

XK

Ultra-low Phase Noise Quartz-based PLL Oscillators

Description

The XK devices are a second-generation follow-on to the XF ProXO high-performance oscillators. The devices are often referred to as ProXO II.

The XK family of devices uses internal regulators to provide excellent PSNR characteristics.

The devices are offered in a range of industry-standard package footprints. Each device can be factory programmed with up to three frequencies and/or output types that are selected by the 3-level FS pin.

A list of standard frequencies is provided in [Table 19](#).

Applications

- 10G to 800G Ethernet
- 100G to 400G OTN
- 3G to 24G SDI broadcast video
- Servers, switches, storage, accelerators, NICs, HBAs

Features

- 55fs RMS typical phase jitter (12kHz to 20MHz) at 156.25MHz
- 50MHz to 1250MHz output frequency
- Package options:
 - $1.8 \times 1.4 \times 0.85$ mm (1.6×1.2 mm footprint compatible)
 - $2.0 \times 1.6 \times 0.85$ mm
 - $2.5 \times 2.0 \times 0.7$ mm
 - $3.2 \times 2.5 \times 0.7$ mm
- Supply voltage options: 1.8V, 2.5V, 3.3V
- Output types:
 - LVDS, CML, and HCSL (1.8V, 2.5V, 3.3V)
 - LVPECL (3.3V only)
 - LVCMOS differential (1.8V only)
- Total stability (including temperature, power supply, and aging):
 - ± 25 ppm (1.8V)
 - ± 30 ppm (2.5V, 3.3V)
- Operating temperature: -40°C to +85°C

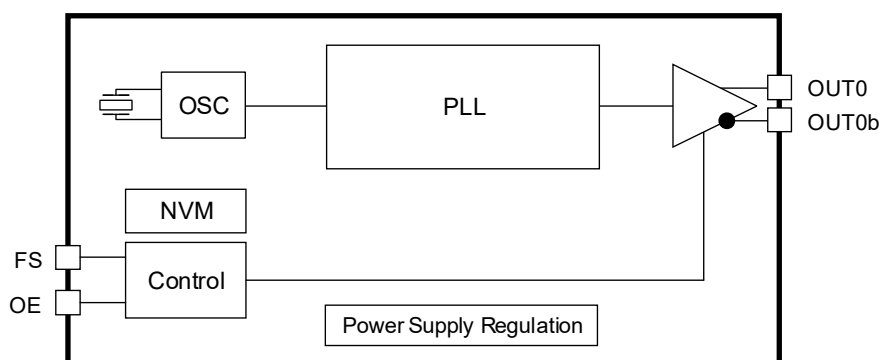


Figure 1. Block Diagram

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1. Pin Information

1.1 Pin Assignments

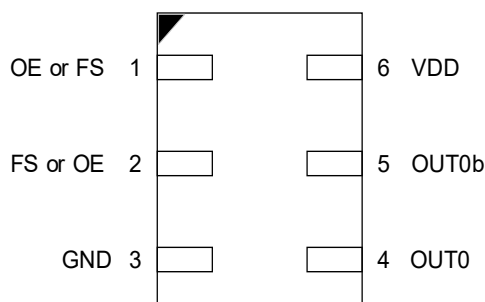


Figure 2. Pin Assignments – Top View

1.2 Pin Descriptions

Pin Number	Pin Name	Description
1	OE or FS	Output Enable (OE) or Frequency Select (FS) pin. The function of this pin is determined by the Ordering Information . When OE is selected, the polarity of the OE is also selectable via ordering option. When FS is selected, the pin is a 3-state (High, Mid (Float), Low) pin that selects on of the three factory-programmed frequencies. <i>Note:</i> The OE function stops the outputs in a differential state, it does not tri-state the outputs or power down the internal circuitry.
2	FS or OE	Frequency Select (FS) or Output Enable (OE) pin. The function of this pin is determined by the ordering options. When FS is ordered, the pin is a 3-state (High, Mid (Float), Low) pin that selects on of the three factory-programmed frequencies. When OE is selected, the polarity of the OE is also selectable via ordering option. This pin is always the function not chosen for pin 1. <i>Note:</i> The OE function stops the outputs in a differential state, it does not tri-state the outputs or power down the internal circuitry.
3	GND	Connect to ground.
4	OUT0	True clock output.
5	OUT0b	Complementary clock output.
6	VDD	Power supply voltage.

2. Specifications

2.1 Absolute Maximum Ratings

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions can adversely impact product reliability and result in failures not covered by warranty.

Parameter	Minimum	Maximum	Unit
V_{DD}	GND - 0.5	GND + 3.8	V
All Other Pins	GND - 0.3	$V_{DD} + 0.3^{[1]}$	V
Maximum Junction Temperature		+125	°C
Storage Temperature Range	-55	+125	°C

1. Not to exceed 3.6V.

2.2 ESD Ratings

ESD Model/Test	Rating	Unit
Human Body Model (Tested per JS-001-2017)	2	kV
Charged Device Model (Tested per JS-002-2018)	1	kV
Latch-Up (Tested per JESD78E; Class 2, Level A)	100	mA

2.3 Recommended Operating Conditions

Parameter	Minimum	Maximum	Unit
1.8V Nominal Supply Voltage, V_{DD}	1.71	1.89	V
2.5V Nominal Supply Voltage, V_{DD}	2.375	2.625	V
3.3V Nominal Supply Voltage, V_{DD}	3.135	3.465	V
Ambient Temperature	-40	+85	°C

2.4 Thermal and Mechanical Specifications

Table 1. Thermal Characteristics - JEDEC Standard PCB

Package	θ_{JA} (°C/W) [1]	θ_{JB} (°C/W) [2]
1814 Package (1612 footprint compatible)	113.2	56.7
2016 Package	114.1	61.1
2520 Package	93.1	39.4
3225 Package	92.0	42.6

1. Still air.

2. Device soldered to JEDEC standard PCB (4 × 4.5 inch 4-layer PCB, one thermal via, one PCB ground plane).

Table 2. Thermal Characteristics - Customer PCB

Package	θ_{JA} (°C/W) [1]	θ_{JB} (°C/W) [2]
1814 Package (1612 footprint compatible)	94.4	56.7
2016 Package	97.6	61.1
2520 Package	76.7	40.4
3225 Package	76.8	42.6

1. Still air.

2. Device soldered to 200 × 250mm 10-layer PCB with one thermal via, and four PCB ground planes.

Thermal vias in the PCB pads can also be used to maximize performance. The vias act as “heat pipes” conducting heat from the device to the PCB ground plane(s). For specific recommendations, contact Renesas.

