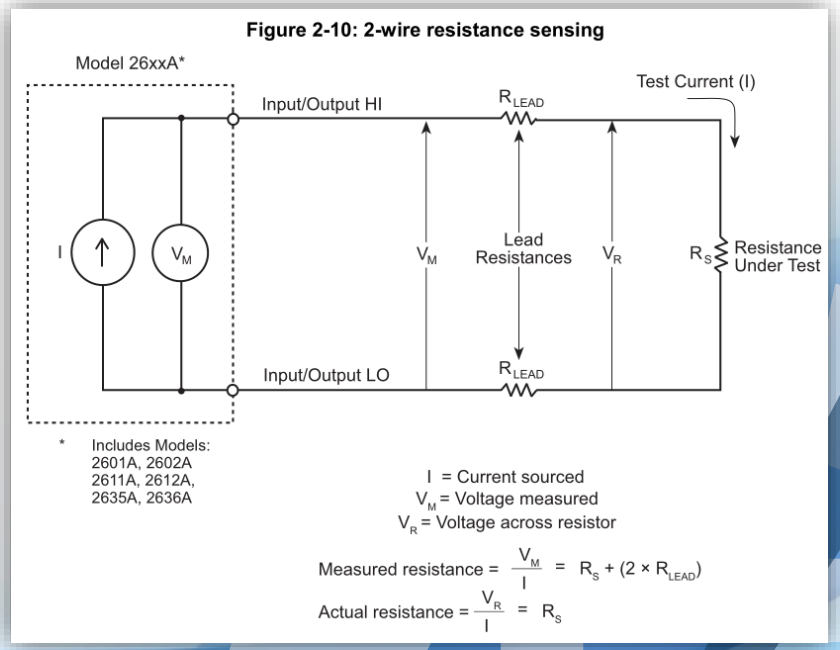
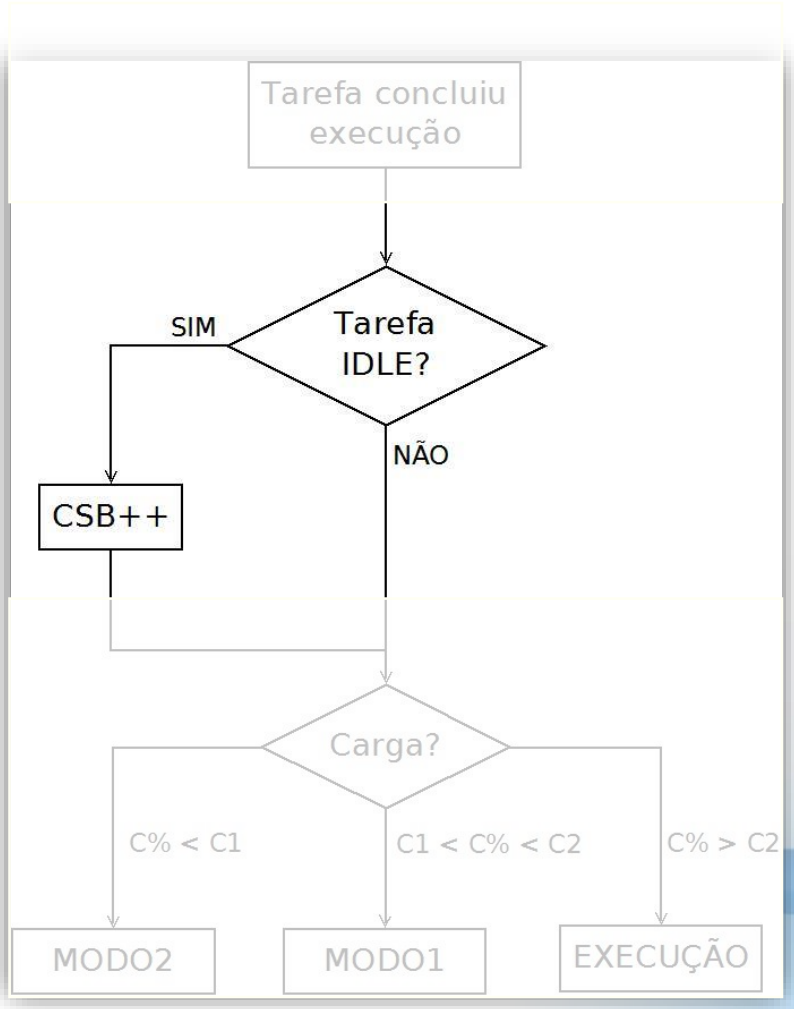


