

TUTORIAL: Oscillators

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Outline

1

Oscillators (XO)

- Working principle and external influences
- Oscillator types
- Clock types

Oscillators

Oscillators

Local Reference in systems

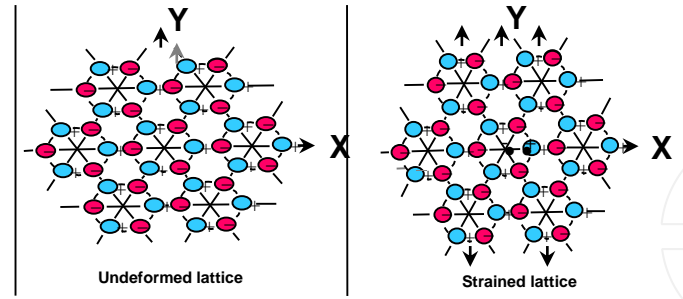
Stability Requirements

Various Technologies

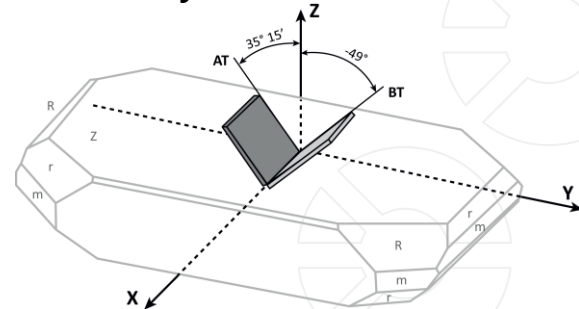
Quartz based Oscillators

Other technologies

Piezo Electric Effect

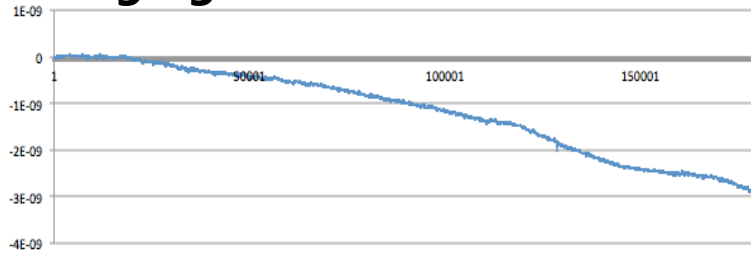


"Cut" of the crystal

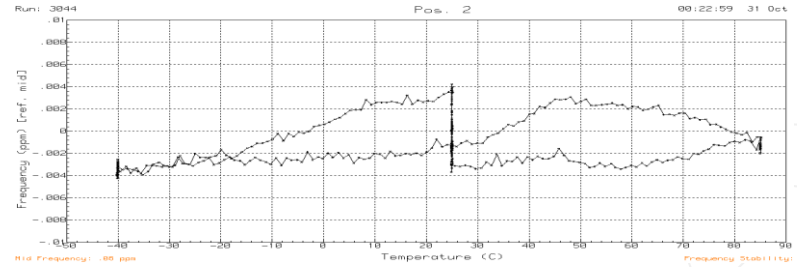


Influences on Oscillators