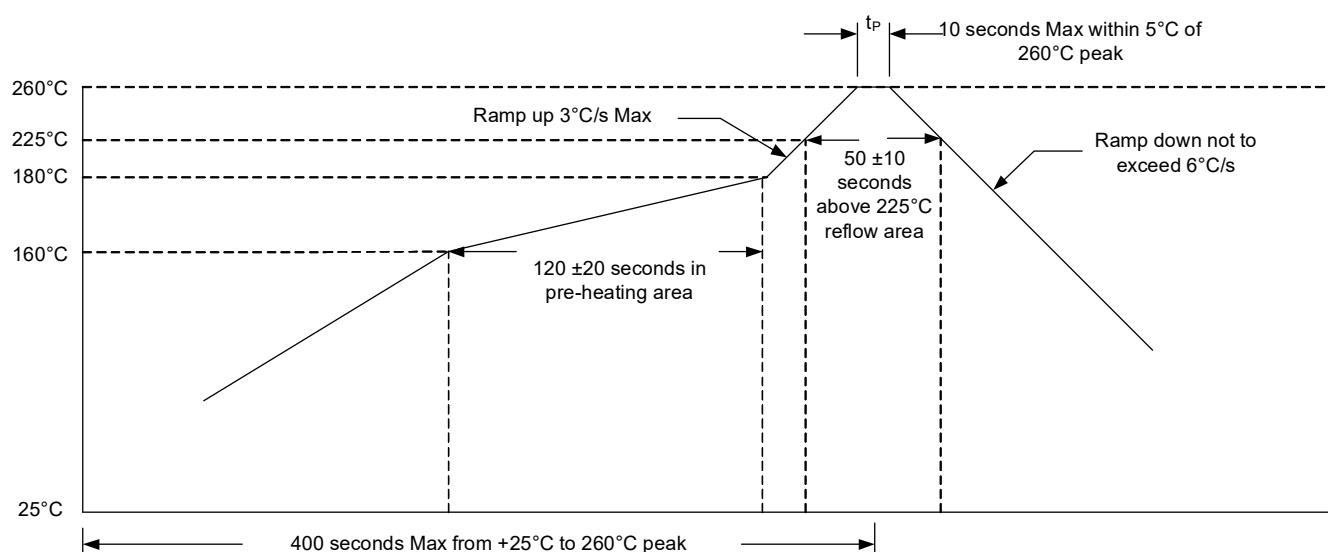


Figure 3. Solder Re-flow Profile

Table 3. Package Mechanical Characteristics

Parameter	Test Method	Value
Mechanical Shock	Half-sine wave with 0.3ms 3000G. X, Y, Z each direction 1 time.	-
Mechanical Vibration	Frequency: 10 to 55MHz amplitude: 1.5mm. Frequency: 55 to 2000Hz peak value: 20G. Duration time: 4H for each X, Y, Z axis; total 12hours.	-
High Temp Operating Life (HTOL)	1000 hours at 125°C (under power).	-
MSL Level	JEDEC-STD-020E, Moisture/Reflow Sensitivity Classification for Non-hermetic Surface Mount Devices, December 2014.	3
Pb-Free Reflow Profile	See Figure 3	-

2.5 Electrical Specifications

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$. Typical values are at $T_A = +25^{\circ}\text{C}$, unless otherwise specified. A $0.01\mu\text{F}$ bypass capacitor between V_{DD} and GND is used to minimize power supply noise.

2.5.1 Common Specifications

$V_{DD} = 1.8\text{V} \pm 5\%$, $2.5\text{V} \pm 5\%$, $3.3\text{V} \pm 5\%$, $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$.

Table 4. Common Specifications

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Output Frequency	F_{OUT}	-	50	-	1250	MHz
Frequency Stability ^[1]	-	1.8V operation	-	-	± 20	ppm
	-	2.5V or 3.3V operation	-	-	± 30	
Output Test Load	-	CML (to V_{DD})	-	50	-	Ω
		HCSL (to GND)	-	50	-	
		LVC MOS (to $V_{DD}/2$)	-	50	-	
		LVDS (differential)	-	100	-	
		LVPECL (Thevenin equivalent)	-	50	-	
Start-up Time	T_{SU}	-	-	15	-	ms
Output Enable/Disable Time	T_{OE}	-	-	0.1	-	
Input High Voltage	V_{IH}	FS pin (tri-level)	$0.8 \times V_{DD}$	-	$V_{DD} + 0.3$	V
Input Mid-Level Voltage	V_{IM}		$0.4 \times V_{DD}$	$V_{DD}/2$	$0.6 \times V_{DD}$	
Input Low Voltage	V_{IL}		GND - 0.3	-	$0.2 \times V_{DD}$	
Input High Voltage	V_{IH}	OE pin	$0.7 \times V_{DD}$	-	$V_{DD} + 0.3$	V
Input Low Voltage	V_{IL}		GND - 0.3	-	$0.3 \times V_{DD}$	
Input Leakage High	I_{IH}	OE pin	0.5	-	2	μA
		FS pin	30	-	70	
Input Leakage Low	I_{IL}	OE pin	-70	-	-30	μA
		FS pin	-70	-	-30	

1. Includes initial accuracy, aging, and thermal effects.

2.5.2 1.8V Specifications

$V_{DD} = 1.8V \pm 5\%$, 12kHz to 20MHz integration range.

Table 5. Phase Jitter at 1.8V

Parameter	Symbol	Test Frequency (MHz)	Output Type	Typical	Maximum	Unit
Phase Jitter	Φ_{jit}	100	CML	76	90	fs RMS
			HCSL	78	90	
			LVC MOS	77	90	
			LVDS	85	105	
Phase Jitter	Φ_{jit}	106.25	CML			fs RMS
			HCSL			
			LVC MOS			
			LVDS			
Phase Jitter	Φ_{jit}	122.88	CML			fs RMS
			HCSL			
			LVC MOS			
			LVDS			
Phase Jitter	Φ_{jit}	125	CML	70	84	fs RMS
			HCSL	73	85	
			LVC MOS	70	84	
			LVDS	69	91	
Phase Jitter	Φ_{jit}	153.6	CML			fs RMS
			HCSL			
			LVC MOS			
			LVDS			
Phase Jitter	Φ_{jit}	156.25	CML	55	66	fs RMS
			HCSL	53	62	
			LVC MOS	54	64	
			LVDS	55	64	
Phase Jitter	Φ_{jit}	161.132813	CML	52	61	fs RMS
			HCSL	52	61	
			LVC MOS	53	64	
			LVDS	55	66	
Phase Jitter	Φ_{jit}	212.5	CML	51		fs RMS
			HCSL	49		
			LVC MOS	50		
			LVDS	50		

Table 5. (Cont.)Phase Jitter at 1.8V (Cont.)