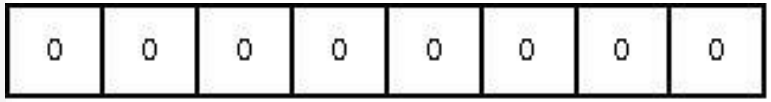
Fonte: Freescale

Instrumentação



CSB - Cálculo C% no FreeRTOS





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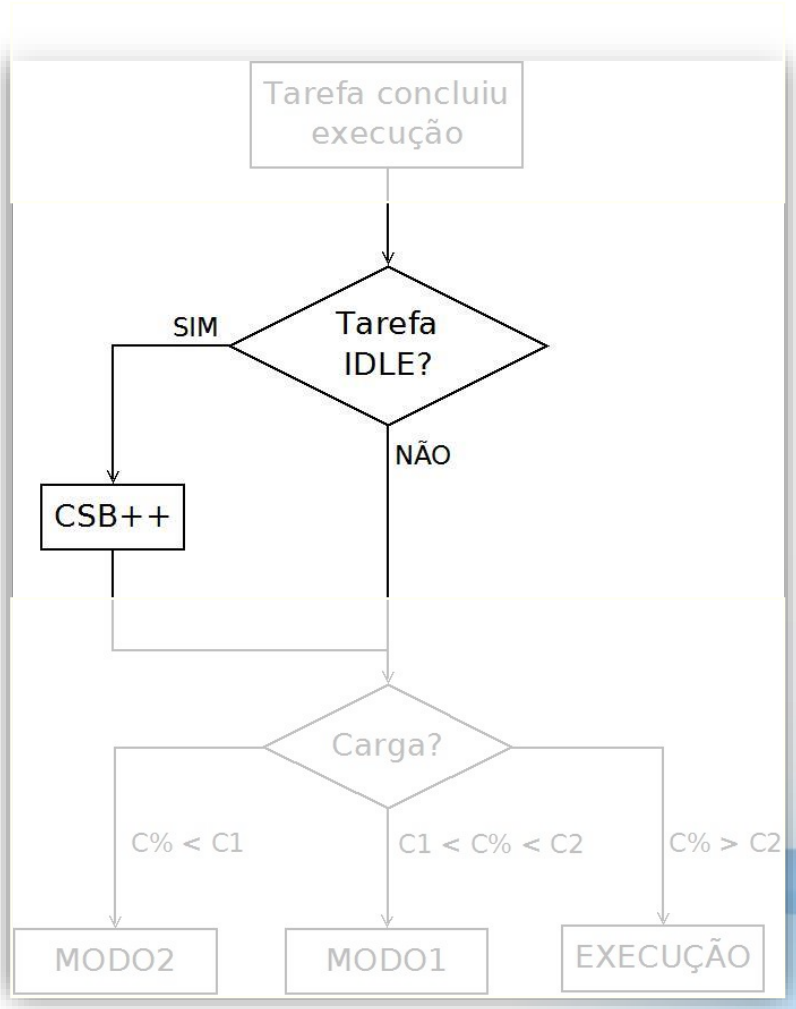

