

# Evaluation of Subsystem Clock Oscillation Circuit

[M30855FWUGP-144P] LQFP(20x20) 0.50mm pitch

Measurement conditions : 5.0V

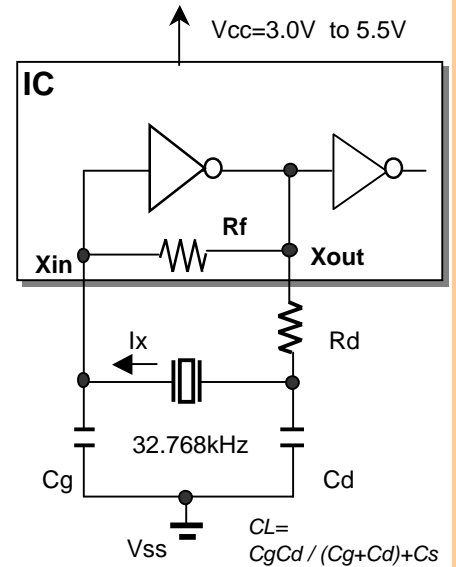
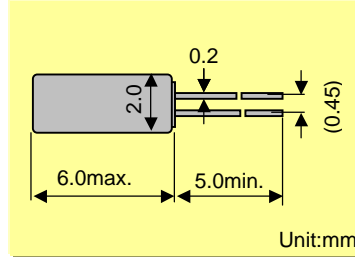


Model	:VT-200
Frequency	:Fo=32.768kHz
Frequency tolerance	:dF/Fo= +/-20x10 <sup>6</sup>
Load capacitance	:CL=12.5pF
Equivalent series resistance	:R1=50kohm max
Max. Drive level	:DL=1x10 <sup>6</sup> W max
Recommended drive level	:DL=0.1x10 <sup>6</sup> W typ

## FEATURES

- 1.Compact tubular package
- 2.Photolithographic process
- 3.Excellent shock resistance and environmental characteristics.
- 4.Real time clocks, Timers, Portable applications

## DIMENSIONS(VT-200)



Remark)  $I_x$  : current through crystal

MODEL:VT-200 12.5pF with M30855FWUGP at Vcc=5.0V,25°C

Key specifications	Low	High	Remarks
Current control resistance : Rd ( k ohm )	0	0	Control drive level & secure phase margin
Capacitance at gate : Cg ( pF )	9	15	Optimal capacity in response to CL
Capacitance at drain : Cd ( pF )	9	15	( CL = Cd // Cg + stray capacitance )

Circuit characteristics ( at 25°C )	Low	High	Remarks
Matching Accuracy : $df / f$ ( $\times 10^{-6}$ )	0.3	-0.1	Frequency offset volume at specified Vdd
Voltage Fluctuation : $\pm df / V$ ( $\times 10^{-6}$ )	0.0	0.0	Vdd $\pm 10\%$ ( Standard operating voltage range )
Drive Level : DL ( $\times 10^{-6}$ W )	0.07	0.08	$DL = I_x^2 R_e < 1 \times 10^{-6}$ W, $R_e = R_1(1 + C_o / CL)^2$
Negative resistance : $ -RL $ ( kohm )	254	784	5 times larger than $R_{1MAX}$
Oscillation allowance : M ( times )	5.1	15.7	Judgemental standard of oscillation stability
Oscillation start up time : Ts ( sec )	-	0.52	Time to reach 90% of output level

Temperature characteristics of circuit		Low	High	Remarks
at -40°C	Variation : $df / T$ ( $\times 10^{-6}$ )	-142	-142	Typ.Tp=25°C ( K = $-3.5 \times 10^{-8} / ^\circ\text{C}^2$ )
at +85°C	Variation : $df / T$ ( $\times 10^{-6}$ )	-129	-129	Typ.Tp=25°C ( K = $-3.5 \times 10^{-8} / ^\circ\text{C}^2$ )

The mention value is only for your reference. The value is for the arbitrary samples and does not guarantee the product's characteristics. Please review and check above parameters at customer's end.

