Crystals and Oscillators for Next Generation Timing Solutions

Introduction

This Application Note provides a list of Microchip oscillators available in compatible frequencies for use with Microchip's PLLs, in various timing & synchronization applications that include clock synthesis, frequency conversion, numerically controlled oscillators, PDH, SONET/SDH, SyncE (Synchronous Ethernet) and IEEE 1588-2008. This list has been categorized based on applicable standards.

The oscillators in this document support both physical layer and protocol layer synchronization PLLs. Both of these applications have different needs depending on the use case.

Performance Reports

Some reports exist that cover performance combining Microchip's oscillator, PLL and, where applicable, Ethernet PHY products. A brief list is below.

IEEE1588 Performance Reports

- IEEE1588, OX-402, G.8273.4/G.8261 Appendix VI, ZLS30380, ZLAN-565
- IEEE1588, OX-221, G.8273.4/G.8261 Appendix VI, ZLS30380, ZLAN-624

SyncE Performance Reports

- SyncE, TX-500-0083, G.8262 Option 1, ZL3062x/ZL3072x ZLAN-546
- SyncE, TX-500-0083, G.8262 Option 2, ZL3062x/ZL3072x, ZLAN-547

Jitter Performance Reports

- Jitter, VCC1-1537-114M285, 100GbE, ZL3060x/ZL3070x, ZL3061x
- Jitter, VCC1-1537-114M285, 100GbE, ZL30151, ZL30169, ZL3024x
- Jitter, VCC1-1535-125M000, 100GbE, ZL30151, ZL30169, ZL3024

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Physical Layer Synchronization

The oscillator requirements for physical layer synchronization are well defined in a variety of ITU-T and ATIS specifications. Namely

- Freerun accuracy – lifetime
- Holdover stability – drift under constant temperature conditions, which includes ageing
- Holdover stability – frequency variation due to variable temperature
- Wander generation (MTIE & TDEV), for the respective filter cut-off frequency, under constant temperature conditions
- Wander generation (MTIE & TDEV), for the respective filter cut-off frequency, under variable temperature conditions

The following are the general classifications used in this document

- Class A1. Used with 3 mHz filter bandwidth for compliance with E1-based ITU-T G.812 Type I (SSU) requirements.
- Class A2. Used with 1 mHz filter bandwidth for compliance with T1-based Stratum 3E & ITU-T G.812 Type III specifications. Note these oscillators may NOT be compliant with 3 mHz filter bandwidth E1-based ITU-T G.812 Type I (SSU) requirements.
- Class C2. Used with 0.1 Hz and higher filter bandwidths for compliance with T1-based hierarchy specifications such as ITU-T G.813 option 2 SEC, ITU-T G.8262 option 2 EEC, Stratum 3 for SONET, Stratum 3 & SMC. Note these oscillators may NOT be compliance with Class D2 requirements for E1-Based hierarchy specifications such as ITU-T G.813 option 1 SEC and ITU-T G.8262 option 2 EEC (specifically frequency stability at constant temperature).
- Class D2. Used with 1 Hz and higher filter bandwidths for compliance with E1-based hierarchy specifications such as ITU-T G.813 option 1 SEC, ITU-T G.8262 option 2 EEC.
- Class E. Used with 14 Hz and higher filter bandwidths for T1-based, E1-based and OTN line card use cases. Class E also used for Clock Synthesis applications.

Details on the test equipment, procedures and test-setups for qualifying oscillators can be found in ZLAN-472 (covering both Stratum 3 and Stratum 3E).

Classification

Below list is a summary of the various classifications of oscillator for use in physical layer synchronization and protocol layer synchronization. Some classifications represent the superset requirements of closely related clocks (where an individual clock requirement may be less than that listed for the superset).

Oscillator Class	A1	A2	C2	D2	E
Superset Grouping			Stratum 3, SMC & Option 2 (PDH, SONET, SyncE)	Option 1 (SDH, SyncE)	Line Card
Telcordia Clock	N/A	Stratum 3E	Stratum 3 for SONET	N/A	Stratum 4
ITU-T Clock	Type I	Type III	G.813 Option 2, G.8262 Option 2	G.813 Option 1, G.8262 Option 1	
PLL implied Bandwidth	3mHz	1mHz	0.1Hz	1Hz	14Hz
Free-run Accuracy (ppm)	N/A	± 4.6	± 4.6	± 4.6	± 32
Frequency Stability (pk-pk) at Variable Temperature (ppb)	2 (Note 2)	10 (Note 2)	300 (Note1, 2)	2000 (Note 2)	N/A
Frequency Stability at Constant Temperature (ppb)	± 0.2	± 1	± 40	± 10	N/A
Wander Generation (MTIE, TDEV)	Refer to standard	Refer to standard	Refer to standard	Refer to standard	Refer to standard
Note 1: Telcordia GR-1244-CORE issue 3, revision 2005 specifies 280ppb pk-pk, Telcordia GR-1244-CORE issue 4, revision 2009 specifies 300ppb pk-pk Note 2: Some vendors will accept +/- range for variable temperature frequency stability rather than pk-pk (i.e. +/-300ppb vs. 300ppb pk-pk)					

Table 1 – Physical Layer Summary Table

Detailed Manufacturer Information

Class A1

Used with 3 mHz filter bandwidth for compliance with E1-based ITU-T G.812 Type I (SSU) requirements.