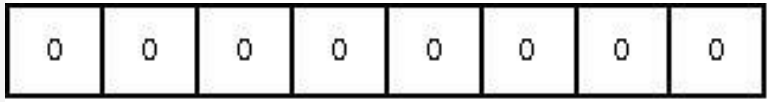

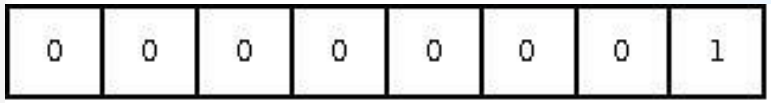

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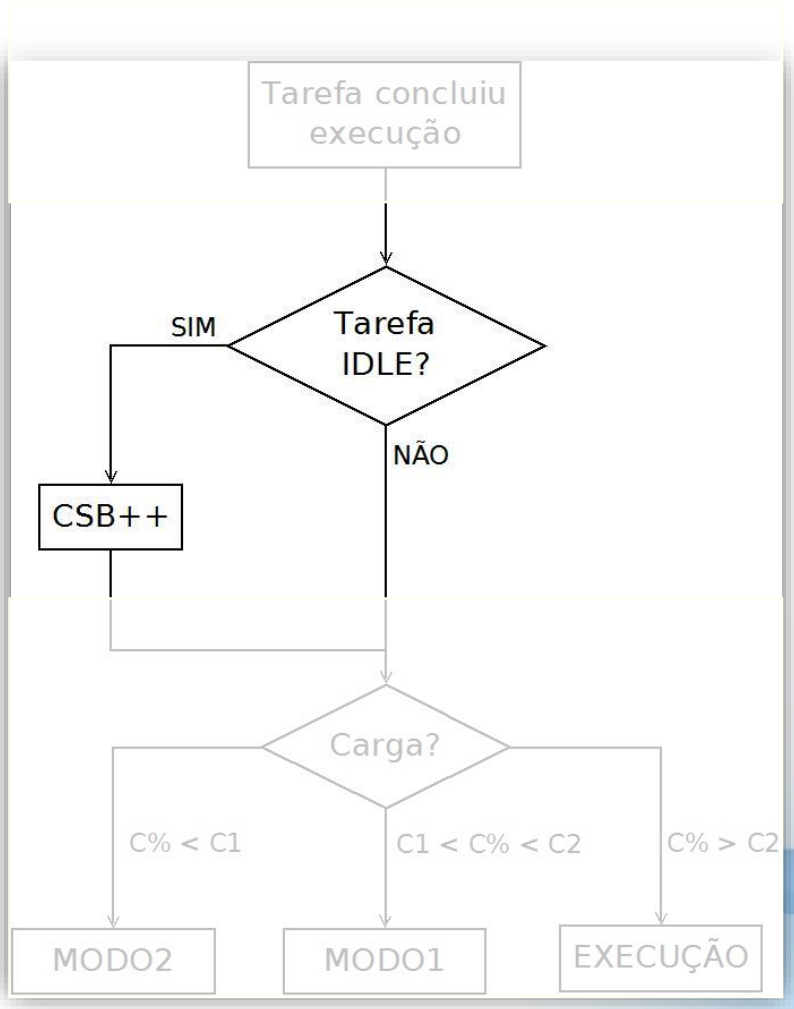