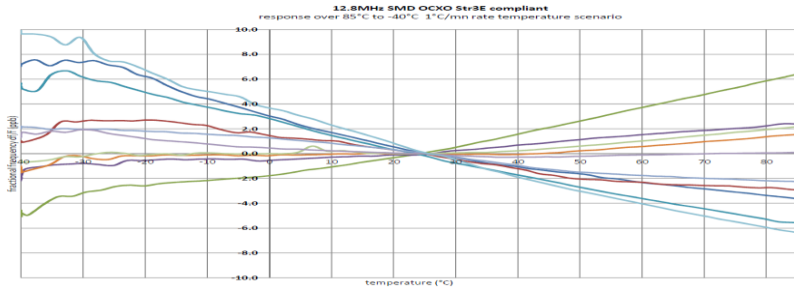
Aging effect on Oscillators



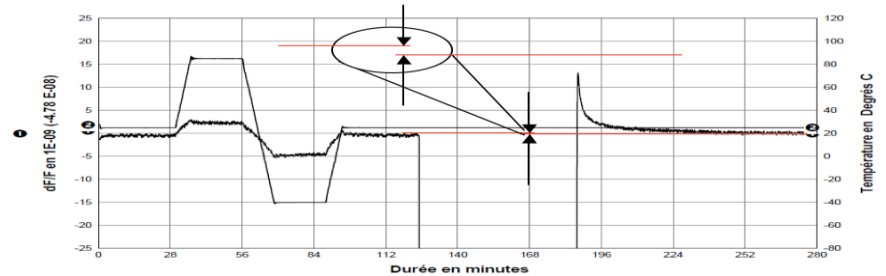
Hysteresis effect on Oscillators



Temperature Effect on Oscillators

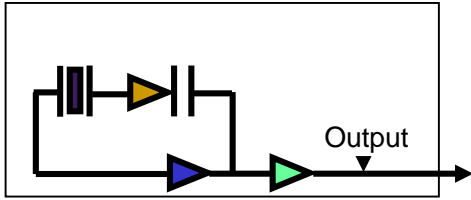


Retrace effect on Oscillators

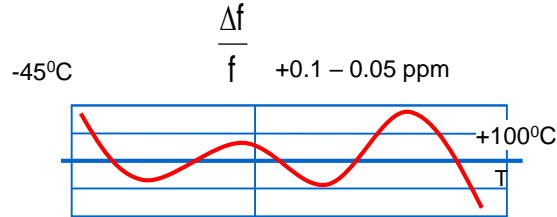
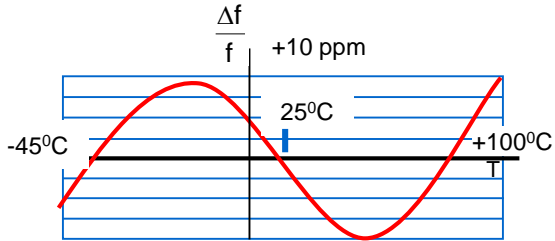
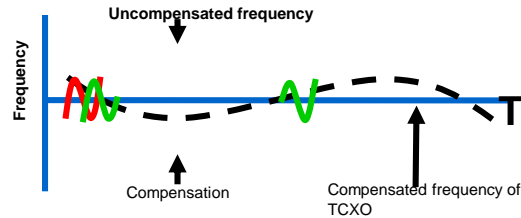
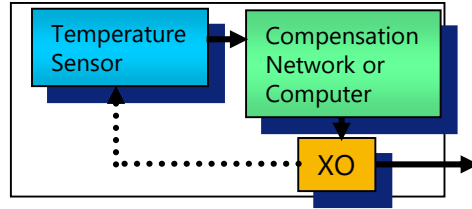


Types of Oscillators

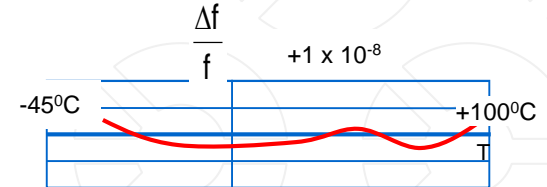
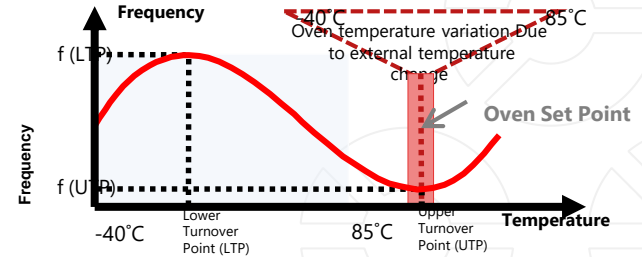
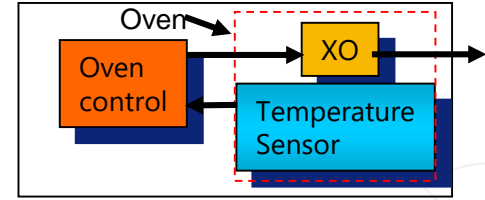
XOs