Class	Oscillator Frequency	Oscillator Type	Oscillator Supply Voltage	Single Ended/ Differential	Manufacturer	Part Number(s)
A1	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-221-0105-20M000
A1	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-221-9133-24M576

Table 2 – Class A1 Oscillators

Class A2

Used with 1 mHz filter bandwidth for compliance with T1-based Stratum 3E & ITU-T G.812 Type III specifications. Note these oscillators may NOT be compliant with class A1, used for 3 mHz filter bandwidth E1-based ITU-T G.812 Type I (SSU) requirements.

Class	Oscillator Frequency	Oscillator Type	Oscillator Supply Voltage	Single Ended/ Differential	Manufacturer	Part Number(s)
A2	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-401-9016-20M000
A2	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-6011-EAE-1080-20M000
A2	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-221-9100-20M000
A2	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-5021-EAE-1080-20M000
A2	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-5021-EAE-1080-24M576
A2	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-6011-EAE-1080-24M576
A2	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-4011-EAE-0580-24M576
A2	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-221-9101-24M576
A2	49.152MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-221-9102-49M152
A2	98.304MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-401-9015-98M304 *(meets frequency stability over any 30 °C window within -40 to 85°C)

Table 3 – Class A2 Oscillators

Class C2 Intro

Used with 0.1 Hz and higher filter bandwidths for compliance with T1-based hierarchy specifications such as ITU-T G.813 option 2 SEC, ITU-T G.8262 option 2 EEC, Stratum 3 for SONET, Stratum 3 & SMC. Note these oscillators may NOT be compliance with Class D2 requirements for E1-Based hierarchy specifications such as ITU-T G.813 option 1 SEC and ITU-T G.8262 option 2 EEC (specifically frequency stability at constant temperature).

Class D2 Intro

Used with 1 Hz and higher filter bandwidths for compliance with E1-based hierarchy specifications such as ITU-T G.813 option 1 SEC, ITU-T G.8262 option 1 EEC.

Class C2 & Class D2 Combined

Table 4 shows oscillators suitable for both C2 and D2 applications.

Class	Oscillator Frequency	Oscillator Type	Oscillator Supply Voltage	Single Ended/ Differential	Manufacturer	Part Number(s)
C2 and D2	20MHz	TCXO	3.3V	SE	Microchip (Vectron)	TX-502-0038-20M0000
C2 and D2	20MHz	TCXO	3.3V	SE	Microchip (Vectron)	VT-803-EAE-2870-20M0000
C2 and D2	20MHz	TCXO	3.3V	SE	Microchip (Vectron)	TX-8010-EAE-2870-20M0
C2 and D2	24.576MHz	TCXO	3.3V	SE	Microchip (Vectron)	VT-803-EAE-2870-24M5760
C2 and D2	24.576MHz	TCXO	3.3V	SE	Microchip (Vectron)	TX-801-0007-24M576 TX-502-0034-24M576
C2 and D2	98.304MHz	TCXO	3.3V	SE	Microchip (Vectron)	TX-500-0083-98M30400

Table 4 – Class C2 and D2 Oscillators

Class E

Used with 14 Hz and higher filter bandwidths for T1-based, E1-based and OTN line card use cases. Also listed are oscillators/crystals for Clock Synthesis applications