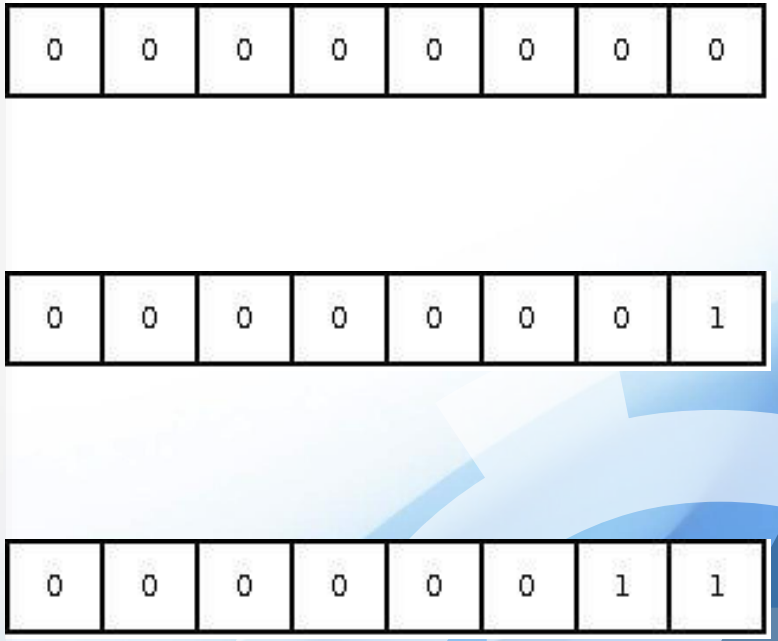

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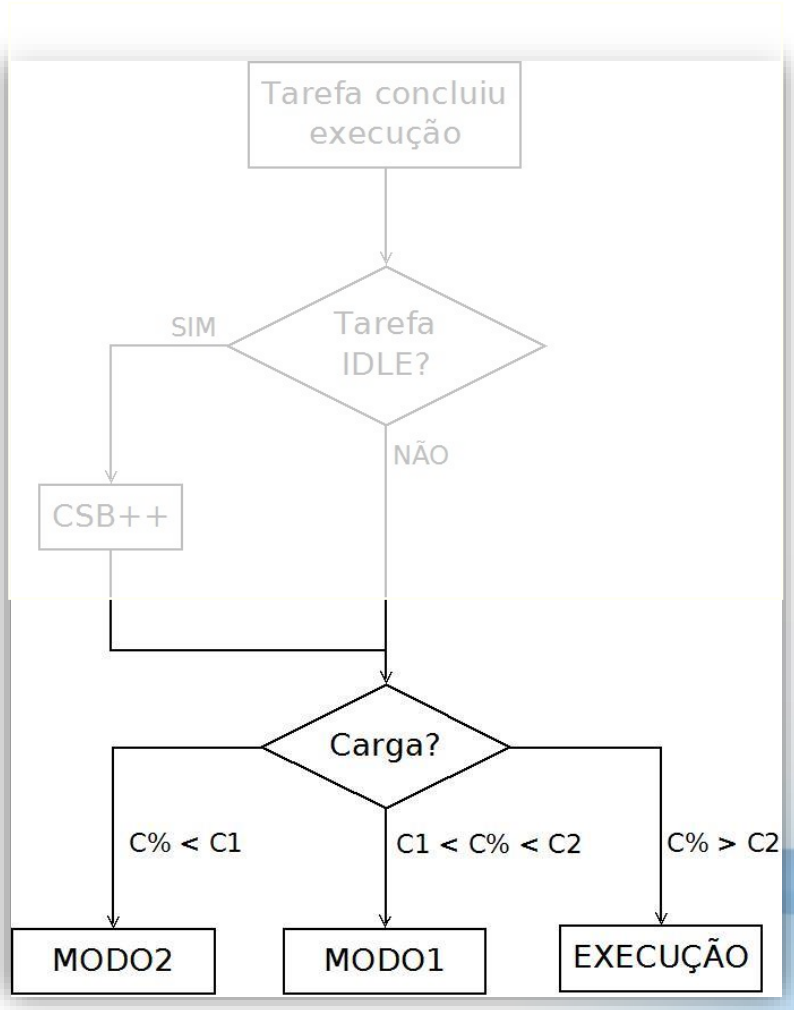
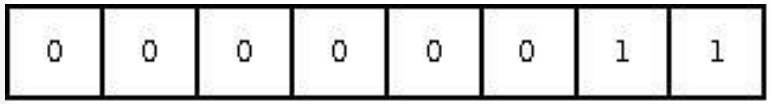
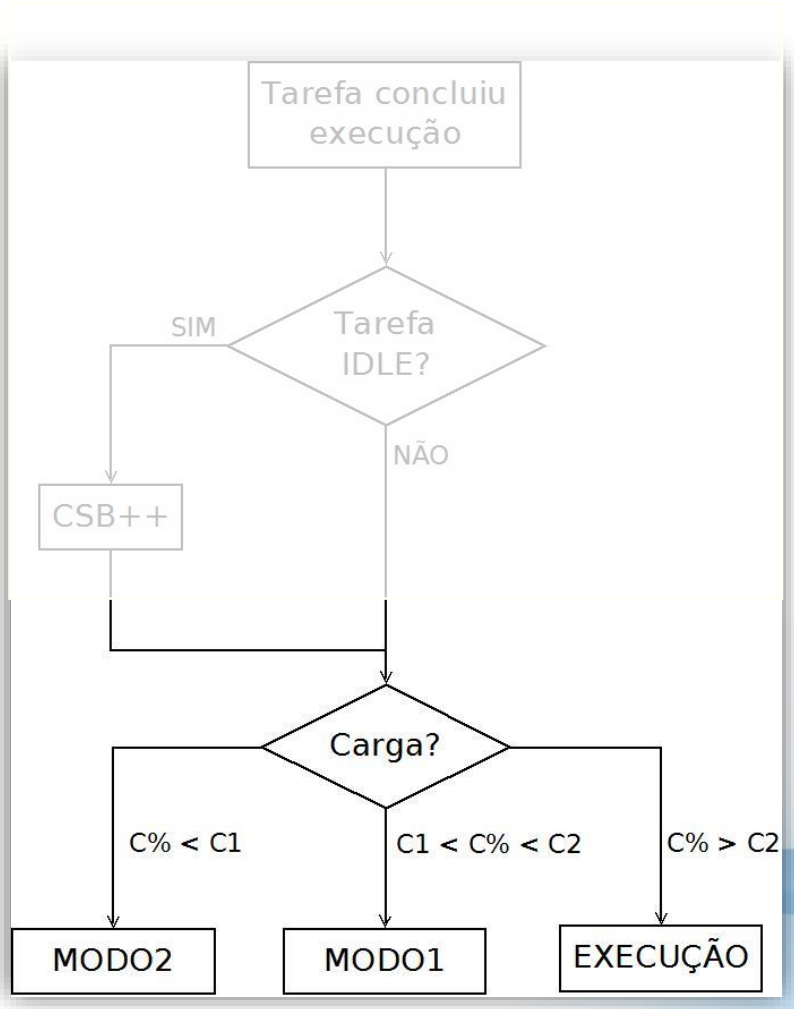
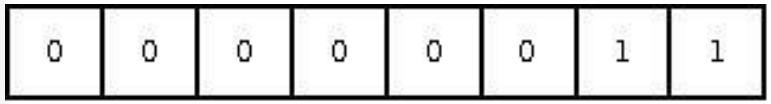
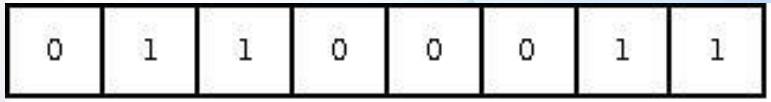