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We value the "takumi" spirit.

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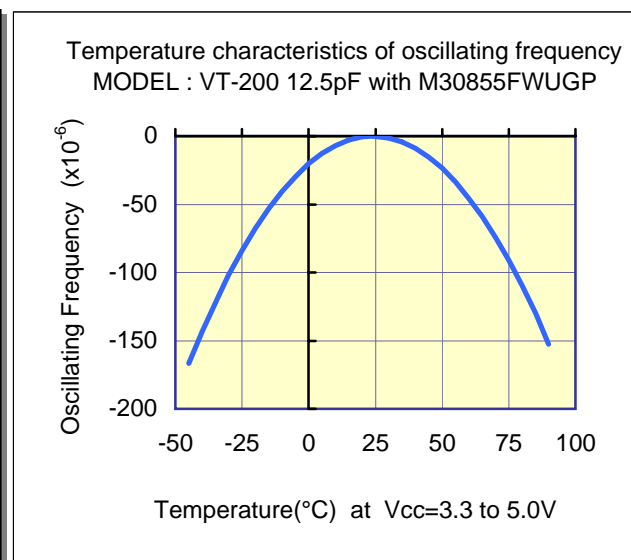
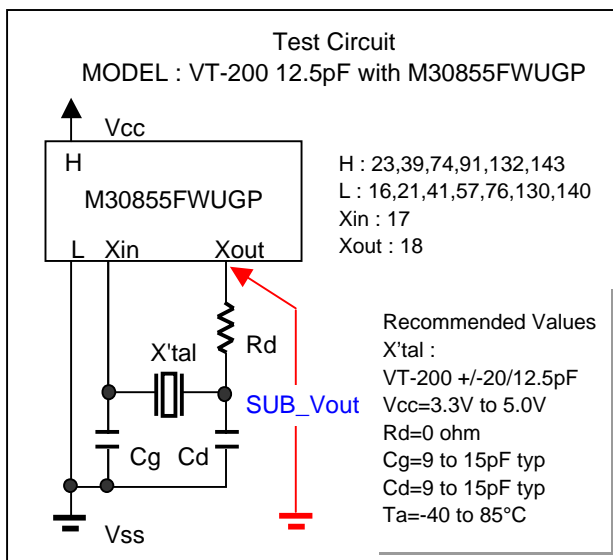