Class	Oscillator Frequency	Oscillator Type	Oscillator Supply Voltage	Single Ended/ Differential	Manufacturer	Part Number(s)
E	20.0MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX554EBA20M0000 – 5x3.2mm, 50ppm
E	20.0MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX574EBA20M0000 – 5x7mm, 50ppm
E	20.0MHz	XO	2.5~3.3V	SE	Microchip	MX554EBC20M0000 – 5x3.2mm, 50ppm
E	20.0MHz	XO	2.5~3.3V	SE	Microchip	MX574EBC20M0000 – 5x7mm, 50ppm
E	20Mhz	XO	3.3V	SE	Microchip (Vectron)	VCC4-B3F-20M0000 (see VC-801-1059-20M000 for improved phase noise)
E	20Mhz	XO	3.3V	SE	Microchip (Vectron)	VC-801-EAE-FAAN-20M0000 (see VC-801-1059-20M000 for improved phase noise)
E	20Mhz	XO	3.3V	SE	Microchip (Vectron)	VC-801-1059-20M0000000
E	24.576MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX554RBA24M5760 – 5x3.2mm, 50ppm
E	24.576MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX574RBA24M5760 – 5x7mm, 50ppm
E	24.576MHz	XO	2.5~3.3V	SE	Microchip	MX554RBC24M5760 – 5x3.2mm, 50ppm
E	24.576MHz	XO	2.5~3.3V	SE	Microchip	MX574RBC24M5670 – 5x7mm, 50ppm
E	24.576MHz	XO	3.3V	SE	Microchip (Vectron)	VCC4-B3F-24M576000 (see VC-801-1060-24M5760000 for improved phase noise)
E	24.576MHz	XO	3.3V	SE	Microchip (Vectron)	VC-801-EAE-EAAN-24M576000 (see VC-801-1060-24M5760000 for improved phase noise)
E	24.576MHz	XO	3.3V	SE	Microchip (Vectron)	VC-801-1060-24M5760000
E	39.0625MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX553BBA39M0625 – 5x3.2mm, 50ppm
E	39.0625MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX573BBA39M0625 – 5x7mm, 50ppm
E	39.0625MHz	XO	2.5~3.3V	SE	Microchip	MX553BBC39M0625 – 5x3.2mm, 50ppm
E	39.0625MHz	XO	2.5~3.3V	SE	Microchip	MX573BBC39M0625 – 5x7mm, 50ppm
E	39.0625MHz	Crystal	NA	NA	Microchip (Vectron)	VXM7-1150-39M062500
E	49.152MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX554RBA49M1520 – 5x3.2mm, 50ppm
E	49.152MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX574RBA49M1520 – 5x7mm, 50ppm
E	49.152MHz	XO	2.5~3.3V	SE	Microchip	MX554RBC49M1520 – 5x3.2mm, 50ppm
E	49.152MHz	XO	2.5~3.3V	SE	Microchip	MX574RBC49M1520 – 5x7mm, 50ppm
E	49.152MHz	XO	3.3V	SE	Microchip (Vectron)	VCC4-B3F-49M152000, (see VC-801-1058-49M152000 for improved phase nosie)
E	49.152MHz	XO	3.3V	SE	Microchip (Vectron)	VC-801-EAE-EAAN-49M152000 (see VC-801-1058-49M152000 for improved phase nosie)
E	49.152MHz	XO	3.3V	SE	Microchip (Vectron)	VC-801-1058-49M152000

* NA = Not Applicable

Table 5 – Class E Oscillators

Class	Oscillator Frequency	Oscillator Type	Oscillator Supply Voltage	Single Ended/ Differential	Manufacturer	Part Number(s)
E	49.152MHz	XO	3.3V	SE	Microchip (Vectron)	VCC1-1545-49M1520000
E	49.152MHz	Crystal	NA	NA	Microchip (Vectron)	VXM7-1149-49M152000
E	50.0MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX555ABA50M000 – 5x3.2mm, 50ppm
E	50.0MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX575ABA50M000 – 5x7mm, 50ppm
E	50.0MHz	XO	2.5~3.3V	SE	Microchip	MX555ABC50M000 – 5x3.2mm, 50ppm
E	50.0MHz	XO	2.5~3.3V	SE	Microchip	MX575ABC50M000 – 5x7mm, 50ppm
E	50MHz	XO	3.3V	SE	Microchip (Vectron)	VCC1-1544-50M0000000
E	50MHz	Crystal	NA	NA	Microchip (Vectron)	VXM7-1148-50M000000
E	57.1425MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX555RBA57M1425 – 5x3.2mm, 50ppm
E	57.1425MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX575RBA57M1425 – 5x7mm, 50ppm
E	57.1425MHz	XO	2.5~3.3V	SE	Microchip	MX555RBC57M1425 – 5x3.2mm, 50ppm
E	57.1425MHz	XO	2.5~3.3V	SE	Microchip	MX575RBC57M1425 – 5x7mm, 50ppm
E	60.0MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX554EBA60M0000 – 5x3.2mm, 50ppm
E	60.0MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX574EBA60M0000 – 5x7mm, 50ppm
E	60.0MHz	XO	2.5~3.3V	SE	Microchip	MX554EBC60M0000 – 5x3.2mm, 50ppm
E	60.0MHz	XO	2.5~3.3V	SE	Microchip	MX574EBC60M0000 – 5x7mm, 50ppm
E	78.1250MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX553BBA78M1250 – 5x3.2mm, 50ppm
E	78.1250MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX573BBA78M1250 – 5x7mm, 50ppm
E	78.1250MHz	XO	2.5~3.3V	SE	Microchip	MX553BBC78M1250 – 5x3.2mm, 50ppm
E	78.1250MHz	XO	2.5~3.3V	SE	Microchip	MX573BBC78M1250 – 5x7mm, 50ppm
E	78.125MHz	XO	3.3V	SE	Microchip (Vectron)	VCC1-1539-78M125000
E	98.3040MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX554JBA98M3040 – 5x3.2mm, 50ppm
E	98.3040MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX574JBA98M3040 – 5x7mm, 50ppm
E	98.3040MHz	XO	2.5~3.3V	SE	Microchip	MX554JBC98M3040 – 5x3.2mm, 50ppm
E	98.3040MHz	XO	2.5~3.3V	SE	Microchip	MX574JBC98M3040 – 5x7mm, 50ppm
E	98.304MHz	XO	3.3V	SE	Microchip (Vectron)	VCC1-1541-98M304000
E	114.285MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX555RBA114M285 – 5x3.2mm, 50ppm
E	114.285MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX575RBA114M285 – 5x7mm, 50ppm
E	114.285MHz	XO	2.5~3.3V	SE	Microchip	MX555RBC114M285 – 5x3.2mm, 50ppm
E	114.285MHz	XO	2.5~3.3V	SE	Microchip	MX575RBC114M285 – 5x7mm, 50ppm
E	114.285MHz	XO	3.3V	SE	Microchip (Vectron)	VCC1-1536-114M285000, VCC1-1537-114M285000, VC-820-0010-114M285000, VC-820-0012-114M285000