CSB - Cálculo C% no FreeRTOS

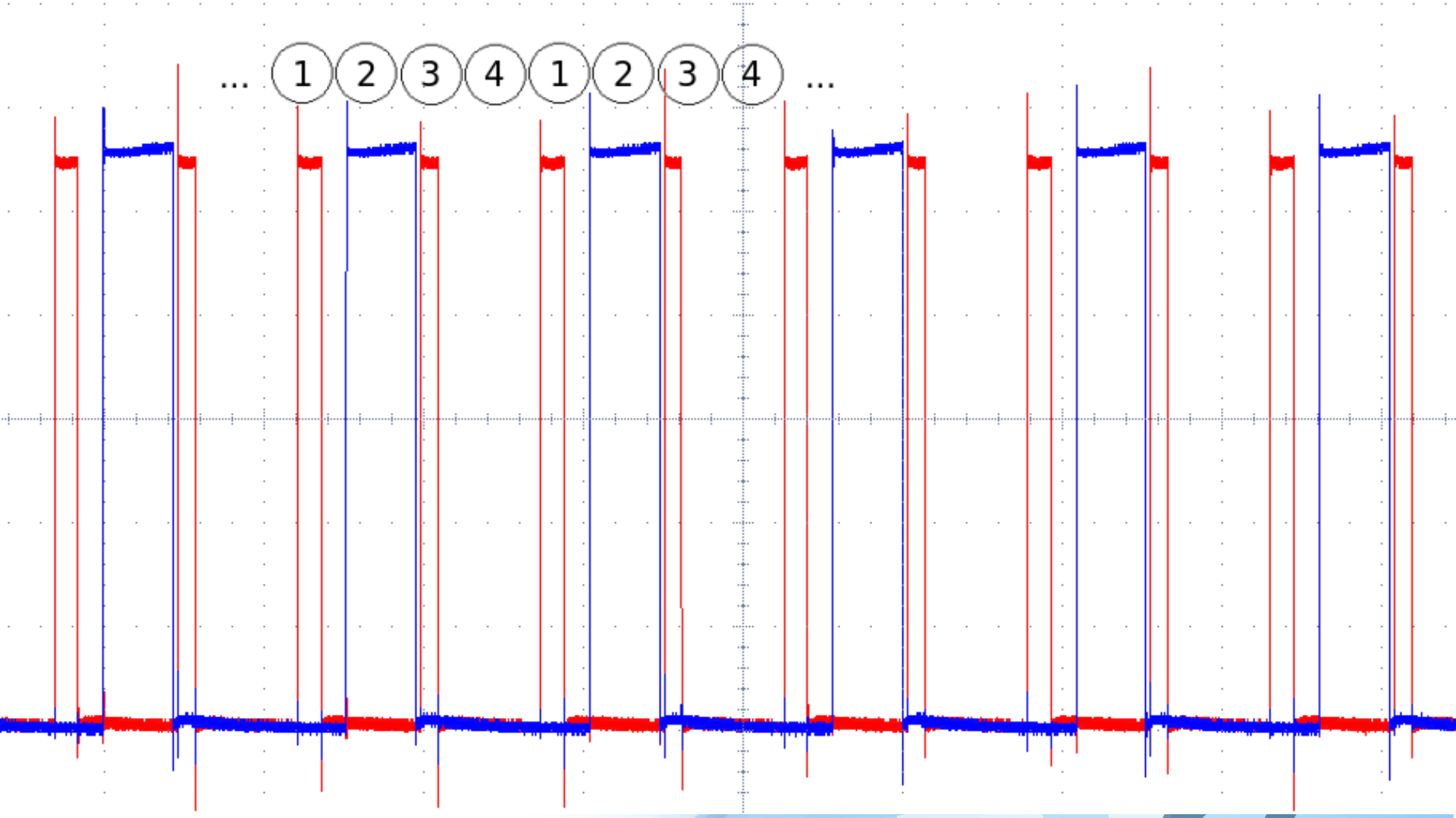






Testes e resultados

Medições de Parâmetros



Tempos Obtidos MSP430

Estado energético	Tempo em IDLE	Tempo de *wake-up*
Active	17.76 µs	-
LPM0	17.79 µs	0.03 µs
LPM1	17.61 µs	-0.15 µs
LPM2	24.64 µs	6.88 µs
LPM3	24.44 µs	6.68 µs