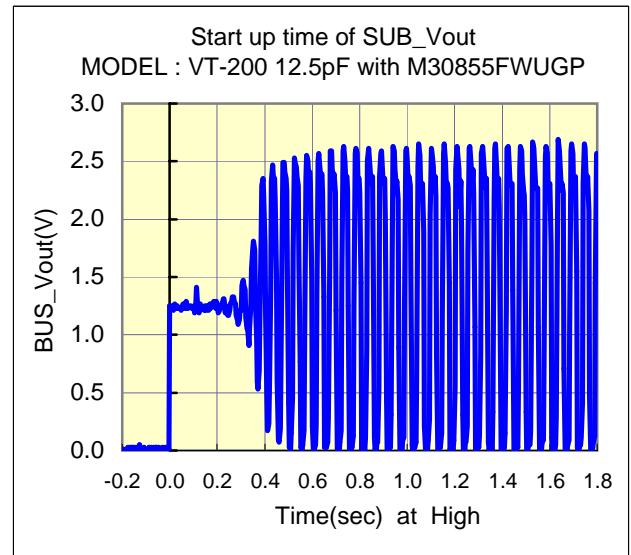
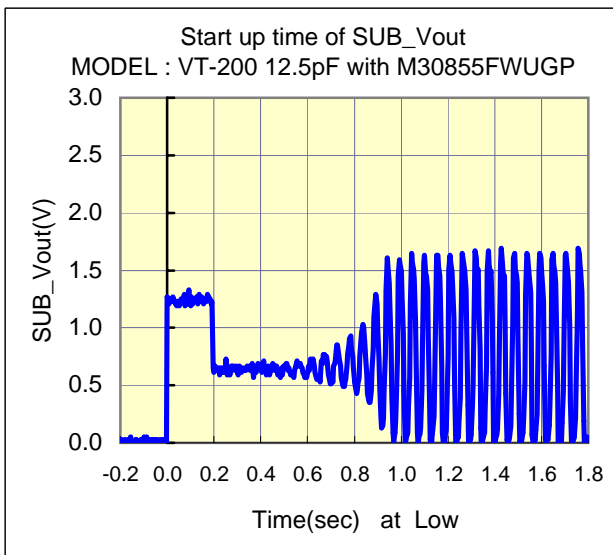
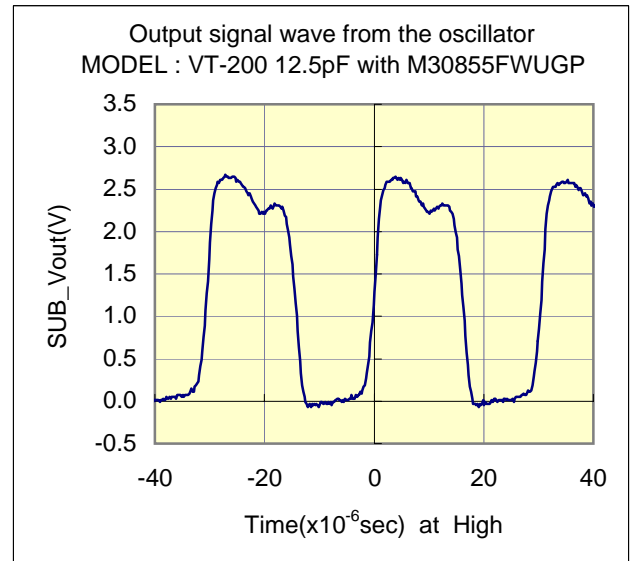
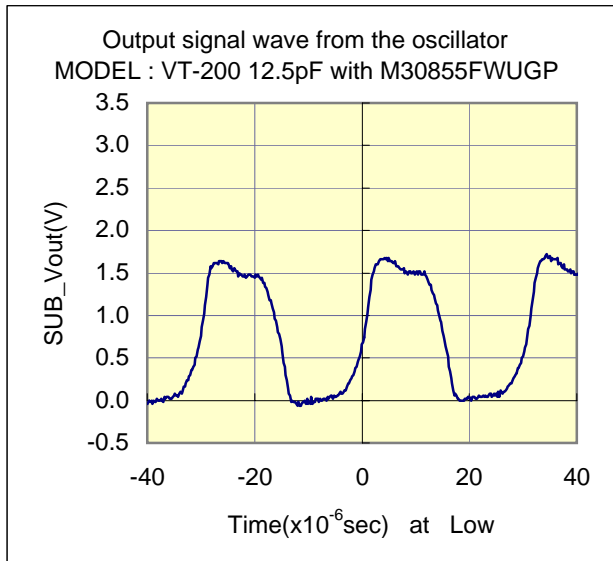
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## Test Data at Vcc=3.3V to 5.0V, 25°C