Parameter	Symbol	Test Frequency (MHz)	Output Type	Typical	Maximum	Unit
Phase Jitter	Φ_{jit}	250	CML	62	79	fs RMS
			HCSL	63	73	
			LVC MOS	65	79	
			LVDS	67	79	
Phase Jitter	Φ_{jit}	307.2	CML			fs RMS
			HCSL			
			LVC MOS			
			LVDS			
Phase Jitter	Φ_{jit}	312.5	CML			fs RMS
			HCSL			
			LVC MOS			
			LVDS			
Phase Jitter	Φ_{jit}	322.265625	CML			fs RMS
			HCSL			
			LVC MOS			
			LVDS			
Phase Jitter	Φ_{jit}	425	CML			fs RMS
			HCSL			
			LVC MOS			
			LVDS			
Phase Jitter	Φ_{jit}	491.52	CML			fs RMS
			HCSL			
			LVC MOS			
			LVDS			
Phase Jitter	Φ_{jit}	500	CML	65	75	fs RMS
			HCSL	64	74	
			LVDS	65	75	
Phase Jitter	Φ_{jit}	614.4	CML			fs RMS
			HCSL			
			LVC MOS			
			LVDS			
Phase Jitter	Φ_{jit}	625	CML	62	79	fs RMS
			HCSL	63	73	
			LVDS	65	79	
Phase Jitter	Φ_{jit}	644.53125	CML	67	79	fs RMS
			HCSL	55		
			LVDS	52		

Table 5. (Cont.)Phase Jitter at 1.8V (Cont.)

Parameter	Symbol	Test Frequency (MHz)	Output Type	Typical	Maximum	Unit
Phase Jitter	Φ_{jit}	983.04	CML	50		fs RMS
			HCSL	51		
			LVCMOS	52	63	
			LVDS	50	58	
Phase Jitter	Φ_{jit}	1250	CML	51	59	fs RMS
			LVDS	52	60	

Table 6. AC Characteristics at 1.8V

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Output Rise Time [1]	t_R	CML	168	195	229	ps
		HCSL	148	185	232	
		LVCMOS	152	177	207	
		LVDS	113	156	177	
Output Fall Time [1]	t_F	CML	155	182	229	ps
		HCSL	176	220	280	
		LVCMOS	147	174	207	
		LVDS	176	230	315	
Output Duty Cycle [2]	O_{DC}	$F_{OUT} \leq 1000\text{MHz}$	49	50.5	53	%
		$F_{OUT} > 1000\text{MHz}$	50	53.2	56	

1. All measurements taken with 20% to 80% thresholds at 156.25MHz

2. All measurements taken at the crossing points for differential signals and at $V_{DD}/2$ for LVCMOS outputs if applicable. Applies to all output configurations.

Table 7. 1.8V DC Characteristics

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Output High Voltage [1]	V_{OH}	CML	1.79	1.8	1.81	V
		HCSL	725	774	825	mV
		LVCMOS, $I_{OH} = -2\text{mA}$	1.6	1.66	1.7	V
Output Low Voltage [1]	V_{OL}	CML	1.0	1.28	1.6	V
		HCSL	0	8	15	mV
		LVCMOS, $I_{OL} = 2\text{mA}$	0	0.1	0.2	V
Output common mode voltage	V_{CMR}	HCSL [2]	0.29	0.36	0.45	V
		LVDS	1.1	1.2	1.31	

Table 7. 1.8V DC Characteristics (Cont.)

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
TRUE Binary state	$V_{OT}(+)$	LVDS	218	366	503	mV
FALSE binary state	$V_{OT}(-)$		-226	-370	-492	
Change in VOT between complementary output states	ΔV_{OT}		-	4.1	79	
Change in VCMR between complementary output states	ΔV_{CMR}		-	22	53	

1. All measurements taken at 156.25MHz.
2. For HCSL V_{CMR} is equivalent to V_{CROSS} .

Table 8. 1.8V Current Consumption

Parameter	Symbol	Output Type	Conditions	Typical	Maximum	Unit
Current Consumption	I_{DD}	CML	$F_{OUT} = 156.25\text{MHz}$	94	101	mA
			$F_{OUT} = 1250\text{MHz}$	104	111	
		HCSL	$F_{OUT} = 156.25\text{MHz}$	109	116	mA
			$F_{OUT} = 1250\text{MHz}$	121	127	
		LVCMOS	$F_{OUT} = 156.25\text{MHz}$	92	101	mA
			$F_{OUT} = 322.265625\text{MHz}$	113	120	
		LVDS	$F_{OUT} = 156.25\text{MHz}$	96	103	mA
			$F_{OUT} = 1250\text{MHz}$	111	118	

2.5.3 2.5V Specifications

$V_{DD} = 2.5V \pm 5\%$, 12kHz to 20MHz integration range.

Table 9. Phase Jitter at 2.5V

Parameter	Symbol	Test Frequency (MHz)	Output Type	Typical	Maximum	Unit
Phase Jitter	Φ_{jit}	100	CML	77	86	fs RMS
			HCSL	76	87	
			LVDS	85	103	
Phase Jitter	Φ_{jit}	106.25	CML			fs RMS
			HCSL			
			LVDS			
Phase Jitter	Φ_{jit}	122.88	CML			fs RMS
			HCSL			
			LVDS			
Phase Jitter	Φ_{jit}	125	CML	70	86	fs RMS
			HCSL	66	87	
			LVDS	70	103	

Table 9. Phase Jitter at 2.5V (Cont.)

Parameter	Symbol	Test Frequency (MHz)	Output Type	Typical	Maximum	Unit
Phase Jitter	Φ_{jit}	153.6	CML			fs RMS
			HCSL			
			LVDS			
Phase Jitter	Φ_{jit}	156.25	CML	54	66	fs RMS
			HCSL	53	66	
			LVDS	54	66	
Phase Jitter	Φ_{jit}	161.132813	CML	53	65	fs RMS
			HCSL	52	64	
			LVDS	54	64	
Phase Jitter	Φ_{jit}	212.5	CML			fs RMS
			HCSL			
			LVDS			
Phase Jitter	Φ_{jit}	250	CML	63	75	fs RMS
			HCSL	63	72	
			LVDS	67	76	
Phase Jitter	Φ_{jit}	307.2	CML			fs RMS
			HCSL			
			LVDS			
Phase Jitter	Φ_{jit}	312.5	CML	51	62	fs RMS
			HCSL	50	62	
			LVDS	51	62	
Phase Jitter	Φ_{jit}	322.265625	CML	52	64	fs RMS
			HCSL	50	64	
			LVDS	53	66	
Phase Jitter	Φ_{jit}	425	CML			fs RMS
			HCSL			
			LVDS			
Phase Jitter	Φ_{jit}	491.52	CML			fs RMS
			HCSL			
			LVDS			
Phase Jitter	Φ_{jit}	500	CML	65	74	fs RMS
			HCSL	64	73	
			LVDS	64	77	
Phase Jitter	Φ_{jit}	614.4	CML			fs RMS
			HCSL			
			LVDS			

Table 9. Phase Jitter at 2.5V (Cont.)