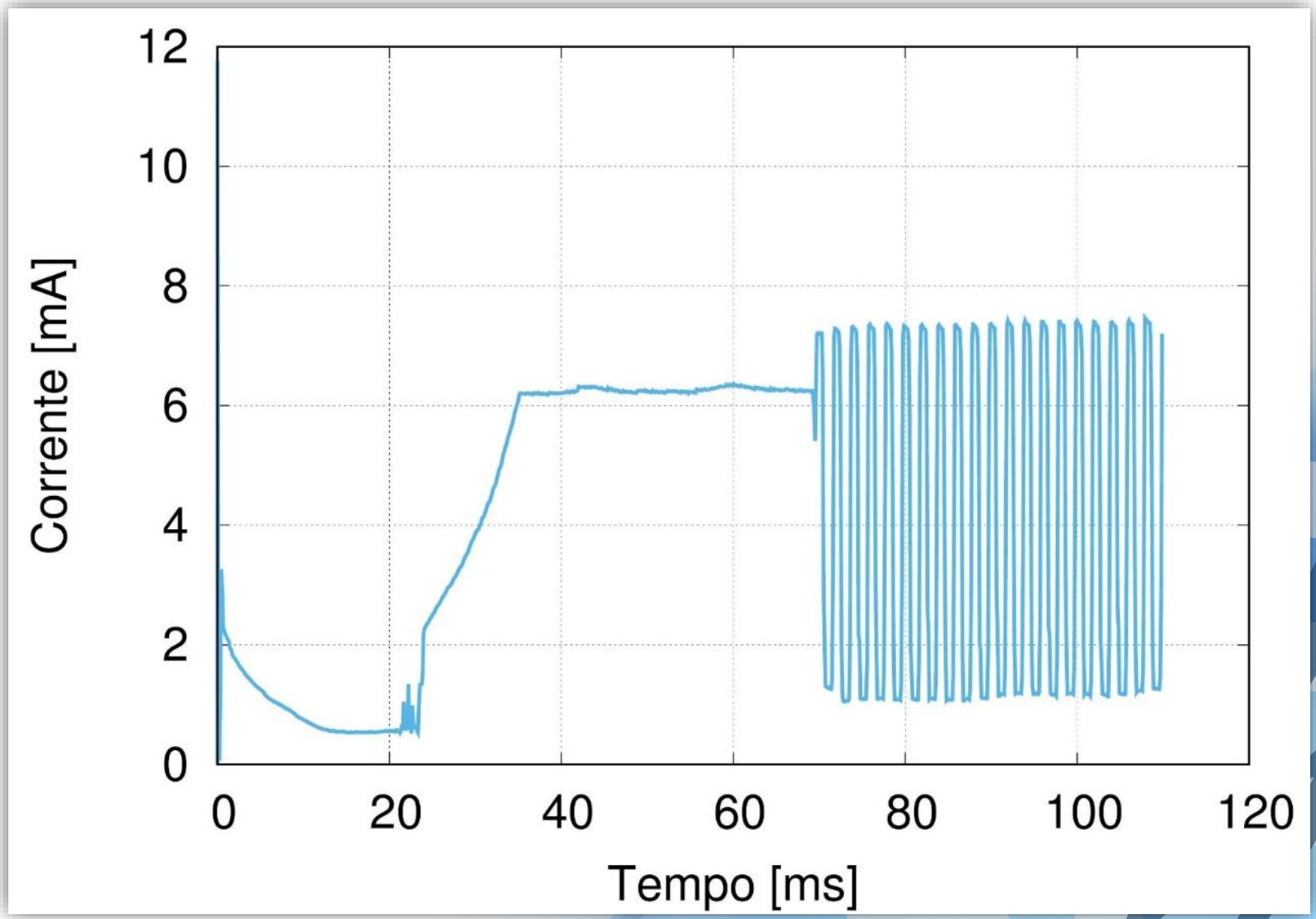
Correntes Medidas

µC	Modo de energia	Consumo médio (fabricante)	Consumo médio (obtido)
MSP430 F5172	*Active*	6.15 mA	6.68 mA
	LPM1	(não fornecido)	895.58 µA
	LPM3	1.5 µA	422.04 µA
MKL25Z128 VLK4	*Run*	5.9 mA	2.04 mA
	Wait	3.8 mA	1.56 mA
	VLPW	366 µA	1.56 mA

CSB Observado

Teste	CSB	IDLE/*Tasks*	C%
1	0111111100000011	9/16	43.8%
2	1111000011111100	10/16	37.5%
3	0011111100001111	10/16	37.5%
4	0000111111000001	7/16	56.3%
5	1111000000111111	10/16	37.5%
Maior carga	0000001111110000	6/16	62.5%
Menor carga	1111111000011111	12/16	25%