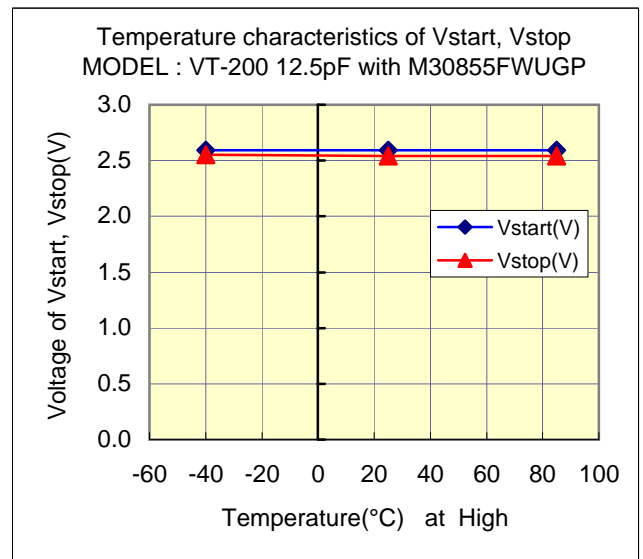
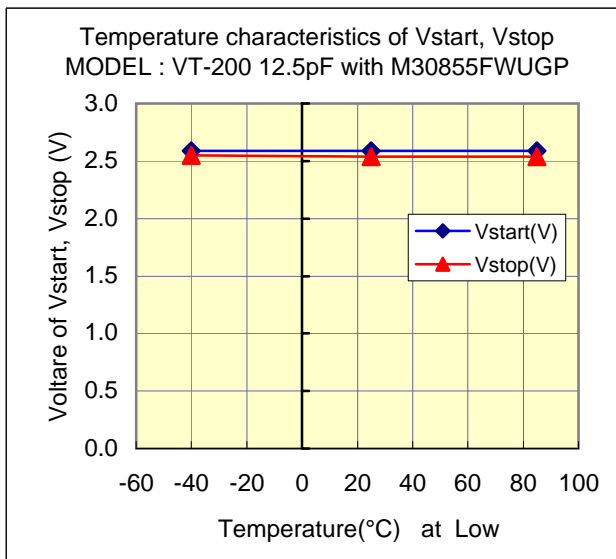
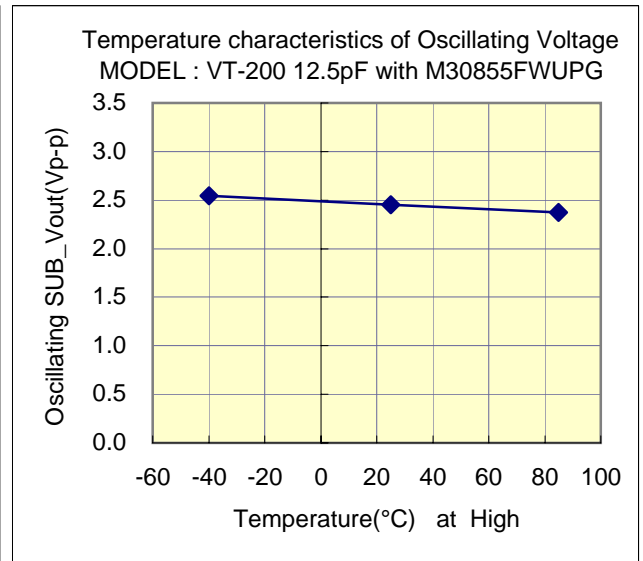
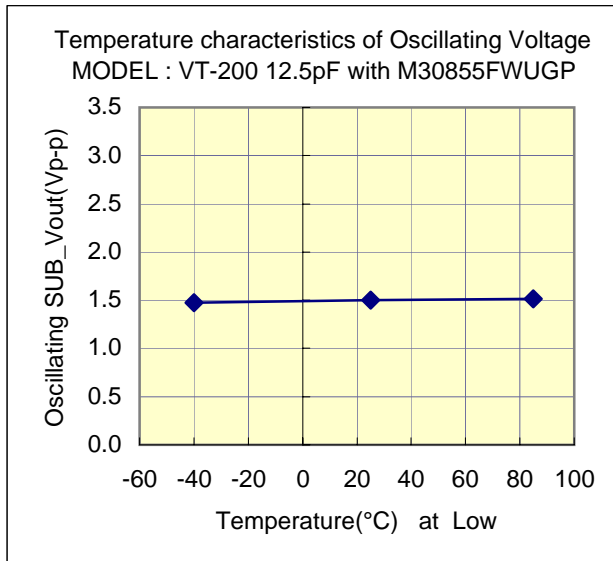
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Test Data : Temperature characteristics at Vcc=3.3V to 5.0V