* NA = Not Applicable

Table 5 – Class E Oscillators (continued)

Class	Oscillator Frequency	Oscillator Type	Oscillator Supply Voltage	Single Ended/ Differential	Manufacturer	Part Number(s)
E	125MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX553EBA125M000, 5x3.2mm, 50ppm
E	125MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX573EBA125M000, 5x7mm, 50ppm
E	125MHz	XO	2.5~3.3V	SE	Microchip	MX553EBC125M000, 5x3.2mm, 50ppm
E	125MHz	XO	2.5~3.3V	SE	Microchip	MX573EBC125M000, 5x7mm, 50ppm
E	125MHz	XO	3.3V	SE	Microchip (Vectron)	VCC1-1534-125M000000, VCC1-1535-125M000000, VC-820-0009-125M000000, VC-820-0011-125M000000
E	190MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX554EBA190M000 – 5x3.2mm, 50ppm
E	190MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX574EBA190M000 – 5x7mm, 50ppm
E	190MHz	XO	2.5~3.3V	SE	Microchip	MX554EBC190M000 – 5x3.2mm, 50ppm
E	190MHz	XO	2.5~3.3V	SE	Microchip	MX574EBC190M000 – 5x7mm, 50ppm
E	190MHz	XO	3.3V	SE	Microchip (Vectron)	VCC1-1546-190M00000
E	200MHz	XO	2.5~3.3V	Diff-HCSL	Microchip	MX555ABD200M000 – 5x3.2mm, 50ppm
E	200MHz	XO	2.5~3.3V	Diff-HCSL	Microchip	MX575ABD200M000 – 5x7mm, 50ppm
E	200MHz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX555ABA200M000 – 5x3.2mm, 50ppm
E	200Mhz	XO	2.5~3.3V	Diff-LvPECL	Microchip	MX575ABA200M000 – 5x7mm, 50ppm
E	200MHz	XO	2.5~3.3V	Diff-LVDS	Microchip	MX555ABB200M000 – 5x3.2mm, 50ppm
E	200Mhz	XO	2.5~3.3V	Diff-LVDS	Microchip	MX575ABB200M000 – 5x7mm, 50ppm
E	200MHz	XO	2.5~3.3V	SE	Microchip	MX555ABC200M000 – 5x3.2mm, 50ppm
E	200MHz	XO	2.5~3.3V	SE	Microchip	MX575ABC200M000 – 5x7mm, 50ppm
E	200MHz	XO	3.3V	SE	Microchip (Vectron)	VCC1-1538-200M000

* NA = Not Applicable

Table 5 – Class E Oscillators (continued)

Protocol Layer Synchronization

The oscillator requirements for protocol layer synchronization are not finalized as most of the ITU-T development work on synchronization over packet networks is still under development (in draft status, or incomplete). The following three classifications are used as a guide

- Class A2. Used for unaware networks with frequency synchronization, suitable for ITU-T G.8263. Also may be used for unaware networks with frequency or phase synchronization, based on ITU-T G.8261 Appendix VI profiles. Oscillator requirements are taken from Stratum 3E. Note that Microsemi has allocated 5 ppb pk-pk for the temperature effects of the Stratum 3E oscillator over a reduced temperature range profile for ITU-T G.8263 testing (see ITU-T G.8263 Amendment 1 Appendix VI).
- Class B. Used for partially aware networks (3-4 nodes) with phase synchronization, such as T-BC-P, T-TSC-P and T-TSC-A clocks. This class is under development in ITU-T G.8273.4 drafts and will be subject to change. Also may be used for unaware networks with relaxed frequency synchronization requirements, based on ITU-T G.8261 Appendix VI profiles.
- Class C1. Used for fully aware BC networks with phase synchronization suitable for ITU-T G.8273.2 T-BC and T-TSC. Note that the first revision of ITU-T G.8273.2 is published based on use of SyncE, but additional amendments and revisions are expected to clarify items such as wander generation and holdover stability when SyncE is not present. Therefore deviations (tougher requirements) from these requirements may be expected, especially related to wander generation (at 0.05 Hz) and holdover stability under variable temperature.
- Class D1. Used for fully aware BC networks when combined with EEC option 1 reference chain, with phase synchronization suitable for ITU-T G.8273.2 T-BC and T-TSC. Note that the first revision of ITU-T G.8273.2 is published, but additional amendments and revisions are expected to clarify items such as operation (possibly holdover) during loss of SyncE. Therefore deviations (tougher requirements) from these requirements may be expected, especially related to holdover performance under variable temperature conditions without SyncE.