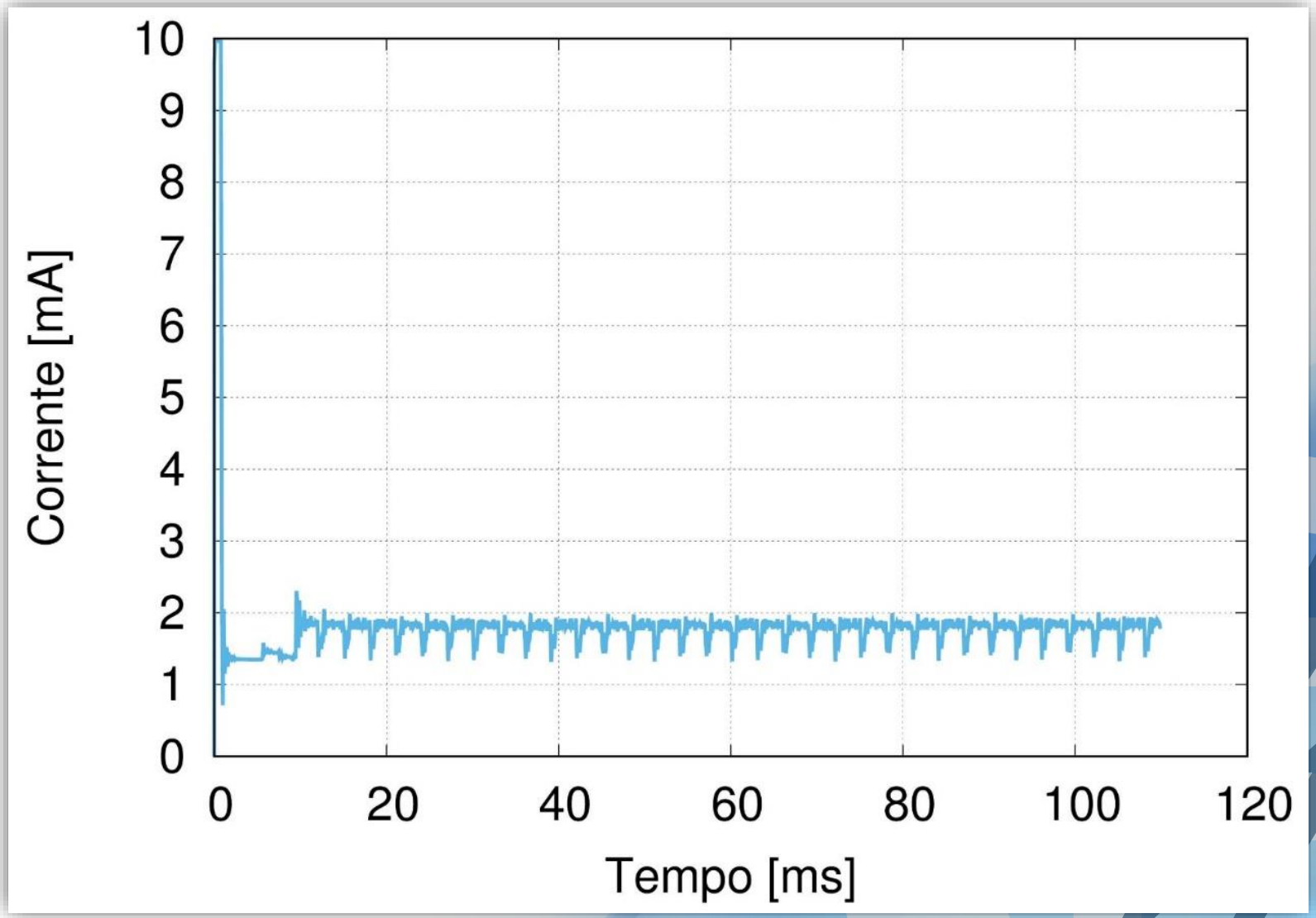
Política MSP430



Política MSP430

Carga	*Active* [mA]	LPM1 [mA] (economia)	LPM3 [mA] (economia)	Política [mA] (economia)
1 *task* + IDLE	5.52489	4.53181 (17.97%)	4.29804 (22.21%)	3.73547 (32.39%)
2 *tasks* + IDLE	5.49899	4.09832 (25.47%)	3.86721 (29.67%)	3.42082 (37.79%)
3 *tasks* + IDLE	5.55088	6.28608 (-13.24%)	6.23779 (-12.37%)	5.49048 (1.09%)