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## Referencial components layout(see Figure 1)

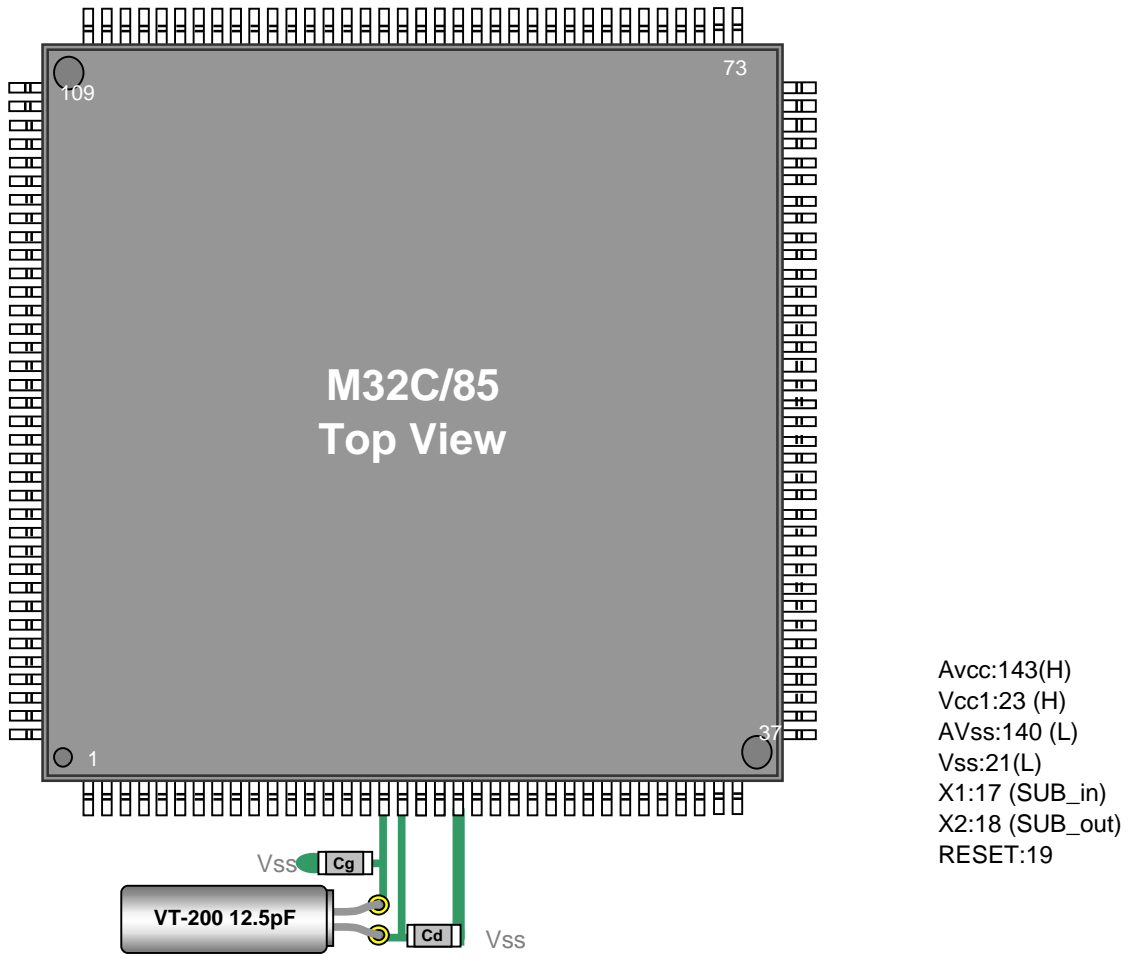


Figure 1 Referencial components layout

## Notes Board Design

When using a crystal resonator, place the resonator and its load capacitors as close as possible to SUB\_in and SUB\_out pins.

Other signal lines should be routed away from the resonator circuit to prevent induction from interfering with correct oscillation (see figure 2).