Handling Unknown Deployment Scenarios

When a system is designed to handle a variety of deployment scenarios (unaware networks, partially aware networks, fully aware networks) with differing performance requirements (frequency accuracy, frequency, phase alignment), it is suggested to use a class A2 oscillator or at least dual footprint a class A2 oscillator with a lower cost class oscillator (such as B).

Classification

Below list is a summary of the various classifications of oscillator for use in physical layer synchronization and protocol layer synchronization. Some classifications represent the superset requirements of closely related clocks (where an individual clock requirement may be less than that listed for the superset).

Oscillator Class	A2	B	C1	D1/D2
Superset Grouping	Unaware Networks	Partially Aware Networks T-BC-P, T-TSC-P, T-TSC-A or Unaware Networks OC	Fully Aware Networks T-BC, T-TSC	Fully Aware Networks, combined with SyncE, T-BC, T-TSC (Note 2)
ITU-T Clock	G.8263 (Note 1)	G.8273.4 (Note 1)	G.8273.2 (Note 1)	G.8273.2 (Note 1)
Non- standardized network profiles	G.8261 Appendix VI	G.8261 Appendix VI		
PLL implied Bandwidth	1mHz	3mHz	TBD (0.05Hz)	1Hz for SyncE 0.05Hz for PTP
Free-run Accuracy (ppm)	± 4.6	± 4.6	± 4.6	± 4.6
Frequency Stability (pk-pk) at Variable Temperature (ppb)	10	TBD	TBD	TBD
Frequency Stability at Constant Temperature (ppb)	± 1	TBD (± 2)	± 10	± 10
Wander Generation (MTIE, TDEV)	Refer to Stratum 3E standard	Use Stratum 3E standard, but at PLL implied bandwidth (Note 3)	Refer to standard (Note 3)	Refer to standard (Note 3)
Estimated Frequency Stability (pk-pk) at Variable Temperature (ppb) to meet Wander Generation (Note 4)	5 (reduced temp range) 10 (full temp range)	TBD (100)	TBD (140 for 30°C/hr 340 for 12°C/hr)	TBD (2000)

Note 1: Specifications under revision, under draft or no yet reached draft.

Note 2: Oscillator must comply with both class D1 (G.8273.2) and class D2 (G.8262 option 1 EEC)

Note 3: When measurement is performance on a PTP output there is up to 8 ns of additional timestamp noise. Therefore clearance/margin of 8 ns or 25% (whichever is larger) against the wander generation MTIE & TDEV masks may be requested.

Note 4: Assumption of linear response of oscillator to temperature ramp

Table 6 –Protocol Layer Summary

Detailed Manufacturer Information

Class A2

Used for unaware networks with frequency synchronization. Suitable for ITU-T G.8263 specification. Also used for unaware networks with frequency or phase synchronization, based on ITU-T G.8261 Appendix VI profiles.

See table in physical layer section above for suitable oscillators.

Class B

Used for partially aware networks with phase synchronization, such as T-BC-P, T-TSC-P and T-TSC-A clocks. Used for unaware aware networks with relaxed frequency synchronization requirements, based on ITU-T G.8261 Appendix VI profiles.

Class	Oscillator Frequency	Oscillator Type	Oscillator Supply Voltage	Single Ended/ Differential	Manufacturer	Part Number(s)
B	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-221-9100-20M000
B	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-401-9016-20M000
B	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-5021-EAE-1080-20M000
B	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-6011-EAE-1080-20M000
B	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-221-9101-24M576
B	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-4011-EAE-0580-24M576
B	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-5021-EAE-1080-24M576
B	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-6011-EAE-1080-24M576
B	49.152MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-221-9102-49M152

Table 7 – Class B Oscillators

Class C1

Used for fully aware BC networks with phase synchronization suitable for ITU-T G.8273.2 T-BC and T-TSC.