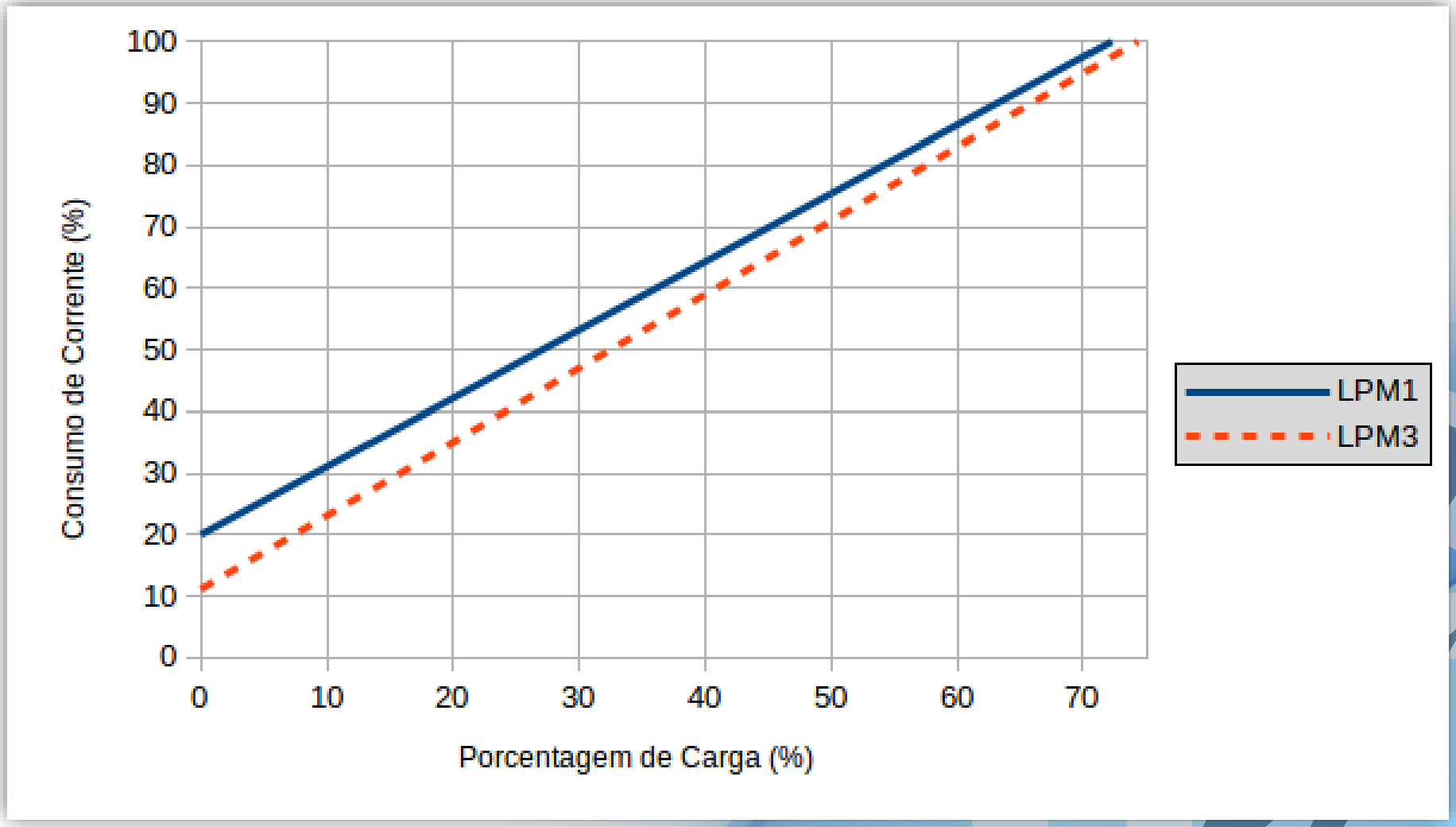
Política KL25Z



Política KL25Z

Carga	*Active* [mA]	Wait [mA] (economia)	VLPW [mA] (economia)	Política [mA] (economia)
1 *task* + IDLE	1.975	1.679 (14.99%)	1.679 (14.99%)	1.676 (15.14%)
2 *tasks* + IDLE	1.996	1.651 (17.28%)	1.653 (17.18%)	1.652 (17.23%)
3 *tasks* + IDLE	1.880	1.781 (5.27%)	1.781 (5.27%)	1.782 (5.21%)

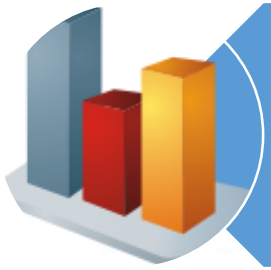
Carga Máxima no MSP430



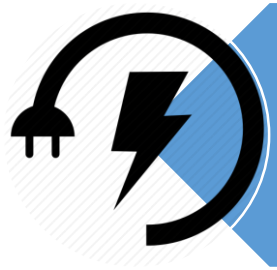
Conclusão

Contribuições

Política Dinâmica



CSB = C%



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Produtos

Artigo

- CBA2016

Patente

- Depositada INPI 2014

Trabalhos Futuros

CSB

- Arquitetura?
- Dinâmico?

Tick RTOS

- Influência

Associar Técnicas

- DVFS

Obrigado!