Parameter	Symbol	Test Frequency (MHz)	Output Type	Typical	Maximum	Unit
Phase Jitter	Φ_{jit}	625	CML	50	61	fs RMS
			HCSL	49	61	
			LVDS	49	61	
Phase Jitter	Φ_{jit}	644.53125	CML	49	62	fs RMS
			HCSL	48	62	
			LVDS	49	63	
Phase Jitter	Φ_{jit}	983.04	CML			fs RMS
			HCSL			
			LVDS			
Phase Jitter	Φ_{jit}	1250	CML	49	62	fs RMS
			LVDS	49	61	

Table 10. AC Characteristics at 2.5V

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Output Rise Time [1]	t_R	CML	153	182	216	ps
		HCSL	162	191	231	
		LVDS	135	152	176	
Output Fall Time [1]	t_F	CML	146	197	232	ps
		HCSL	177	208	257	
		LVDS	183	243	313	
Output Duty Cycle [2]	O_{DC}	$F_{OUT} \leq 1000\text{MHz}$	48	50.5	53.5	%
		CML $F_{OUT} > 1000\text{MHz}$	49	52.5	56	

1. All measurements taken with 20% to 80% thresholds at 156.25MHz

2. All measurements taken at the crossing points for differential signals and at $V_{DD}/2$ for LVCMOS outputs.

Table 11. DC Characteristics at 2.5V

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Output High Voltage [1]	V_{OH}	CML	2.4	2.48	2.5	V
		HCSL	730	794	840	
Output Low Voltage [1]	V_{OL}	CML	1.6	1.89	2.1	V
		HCSL	0	8	20	
Output common mode voltage	V_{CMR}	HCSL[2]	0.3	0.4	0.55	V
		LVDS	1.08	1.2	1.32	

Table 11. DC Characteristics at 2.5V (Cont.)

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
TRUE Binary state	$V_{OT}(+)$	LVDS	311	382	464	mV
FALSE binary state	$V_{OT}(-)$	LVDS	307	385	463	
Change in VOT between complementary output states	ΔV_{OT}	LVDS	-	3	21	
Change in VCMR between complementary output states	ΔV_{CMR}	LVDS		27	62	

1. All measurements taken at 156.25MHz
2. For HCSL V_{CMR} is equivalent to V_{CROSS}

Table 12. Current Consumption at 2.5V

Parameter	Symbol	Output Type	Conditions	Typical	Maximum	Unit
Current Consumption	I_{DD}	CML	$F_{OUT} = 156.25\text{MHz}$	94	102	mA
			$F_{OUT} = 1250\text{MHz}$	105	113	
		HCSL	$F_{OUT} = 156.25\text{MHz}$	113	120	mA
			$F_{OUT} = 1250\text{MHz}$	122	129	
		LVDS	$F_{OUT} = 156.25\text{MHz}$	97	105	mA
			$F_{OUT} = 1250\text{MHz}$	109	117	

2.5.4 3.3V Specifications

$V_{DD} = 3.3\text{V} \pm 5\%$, 12kHz to 20MHz integration range.

Table 13. Phase Jitter at 3.3V

Parameter	Symbol	Test Frequency (MHz)	Output Type	Typical	Maximum	Unit
Phase Jitter	Φ_{jit}	100	CML	78	96	fs RMS
			HCSL	75	89	
			LVPECL	87	105	
			LVDS	76	90	
Phase Jitter	Φ_{jit}	106.25	CML			fs RMS
			HCSL			
			LVPECL			
			LVDS			
Phase Jitter	Φ_{jit}	122.88	CML			fs RMS
			HCSL			
			LVPECL			
			LVDS			

Table 13. Phase Jitter at 3.3V (Cont.)

Parameter	Symbol	Test Frequency (MHz)	Output Type	Typical	Maximum	Unit
Phase Jitter	Φ_{jit}	125	CML	72	85	fs RMS
			HCSL	68	87	
			LVPECL	71	90	
			LVDS	69	86	
Phase Jitter	Φ_{jit}	153.6	CML			fs RMS
			HCSL			
			LVPECL			
			LVDS			
Phase Jitter	Φ_{jit}	156.25	CML	55	66	fs RMS
			HCSL	54	65	
			LVDS	57	67	
			LVPECL	54	64	
Phase Jitter	Φ_{jit}	161.132813	CML	54	68	fs RMS
			HCSL	52	66	
			LVDS	54	68	
			LVPECL	52	64	
Phase Jitter	Φ_{jit}	212.5	CML	50	61	fs RMS
			HCSL	50	61	
			LVPECL	50	61	
			LVDS	49	60	
Phase Jitter	Φ_{jit}	250	CML	63	74	fs RMS
			HCSL	63	71	
			LVPECL	66	78	
			LVDS	62	75	
Phase Jitter	Φ_{jit}	307.2	CML	54	64	fs RMS
			HCSL	57	66	
			LVPECL	54	64	
			LVDS	52	62	
Phase Jitter	Φ_{jit}	312.5	CML	52	62	fs RMS
			HCSL	51	61	
			LVDS	52	62	
			LVPECL	51	61	
Phase Jitter	Φ_{jit}	322.265625	CML	52	69	fs RMS
			HCSL	51	66	
			LVDS	54	67	
			LVPECL	51	64	

Table 13. Phase Jitter at 3.3V (Cont.)

Parameter	Symbol	Test Frequency (MHz)	Output Type	Typical	Maximum	Unit
Phase Jitter	Φ_{jit}	425	CML	49	60	fs RMS
			HCSL	49	60	
			LVPECL	55	65	
			LVDS	54	64	
Phase Jitter	Φ_{jit}	491.52	CML	57	66	fs RMS
			HCSL	54	64	
			LVPECL	52	62	
			LVDS	51	61	
Phase Jitter	Φ_{jit}	500	CML	66	78	fs RMS
			HCSL	64	74	
			LVPECL	65	78	
			LVDS	64	72	
Phase Jitter	Φ_{jit}	614.4	CML	50	61	fs RMS
			HCSL	49	60	
			LVPECL	50	61	
			LVDS	49	60	
Phase Jitter	Φ_{jit}	625	CML	50	61	fs RMS
			HCSL	50	61	
			LVDS	50	61	
			LVPECL	49	60	
Phase Jitter	Φ_{jit}	644.53125	CML	49	67	fs RMS
			HCSL	49	65	
			LVDS	50	66	
			LVPECL	49	63	
Phase Jitter	Φ_{jit}	983.04	CML	51	61	fs RMS
			HCSL	50	61	
			LVPECL	50	61	
			LVDS	50	61	
Phase Jitter	Φ_{jit}	1250	CML	50	62	fs RMS
			LVDS	49	61	
			LVPECL	49	61	

Table 14. AC Characteristics at 3.3V

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Output Rise Time [1]	t_R	CML	144	180	216	ps
		HCSL	162	190	228	
		LVDS	136	152	169	
		LVPECL	147	170	221	
Output Fall Time [1]	t_F	CML	138	190	233	ps
		HCSL	175	204	238	
		LVDS	175	216	259	
		LVPECL	164	200	251	
Output Duty Cycle [2]	O_{DC}	$F_{OUT} \leq 1000\text{MHz}$	49	51	53	%
		$F_{OUT} > 1000\text{MHz}$	51	53	56	

1. All measurements taken with 20% to 80% thresholds at 156.25MHz.

2. All measurements taken at the crossing points for differential signals and at $V_{DD}/2$ for LVCMOS outputs, if applicable. Applies to all output configurations.