Class	Oscillator Frequency	Oscillator Type	Oscillator Supply Voltage	Single Ended/ Differential	Manufacturer	Part Number(s)
C1	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-5021-EAE-2080-20M000
C1	20MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-6011-EAE-2080-20M000
C1	20MHz	TCXO	3.3V	SE	Microchip (Vectron)	VT-803-0051-20M000
C1	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-5021-EAE-2080-24M576
C1	24.576MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-6011-EAE-2080-24M576
C1	24.576MHz	TCXO	3.3V	SE	Microchip (Vectron)	VT-803-0052-24M576
C1	49.152MHz	TCXO	3.3V	SE	Microchip (Vectron)	VT-803-0053-49M1520000
C1	98.304MHz	OCXO	3.3V	SE	Microchip (Vectron)	OX-401-9015-98M304

Table 8 – Class C1 Oscillators

Class D1/D2

Used for fully aware BC networks when combined with EEC option 1 reference chain, with phase synchronization suitable for ITU-T G.8273.2 T-BC and T-TSC.

Class	Oscillator Frequency	Oscillator Type	Oscillator Supply Voltage	Single Ended/ Differential	Manufacturer	Part Number(s)
D1/D2	20MHz	TCXO	3.3V	SE	Microchip (Vectron)	VT-803-0051-20M0000000
D1/D2	24.576MHz	TCXO	3.3V	SE	Microchip (Vectron)	VT-803-0052-24M5760000
D1/D2	49.152MHz	TCXO	3.3V	Se	Microchip (Vectron)	VT-803-0053-49M1520000

Table 9 – Class D1/D2 Oscillators

VCXO

For ultra-low jitter applications employing an external VCXO, refer to table 12 for a list of suitable VCXO oscillators

Class	Oscillator Frequency	Single Ended/ Differential	Manufacturer	Part Number(s)
VCXO	156.25MHz	SE	Microchip (Vectron)	VX-5010-EAE-3050
VCXO	122.08MHz	SE	Microchip (Vectron)	VX-501-0175-122M88
VCXO	204.8MHz	Diff - LVPECL	Microchip (Vectron)	VX-501-0283-204M8
VCXO	312.5MHz	Diff - LVPECL	Microchip (Vectron)	VX-501-0284-312M5
VCXO	156.25MHz	SE -Sine	Microchip (Vectron)	VX-501-0075

Table 10 - VCXO Oscillators

General Notes

Holdover Stability Parameter

Referencing Stratum 3E, the Telcordia GR-1244-CORE and ITU-T G.812 specifications indicate that upon entry into holdover the system will not drift more than 10 ppb from its current position due to changes in temperature. At the extreme, if the system were to enter holdover at the coldest temperature (say -40 °C) then it cannot move more than 10 ppb even if the temperature changes to the warmest temperature (say +85 °C). Thus the oscillator selected should have a maximum 10 ppb peak-peak variation over the full temperature range expected to be experienced during deployment. This temperature range may be less than industrial temperature range, if that is allowed for the deployment.

Likewise, referencing Stratum 3, the drift limit due to holdover is 280 ppb (Telcordia GR-1244-CORE, revision 2005) or 300 ppb (Telcordia GR-1244-CORE, revision 2009).

Constant Temperature

In general constant temperature is taken as ±2.8°C or ±5°F. This therefore includes the drift due to ageing, but additionally some movement of the oscillator due to temperature changes. A maximum rate of change of temperature (under constant temperature conditions) of 0.1°C/minute may be reasonable.

Variable Temperature

The total temperature range for which the system is qualified may fall into a variety of classifications (which are not listed here). The largest temperature range allowed should be the one used to select the oscillator. There are a few different specifications that may cover the maximum rate of change of temperature (under variable temperature conditions), notably 0.5°C/minute or 20°C/hour. Typically 12°C/hour may be acceptable.

In general the oscillator manufacturer will specify a temperature range over which the oscillator will meet one of the relevant specifications. The agreed/target temperature range is to be carefully chosen by the system designer in consultation with the oscillator manufacturer.

When the specified temperature range is wider for the same criteria (e.g. 10 ppb pk-pk stability over industrial vs. commercial temperature range) then it will decrease the frequency rate of change seen during a variable temperature test for the same temperature change rate.

Example Temperature Profile

Microsemi may typically use the following temperature profile during characterization of oscillators, but this is not intended to replace or override industry environmental standards or those specified by individual system vendors or operators. The temperature profile has flat stabilization durations of 1 hour, a ramp rate of 12°C/hour and a peak-peak temperature variation of 125 °C.