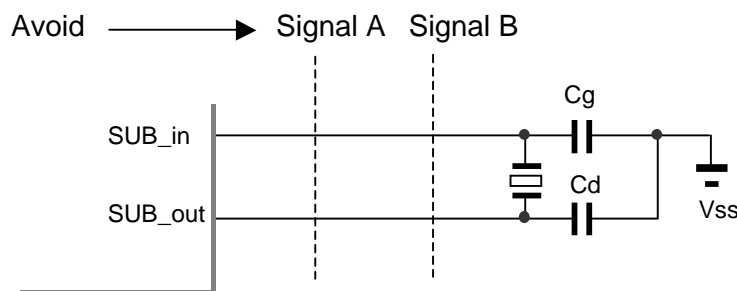


Figure 2 Example of Incorrect Board Design

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## [Evaluation Sample : VT-200 12.5pF at 25°C]

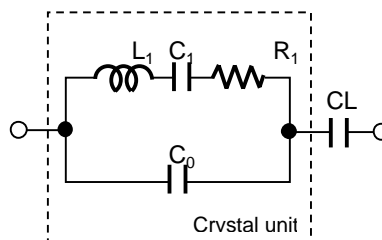
SAMPLE	No.	CL( pF )	Fo( Hz )	fr( Hz )	R1( kohm )	Co( pF )	C1( fF )	Q( k )
VT-200 12.5pF	1	12.5	32768.11	32765.28	27.4	0.91	2.319	76.5
	2	12.5	32768.09	32765.24	26.9	0.89	2.333	77.4
	3	12.5	32768.34	32765.45	29.9	0.93	2.368	68.6

## [IC Test Data : IC samples Rd=0 ohm,Cg=Cd=15pF(High),Cg=Cd=9pF(Low) at 25°C]

Mode	IC samples	Fosc( Hz )	df / f( x10 <sup>-6</sup> )	DL(x10 <sup>-6</sup> W)	-RL  ( kohm )	Vstart( V )	Ts(sec)
High	TYP	32768.34	-0.07	0.08	784	2.59	0.52
	HHD	32768.40	1.86	0.07	1034	2.58	0.47
	LLD	32768.38	1.25	0.08	784	2.58	0.52
Low	TYP	32768.35	0.30	0.07	254	2.59	-
	HHD	32768.40	1.86	0.08	254	2.58	-
	LLD	32768.28	-1.68	0.07	334	2.58	-

### Remak ( see figure 3 )

$$F_o = f_r \times \left\{ \frac{C_1}{2 \times (C_o + C_L) + 1} \right\} \text{ ( Hz )}$$



$F_o$  : Load resonance frequency  
 $f_r$  : Resonance frequency  
 $R_1$  : Motional resistance  
 $C_1$  : Motional capacitance  
 $C_o$  : Shunt capacitance  
 $C_L$  : Load Capacitance

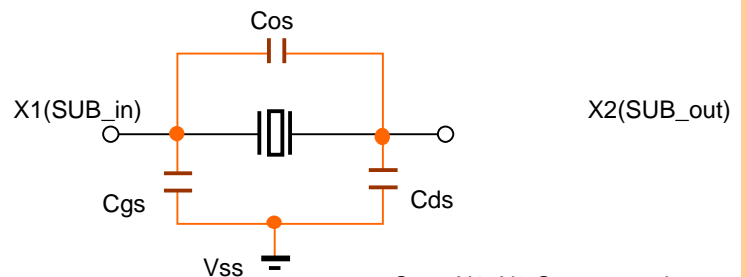
Figure 3 Equivalent circuit of crystal unit, and CL

### Remak ( see figure 4 )

Approximate formula of the load capacitance of the circuit CL.

$$C_L = \frac{C_g \times C_d}{C_g + C_d} + C_s \text{ ( pF )}$$

Where  $C_s$  Stands for stray capacity of the circuit.



$C_{os}$  : X1\_X2 Stray capacitance  
 $C_{gs}$  : X1\_Vss Stray capacitance  
 $C_{ds}$  : X2\_Vss Stray capacitance

Figure 4 Stray capacitance  $C_{os}, C_{gs}, C_{ds}$  of the circuit

Resonator circuit constants will differ depending on the resonator element, stray capacitance in its interconnecting circuit, and other factors. Suitable constants should be determined in consultation with the resonator element manufacturer.