CONTROL OF GRID-CONNECTED INVERTER

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EFFECTS OF DISCRETISATION
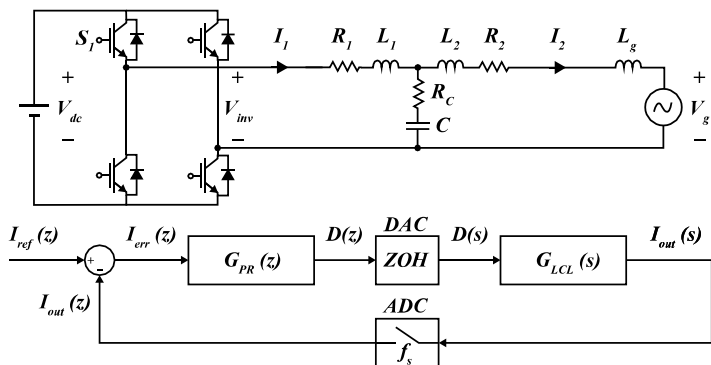
Purpose

To examine the **effects of discretising** a **proportional-resonant controller** by **different discretisation methods**. This is done by considering:

1. **system stability**; and
2. **controller performance**.

Impulse invariant was found to **perform best**.

Grid Connected Inverter

$$G_{PR}(s) = Kp + \frac{K_i s}{s^2 + \omega^2}$$

Vdc	350 V	C	3.29 uF
R1	0.1 Ω	L1	4.58 mH
R2	0.1 Ω	L2	0.87 mH
RC	4.98 Ω	Vg	230 V RMS
PWM freq.	10 kHz	ESC freq.	1 Hz
Kp	0.01	Ki	10

Discretisation Analysis Results (I_ref = 3 A RMS)

Discretisation method	Susceptible to Instability	GM (dB)	PM (degrees)	THD (%)	Error (A RMS)
N/A (Continuous Time)	-	22.73	40.41	1.48	0.87
Forward Euler	Yes	23.16	35.30	3.90	0.13
Backward Euler	Yes	22.29	40.32	4.71	1.07
Tustin	Yes	22.71	37.86	4.71	1.07
Zero-order hold	No	23.16	35.87	2.09	0.87
First-order hold	No	22.71	37.85	2.18	0.87
Tustin w/ Pre-warp	No	22.71	37.85	2.09	0.88
Zero-pole matching	No	23.16	35.86	2.16	0.87
Impulse invariant	**No**	**22.29**	**39.55**	**2.02**	**0.84**

EXTREMUM SEEKING CONTROL FOR ROBUSTNESS TO GRID IMPEDANCE VARIATION
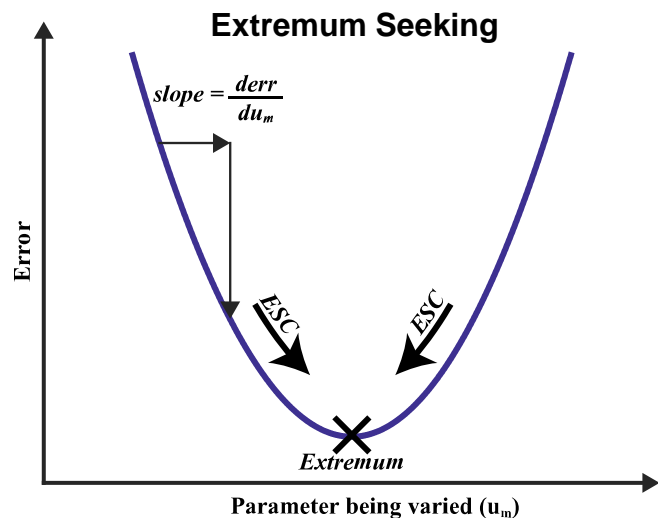
Purpose

To examine the use of an **extremum seeking** controller (ESC) to **compensate for changes in grid impedance**.
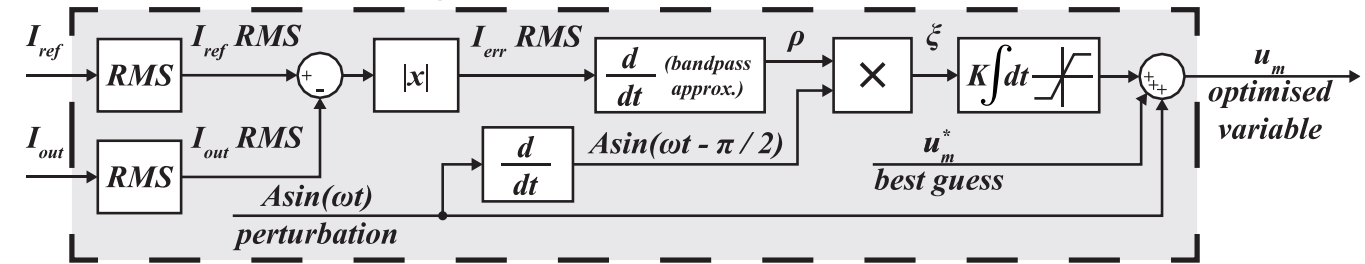
Grid Impedance (Lg)

Strong Grid → Weak Grid

Two models are developed:

1. **black box (proof of concept)**; and
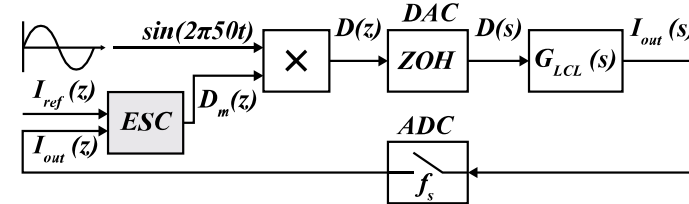2. **grey box (viable for implementation*)**.