Table 15. DC Characteristics at 3.3V

Parameter	Symbol	Conditions	Minimum	Typical	Maximum	Unit
Output High Voltage [1]	V_{OH}	CML	3.2	3.28	3.3	V
		HCSL	760	820	875	mV
		LVPECL	2	2.2	2.4	V
Output Low Voltage [1]	V_{OL}	CML	2.4	2.6	2.9	V
		HCSL	0	8	20	mV
		LVPECL	1.6	2.0	2.6	V
Output common mode voltage	V_{CMR}	HCSL [2]	0.33	0.40	0.47	V
		LVDS	1.1	1.2	1.3	
		LVPECL	2.22	2.26	2.3	
TRUE Binary state	$V_{OT} (+)$	LVDS	231	360	490	mV
FALSE binary state	$V_{OT} (-)$		-233	-362	-492	
Change in VOT between complementary output states	ΔV_{OT}		-	1.7	22	
Change in VCMR between complementary output states	ΔV_{CMR}		-	20.2	35	

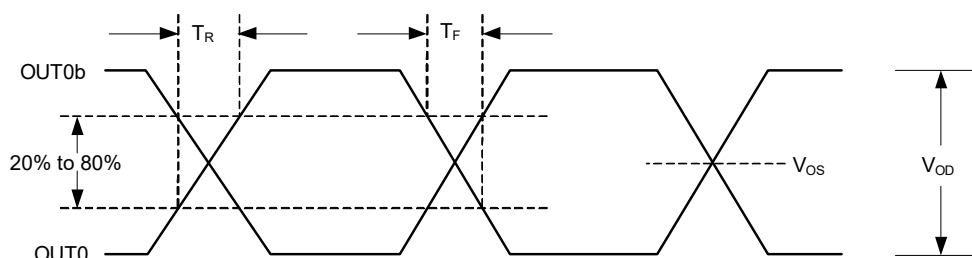
1. All measurements taken at 156.25MHz.

2. For HCSL V_{CMR} is equivalent to V_{CROSS} .

Table 16. Current Consumption at 3.3V

Parameter	Symbol	Output Type	Conditions	Typical	Maximum	Unit
Current Consumption	I_{DD}	CML	$F_{OUT} = 156.25\text{MHz}$	97	104	mA
			$F_{OUT} = 1250\text{MHz}$	110	117	
		HCSL	$F_{OUT} = 156.25\text{MHz}$	113	120	mA
			$F_{OUT} = 1250\text{MHz}$	123	130	
		LVPECL	$F_{OUT} = 156.25\text{MHz}$	113	120	mA
			$F_{OUT} = 1250\text{MHz}$	124	132	
		LVDS	$F_{OUT} = 156.25\text{MHz}$	97	104	mA
			$F_{OUT} = 1250\text{MHz}$	110	117	

Output Levels/Rise Time/Fall Time Measurements



Oscillator Symmetry

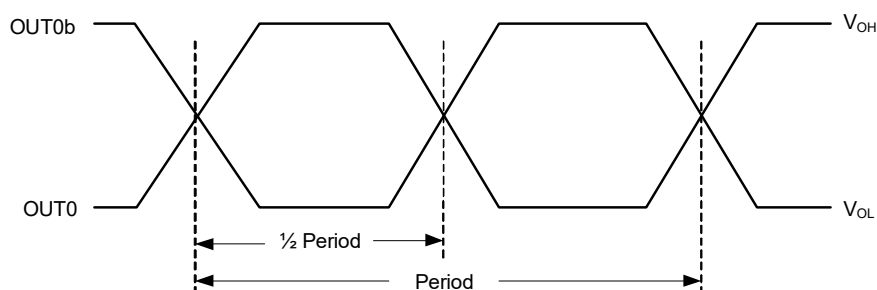


Figure 4. Differential Waveform Measurement Points

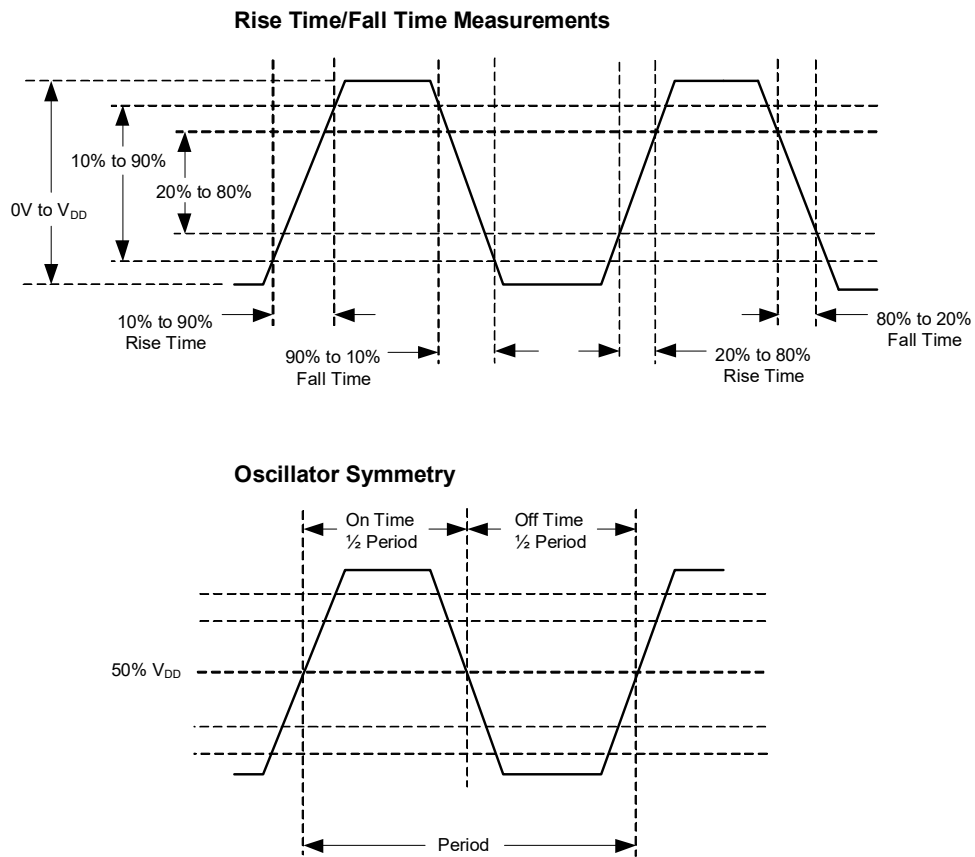


Figure 5. LVCMOS Waveform Measurement Points

3. Typical Performance Graphs

$T_A = +25^\circ\text{C}$, unless otherwise stated.