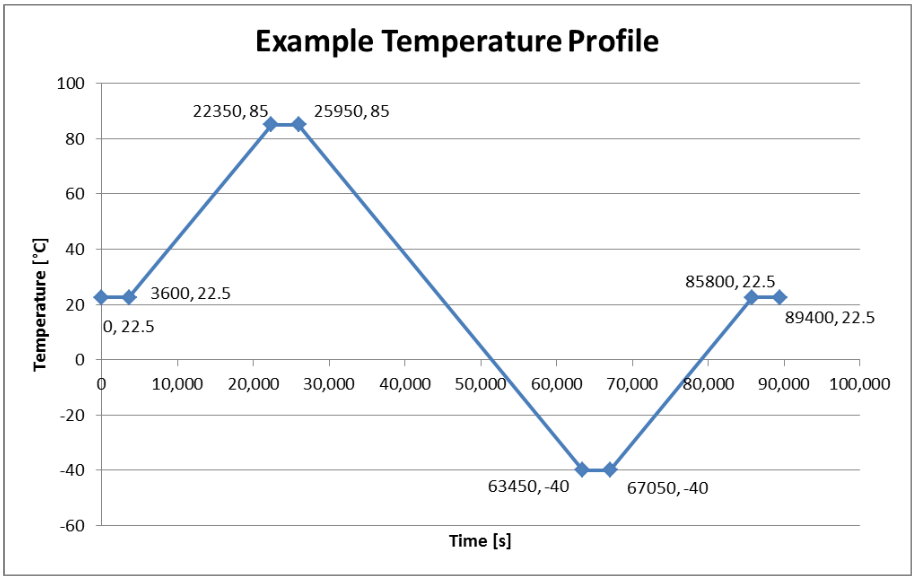

Figure 1 – Example Microsemi Temperature Profile

Class A2 Temperature Consideration

In general a designer is recommended to use a Stratum 3E oscillator. Related to ITU-T G.8263, Microsemi has budgeted 5 ppb for the oscillator, from the overall 16 ppb budget, when it is desired to jointly test worse-case wander tolerance and variable temperature ramps. The remaining 11 ppb is allocated to the PDV filtering algorithm and some portions of the oscillator ageing.

ITU-T G.8263 Amd 1 (Appendix IV) and G.8273 Amd 1 (Appendix I) have added an informational Appendices to cover variable temperature profile. An example temperature ramp rate was 0.5 °C/min, with a temperature range of 40 °C pk-pk with stable temperature instances occurring at the minimum, mean and maximum temperature values. The temperature profile diagram is copied below for information.

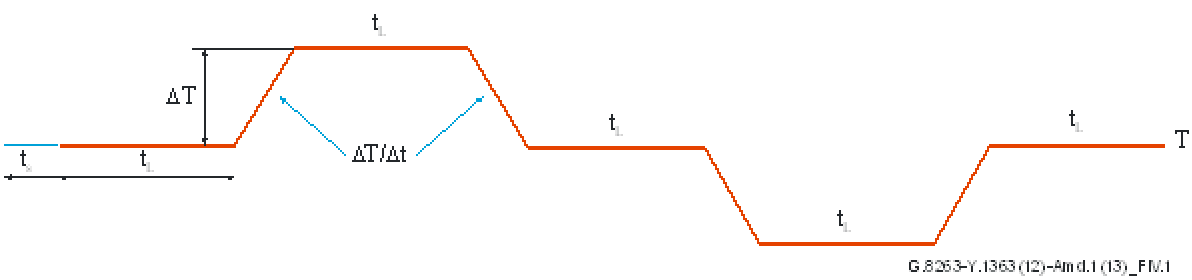

Figure 2 – Example Temperature Profile from ITU-T G.8263 Amd 1 and ITU-T G.8273 Amd 1.

Wander Generation Temperature Considerations

Wander generation is not typically listed in an oscillator datasheet (where normally only frequency-based characteristics are listed). Nevertheless it is a critical parameter that the oscillator must meet in order for the overall system to comply with the relevant specification. Wander generation may be measured both at constant temperature and possibly also under variable temperature conditions.

Jitter Generation

The jitter from the oscillator is an important contributing factor to the output jitter of the PLL. We have evaluated the jitter of our products in the lab with a number of crystals and XOs. Many of these are listed in this application note. There are too many oscillator options for us to evaluate them all. We recommend that you use oscillator vendor phase noise plots and information in ZLAN-442 to guide your selection. Based on the application jitter requirements, example oscillator phase noise plots are available upon request.

Appendix: OCXO with Register Map

Some OCXO may support an internal register map that is accessible through I2C or SPI interface. This Appendix provides information about Microsemi evaluation boards and their inter-connection with such OCXO.

OCXO I2C Footprint

The following footprint is used by Microsemi on our evaluation boards for OCXO with I2C capability.

Surface Mount 25x22

Package size is 25 mm x 22 mm.