*limited potential** in tested configuration

Extremum Seeking

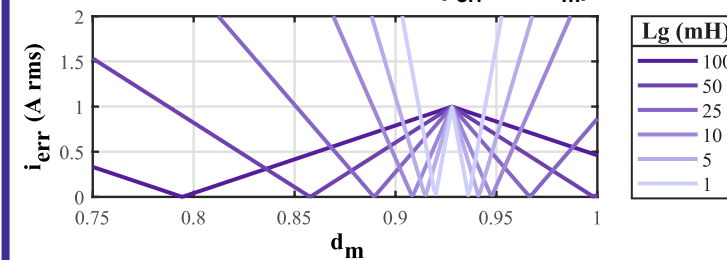
$$slope = \frac{derr}{du_m}$$

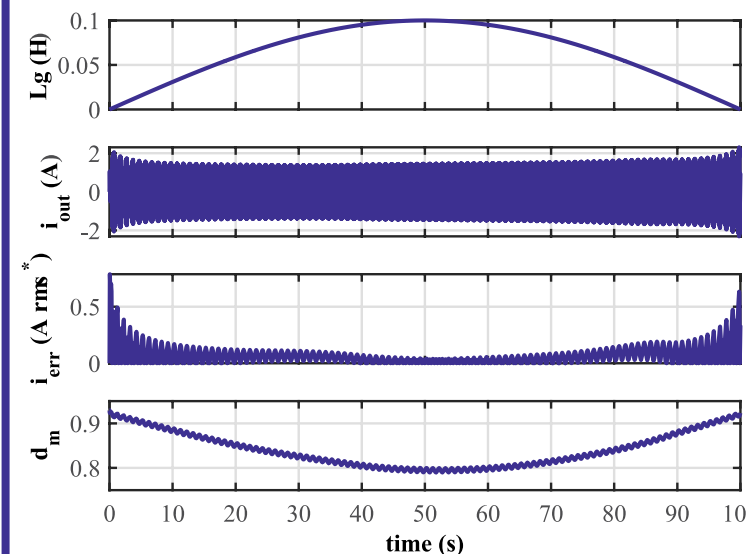## Extremum Seeking Controller for Current Controlled Inverter
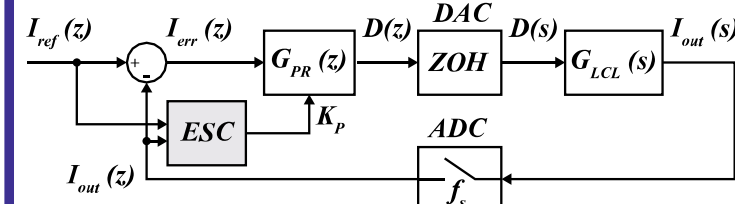

Black Box Extremum Seeking

Cost Function (I_err vs D_m)

Results (I_ref = 1 A RMS)
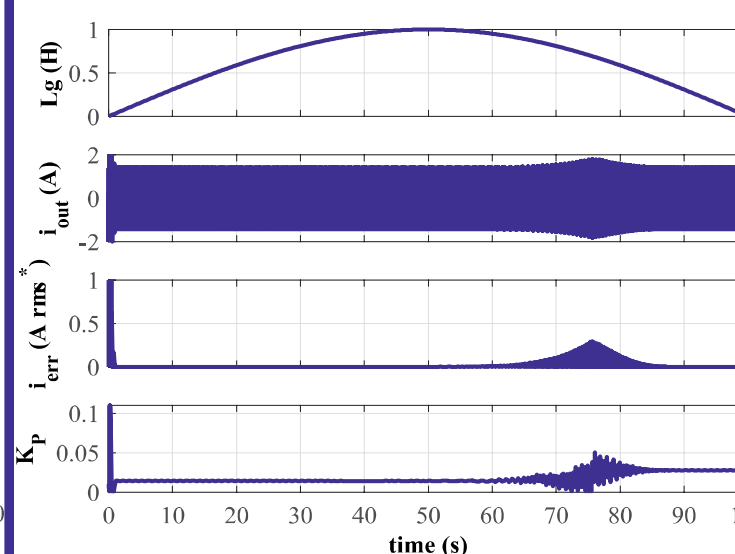

Grey Box Extremum Seeking

Cost Function (I_err vs K_p)
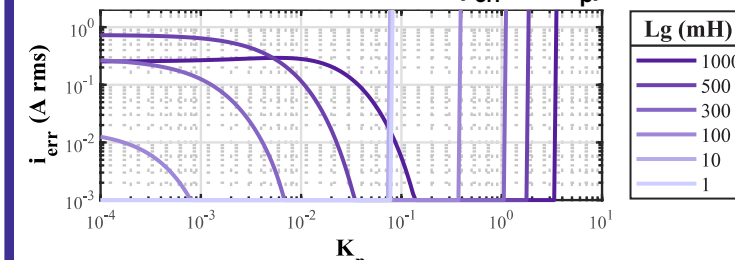
Results (I_ref = 1 A RMS)

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