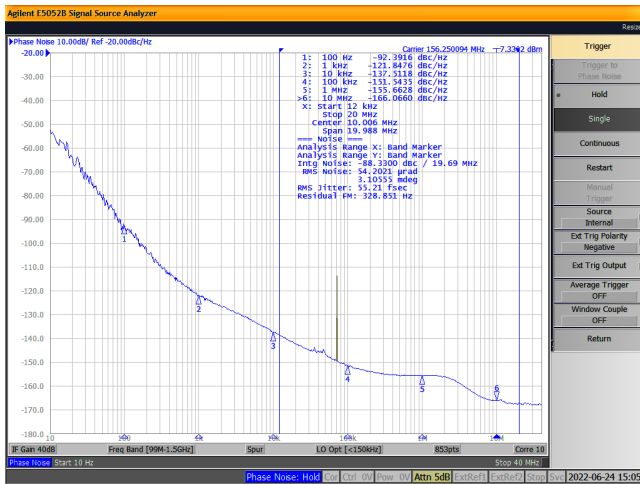


Figure 6. 1.8V LVCMOS, 156.25MHz

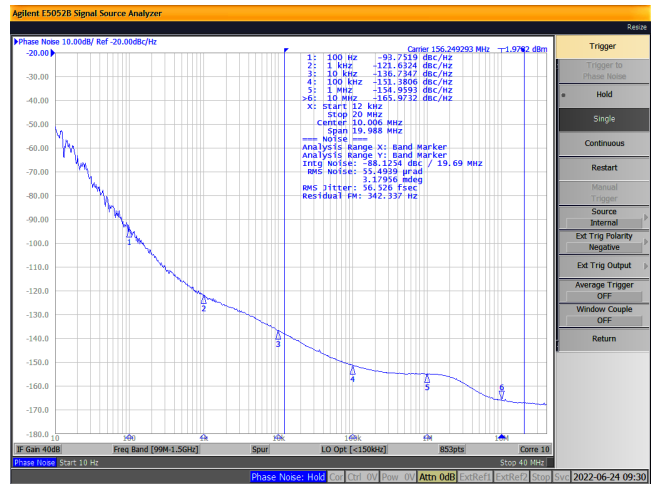


Figure 7. 3.3V HCSL, 156.25MHz

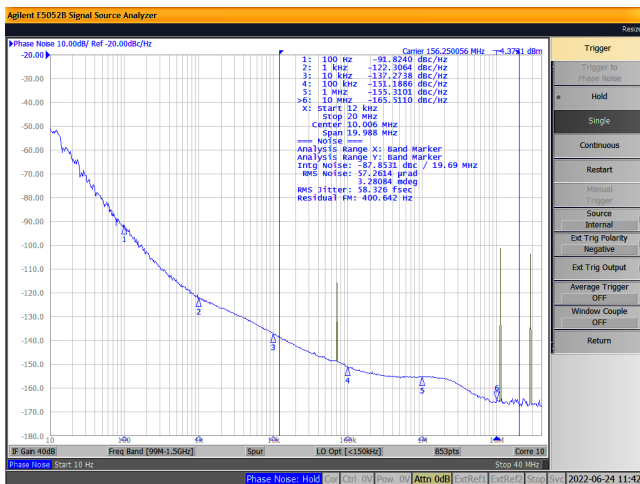


Figure 8. 1.8V LVDS, 156.25MHz

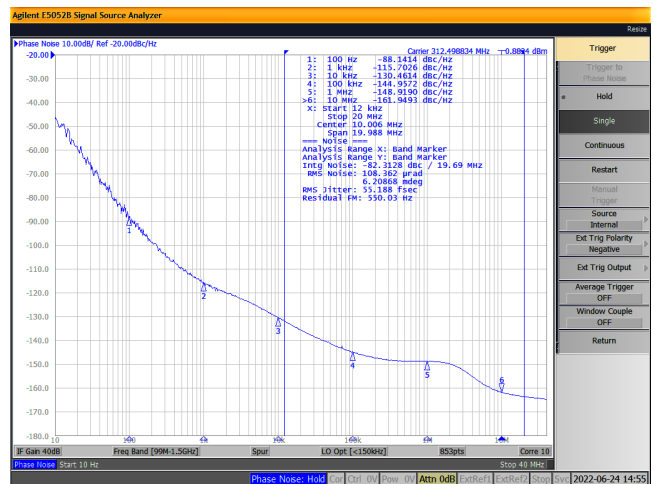


Figure 9. 3.3V LVPECL, 312.5MHz

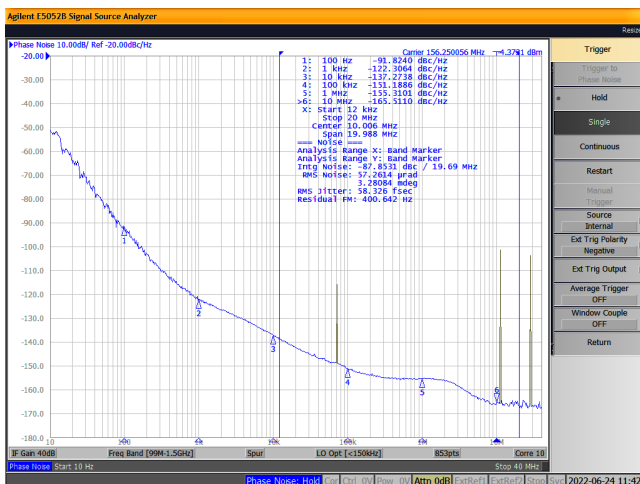


Figure 10. 1.8V HCSL, 156.25MHz

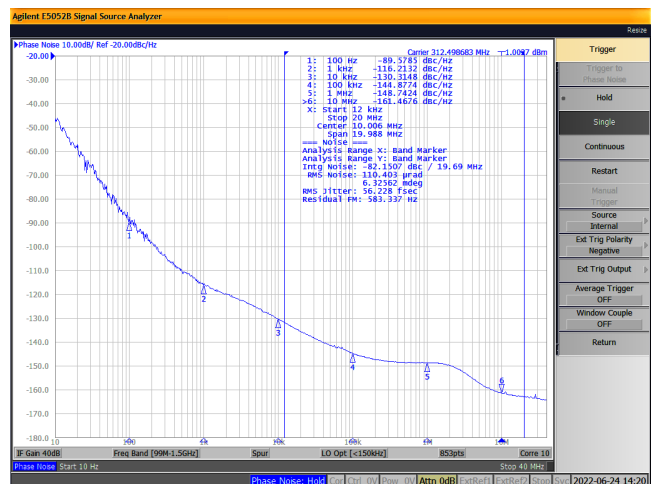


Figure 11. 3.3V CML, 312.5MHz

4. Applications Information

The following figures illustrate the termination schemes that are referenced in the “Output Test Loads” section of [Figure 4](#). There are also numerous other terminations possible, depending on the application requirements.