Pinout is

Pin	1	2	3	4	5	6	7
Name	NC/IC	NC/IC	VCC/VDD	Output	I2C-SDL	I2C-SDA	GND

Table 11 · OCXO I2C Footprint, Surface Mount, 25x22

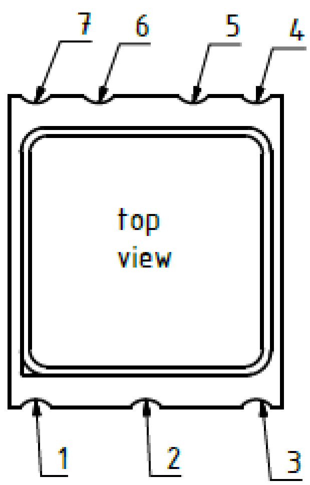

Figure 3 · **OXCO I2C Footprint, Surface Mount, 25x22**

OCXO I2C Device Address

The following I2C device addresses is used by default by Microsemi on our evaluation boards to access the OCXO with I2C capability

- 0x70 (7-bits)

OCXO Register Map

The following register map is associated with such OCXO. The first table contains common fields for compatibility. Based on the first few registers in the common fields the upper registers may vary.

Address	Name	Description	Enum/Units	Format	Bytes	Type
0x0000:0x0000	MM_REV	Memory map revision	Invalid: 0x00 1st version: 0x01 Proprietary: 0x80-0xEF Experimental: 0xF0-xFE Invalid: 0xFF	Uint	1	R
0x0001:0x0002	MM_SIZE	Highest valid address in memory	Byte	Uint	2	R
0x0003:0x0007	VENDOR_ID	Vendor ID	Invalid: 0x0000000000 Rakon/RAK: 0x000052414B Microchip/MCHP: 0x004D434850 Microsemi/MSCC: 0x004D534343 Proprietary: 0xE000000000 -0xEFFFFFFFFF Experimental: 0xF000000000 -0xFFFFFFFFFE Invalid: 0xFFFFFFFFFF	ASCII	5	R
Note: Byte format is little endian Note: First byte of ASCII is NULL (0x00) Note: Float format is 64-bit double precision floating point according to IEEE 754 Note: Proprietary indicates non-standard or hidden (for use in production) Note: Experimental indicates non-standard or hidden (for use in development) Note: Reserved fields should be 0x00 and not used for other purposes. May be used in future versions of the memory map. Note: Vendor-specific fields may be used for any purpose by the oscillator manufacturer Note: Customer-specific fields may be used for any purpose by the system vendor						

Table 12 · OCXO Register Map, Common Compatibility Fields

Address	Name	Description	Enum/Units	Format	Bytes	Type
0x0008:0x0027	PART_ID	Vendor part identification	Vendor-specific	ASCII	32	R
0x0028:0x002B	NOM_FREQ	Nominal Freq	Hz	Uint	4	R
0x002C:0x002E	SERIAL_NUM	Part serial number	Vendor-specific	Uint	3	R
0x002F:0x0033	DATECODE_ASC	Date code of manufacture	Vendor-specific	ASCII	5	R
0x0034:0x0043	CUSTOMER_CODE	Customer code	Vendor-specific	ASCII	16	R
0x0044:0x0045	V_TEMP_MIN	Minimum Vtemp	Vendor-specific	Uint	2	R
0x0046:0x0047	V_TEMP_MAX	Maximum Vtemp	Vendor-specific	Uint	2	R
0x0048:0x004F	A0	Coefficient A0	Vendor-specific	Float	8	R
0x0050:0x0057	A1	Coefficient A1	Vendor-specific	Float	8	R
0x0058:0x005F	A2	Coefficient A2	Vendor-specific	Float	8	R
0x0060:0x0067	A3	Coefficient A3	Vendor-specific	Float	8	R
0x0068:0x006F	A4	Coefficient A4	Vendor-specific	Float	8	R
0x0070:0x0077	A5	Coefficient A5	Vendor-specific	Float	8	R
0x0078:0x007F	RESERVED	Reserved	Reserved	Reserved	8	
0x0080:0x009F	RESERVED	Reserved	Reserved	Reserved	32	
0x00A0:0x00C7	VENDOR_SPECIFIC	Vendor-specific	Vendor-specific	Vendor-specific	40	
0X00C8:0X00EF	CUSTOMER_SPECIFIC	Customer-specific	Customers-specific	Customer-specific	40	
0x00F0:0x00F1	VTEMP	Ambient temperature indicator	Vendor-specific	Uint	2	R
0x00F2:0x00FF	VENDOR_SPECIFIC	Vendor-specific	Vendor-specific	Vendor-specific	14	
0x0100:0xFFFF	VENDOR_SPECIFIC	Vendor-specific	Vendor-specific	Vendor-specific	65280	

Note: Byte format is little endian
Note: First byte of ASCII is NULL (0x00)
Note: Float format is 64-bit double precision floating point according to IEEE 754
Note: Proprietary indicates non-standard or hidden (for use in production)
Note: Experimental indicates non-standard or hidden (for use in development)
Note: Reserved fields should be 0x00 and not used for other purposes. May be used in future versions of the memory map.
Note: Vendor-specific fields may be used for any purpose by the oscillator manufacturer
Note: Customer-specific fields may be used for any purpose by the system vendor

Table 13 · OCXO Register Map, Other Fields (MM_REV = 0x01)

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