TCXOs

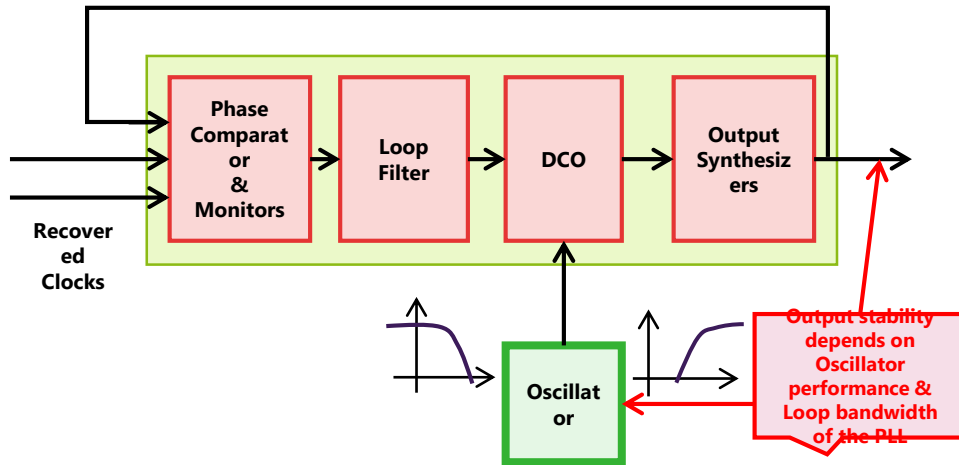


• OCXOs



Oscillator qualification for Clocks

Servo Model



Qualifying Parameters

Free Run

- Pull – in Range

Wander Generation

- MTIE and TDEV requirements
 - Over the operating temperature ranges

Holdover

- Temperature & Ageing effects

Jitter

- Depending on the servo architecture

Summary of requirements

Oscillator requirements are based on

- Free Run -> Clock stability for 20 years, all causes
- Loop bandwidth -> Support for loop bandwidth at required output error, at constant temperature and at variable temperature
- Frequency Vs Temperature performance -> This forms part of the wander generation and holdover requirement of the standards
- Ageing performance -> This forms part of the wander generation and holdover requirement specifications

A list of the clocks and the summary of requirements are listed in the next few pages

Physical Layer Clock Types

Node & Equipment Clocks – Traditional

SI No	Clock	Type	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.812	Type I	NA	3mHz	2ppb	0.2ppb/day	OCXO
		Type III	4.6ppm	1mHz	10ppb	1ppb/day	OCXO
2	G.813	Option 1	4.6ppm	1-10Hz	2000ppb	10ppb/day	TCXO
		Option 2	4.6ppm	0.1Hz	300ppb	40ppb/day	TCXO

Ethernet Equipment Clocks

SI No	Clock	Type	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.8262	Option 1	4.6ppm	1-10Hz	2000ppb	10ppb/day	TCXO
		Option 2	4.6ppm	0.1Hz	300ppb	40ppb/day	TCXO

Enhanced Ethernet Equipment Clocks

SI No	Clock	Type	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.8262.1		4.6ppm	3Hz	?	?	TCXO

Packet Clock Types - Frequency

Packet Equipment Clock – Master – Frequency

SI No	Clock	Type	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.8266	[ITU-T G.812] Type I	NA	3mHz	2ppb	0.2ppb/day	OCXO
		[ITU-T G.812] Type III	4.6ppm	1mHz	10ppb	1ppb/day	OCXO

Packet Equipment Clock – Frequency

SI No	Clock	Type	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.8263	PEC-F	4.6ppm	1mHz	10ppb	1ppb	OCXO

Packet Clock Types – Time

Full On-Path support Clocks

SI No	Clock	Type	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	T-BC	Option 1	4.6ppm	1-10Hz(SyncE)	2000ppb	10ppb/day	TCXO
2	T-TSC	Option 1	4.6ppm	1-10Hz(SyncE)	2000ppb	10ppb/day	TCXO
3	T-TSC (End APP)						Customer Requirement

Transparent Clocks

SI No	Clock	Type	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	T-TC		?	?	?	?	OCXO

Assisted & Partial Support Clocks

SI No	Clock	Type	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	T-BC-P, T-BC-A	?	4.6ppm	<1mHz?	1-5ppb?	1ppb	OCXO
1	T-TSC-P, T-TSC-A	?	4.6ppm	<1mHz?	1-5ppb?	1ppb	OCXO

Thank you

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