Other termination schemes can be found in application note, [Quick Guide - Application Terminations](#).

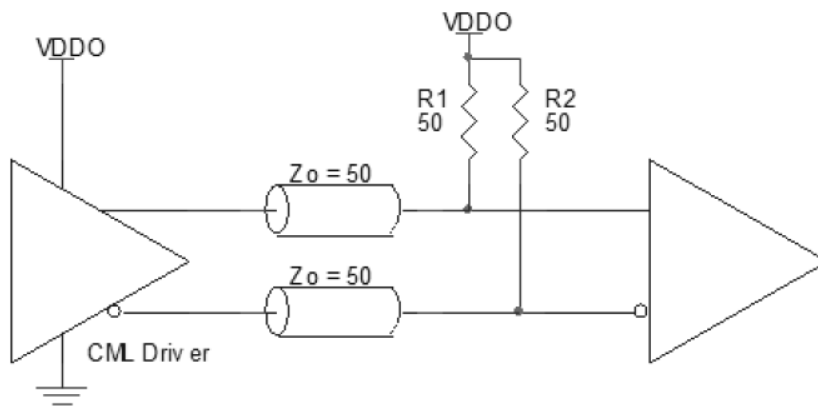


Figure 12. CML Output Termination

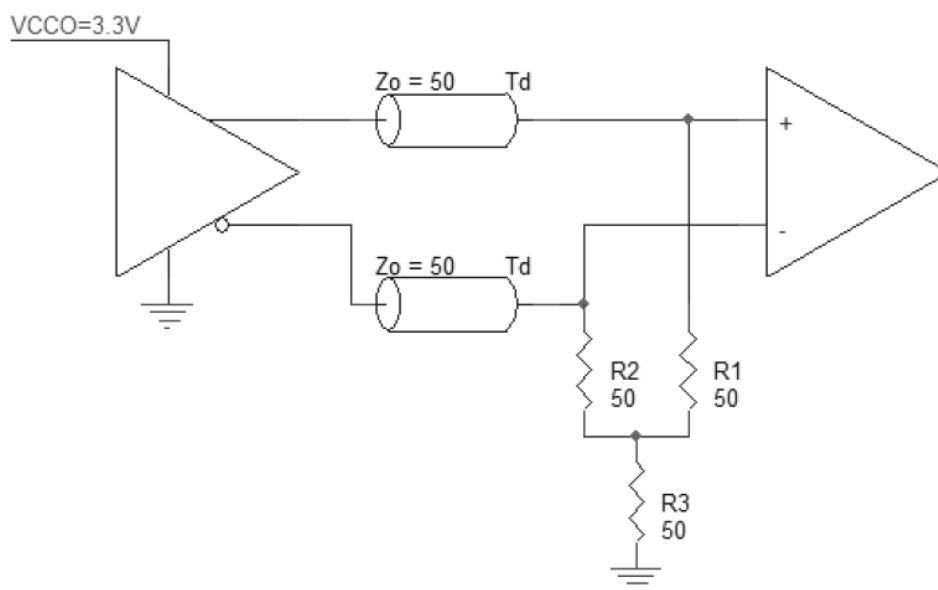


Figure 13. 3.3V LVPECL Output Termination

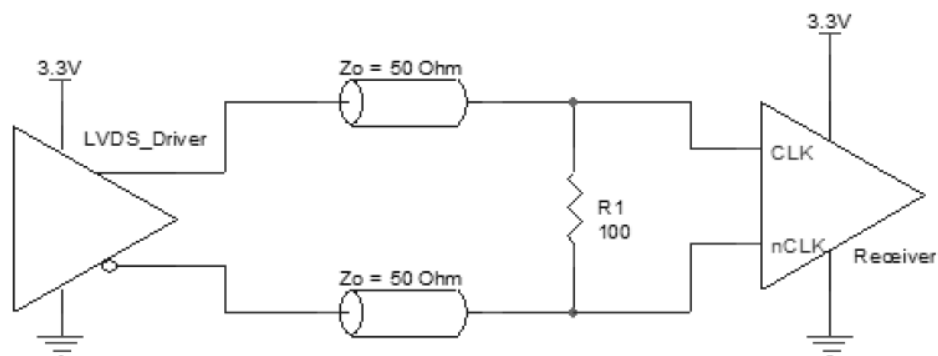


Figure 14. LVDS Output Termination [1]

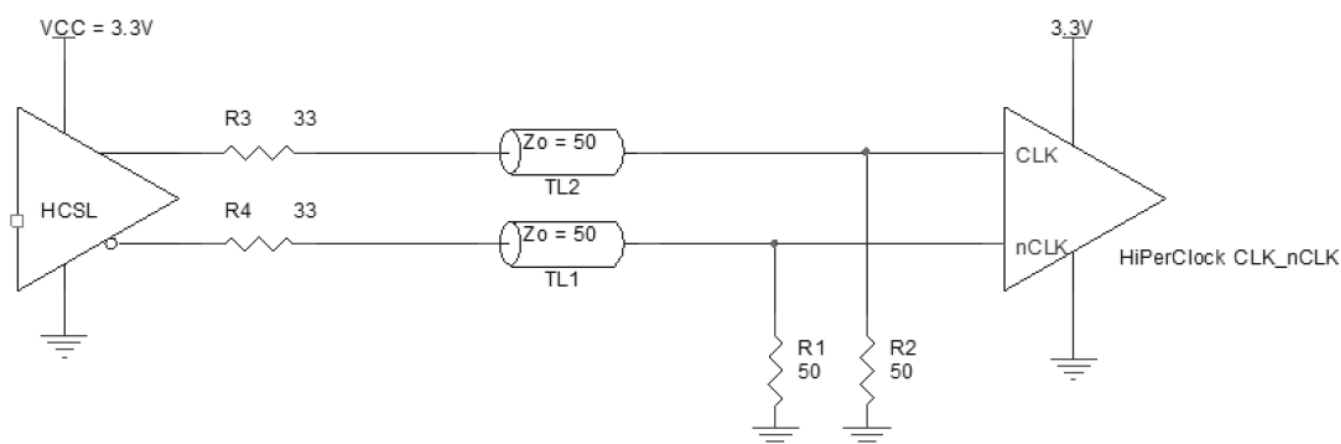


Figure 15. HCSL Output Termination [2]

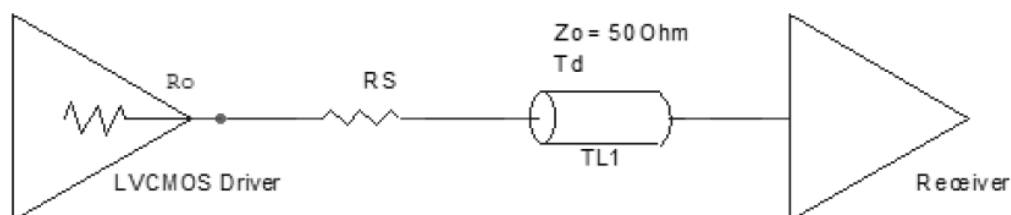


Figure 16. LVCMOS Output Termination

The LVCMOS output impedance R_o is 28 ohms. $R_o + R_s$ should equal Z_o . For $Z_o = 50$ ohms, $R_s = 22$ ohms.

1. 3.3V is shown in Figure 14, but this drawing applies to both 2.5V and 1.8V applications.
2. 3.3V is shown in Figure 15, but this drawing applies to both 2.5V and 1.8V applications.

5. Package Outline Drawings

The package outline drawings are located at the end of this document and are accessible from the Renesas website. The package information is the most current data available and is subject to change without revision of this document.

6. Marking Diagram

The XK devices provide operating voltage, frequency group and date code information in the crystal top mark, which is mounted on the top of the XK oscillator. Customer-specific configuration information is contained in a factory-readable field stored in the part. The XK device may be configured with up to three frequencies from a *single group*. Frequencies from different groups are not allowed in a single device.

	MHz	1.8V	2.5V or 3.3V
Frequency Group 1	50		
	100		
	125		
	250		
	500		
Frequency Group 2	156.25		
	312.5		
	625		
	1250		
Frequency Group 3	161.1328125		
	322.325625		
	644.53125		
Frequency Group 4	122.88, 153.6		
	245.76, 307.2		
	491.52, 614.4		
	983.04		
Frequency Group 5	106.25		
	212.5		
	425		
S X y m PrefixVoltage/ Frequency Group CodeYear CodeMonth Code			

Figure 17. Voltage and Frequency Group Codes and Marking Diagrams

The topside markings consist of four characters as shown in [Figure 17](#). The first character is always the prefix “S.” The second character indicates the operating voltage and the frequency group of the oscillator. The third and fourth character codes year and month) are described in [Table 17](#).

Table 17. Date Codes

Last Digit of Year	Year Code (y)	Month	Month Code (m)
0	A	1	A
1	B	2	B
2	C	3	C
3	D	4	D
4	E	5	E
5	F	6	F
6	G	7	G
7	H	8	H
8	J	9	J
9	K	10	K
-	-	11	L
-	-	12	M

For example, a top mark of “S7DK” would be 1.8V, Frequency Group 2, with a crystal data code of October, 2023. Note that this is the crystal date code and not the silicon date code. The silicon information and customer configuration are stored in the device at the factory.

7. Ordering Information

	Family	Package [1]	Voltage	Config. 1 (FS = low)	Config. 2 (FS = floating)	Config. 3 (FS = high)	Temp. Range
Ordering Code	XK	0 = 1.8 × 1.4 mm [2] 1 = 2.0 × 1.6 mm 2 = 2.5 × 2.0 mm 3 = 3.2 × 2.5 mm	1 = 1.8V ±5% 2 = 2.5V ±5% 3 = 3.3V ±5%	Xfff	Xfff	Xfff	I: -40 to +85°C
Example	XK	3	3	N156	L312	R625	I

1. The Minimum Order Quantity (MOQ) for tape and reel packing is 2500 pieces. Orders less than 2500 pieces, or the portion of orders that are not multiples of 2500 pieces will be packed on cut tape. For example, a 3500 piece order will be packed as 2500 pieces on tape and reel and 1000 pieces on cut tape.

2. Footprint compatible to 1612 package.

The example above gives us the following part number: XK33N156L312R625I. Let us dissect this part number.

We have an XK series XO in a 3225 package running from 3.3V. Three configurations are specified:

- Configuration 1 is a 156.25MHz LVPECL output, with an Active High OE on pin 1.
- Configuration 2 is a 312.5MHz LVDS output with an Active High OE on pin 1.
- Configuration 3 is a 625MHz HCSL output with an Active High OE on pin 1.

The configuration codes are described in Table 18. Note that all configurations in a device must be of the same VDD, OE Pin Polarity, and OE Pin Number assignment. The configurations can consist of different output types and frequencies.

Table 18. Output Configuration Code (X)

Output Type	OE Pin Polarity	OE Pin Number	Code (X)
CML	Active Low	1	D
		2	K
	Active High	1	P
		2	Q
HCSL	Active Low	1	E
		2	T
	Active High	1	R
		2	S
LVCMOS[1]	Active Low	1	A
		2	F
	Active High	1	H
		2	J
LVDS	Active Low	1	B
		2	G
	Active High	1	L
		2	M

Table 18. Output Configuration Code (X) (Cont.)

Output Type	OE Pin Polarity	OE Pin Number	Code (X)
LVPECL ^[2]	Active Low	1	C
		2	I
	Active High	1	N
		2	O

1. VDD must be 1.8 Volts (voltage code 1).

2. VDD must be 3.3 Volts (voltage code 3).

The set of available output frequencies are abbreviated into 3 digit codes to create the order-able part number. These abbreviations are defined in Table 19. If only one configuration is specified, the second and third configurations will be configured identically. If two configurations are specified, the third configuration will be configured identically to the configuration with the lowest frequency. Note that available output frequencies are grouped into frequency groups. Refer to Figure 17 for the definition of the frequency groups.

Table 19. Frequency Codes ^[1]

Code (fff)	Frequency (MHz)
050	50
100	100
106	106.25
122	122.88
125	125
153	153.6
156	156.25
161	161.1328125
212	212.5
245	245.76
250	250
307	307.2
312	312.5
322	322.265625
425	425
491	491.25
500	500
614	614.4
625	625
644	644.53125
983	983.04
C50	1250

1. Contact Renesas for availability of specific frequencies not listed in Table 19.

8. Revision History

Revision	Date	Description
1.04	Jun 9, 2023	Corrected marking diagram (Figure 17) with correct Voltage/Frequency Group Codes. Minor updates to text surrounding Table 17 to be consistent with Figure 17.
1.03	May 9, 2023	Updated marking diagram (Figure 17) to include frequency groups. Deleted Frequency Groups table as a result.
1.02	Mar 2, 2023	Added 245.76 MHz to Table 19 and Table 19. Added footnote about shipping quantities and methods to Ordering Information.
1.01	Feb 15, 2023	Added Frequency Group 1 (50/100/125/250/500MHz) data.
1.00	Feb 9, 2023	Initial release.