

NIPPON PRECISION CIRCUITS INC

SM5005A series

Crystal Oscillator Module ICs

OVERVIEW

The SM5005A series are crystal oscillator module ICs, that incorporate high-frequency, low current consumption oscillator and output buffer circuits. Highly accurate thin-film feedback resistors and high-frequency capacitors are built-in, eliminating the need for external components to make a stable 3rd-harmonic oscillator.

FEATURES

- High-frequency operation
- 3rd-harmonic oscillation
- lacksquare Capacitors C_G , C_D built-in
- Standby function (oscillator stops)
- Power-save pull-up resistor built-in
- Inverter amplifier feedback resistor built-in
- CMOS input level

- 8 mA (V_{DD} = 2.7 V) drive capability
- CMOS output duty level
- Output three-state function
- 2.25 to 3.6 V supply voltage
- Oscillator frequency output
- 8-pin VSOP (SM5005A××V)
- Chip form (CF5005A××)

SERIES CONFIGURATION

| Version ¹ | Recommended operating frequency [MHz] | | gm ratio Output duty | | Output | Built-in capa | acitance [pF] | D [kO] |
|-------------------------|---------------------------------------|-----------------------------------|----------------------|--------------------|--------|----------------|----------------|---------------------|
| Version | V _{DD} = 2.25 to 2.75 V | V _{DD} = 2.7 to 3.6 V | giirratio | level current [mA] | | C _G | C _D | R _f [kΩ] |
| SM5005ALAV | 60 to 70 | 70 to 100 | 1.0 | CMOS | 8 | 8 | 10 | 2.2 |
| SM5005ALBV | - | 90 to 110 | 1.5 | CMOS | 8 | 6 | 6 | 3.3 |
| SM5005ALCV ² | - | 107 to 125 | 1.5 | CMOS | 8 | 3 | 3 | 3.3 |
| CF5005ALD ³ | 45 to 60 | 60 to 80 | 1.0 | CMOS | 8 | 8 | 10 | 3.5 |
| CF5005ALE ³ | 30 to 45 | 40 to 60 | 1.0 | CMOS | 8 | 8 | 15 | 5.6 |

^{1.} Chip form devices have designation CF5005A $\times\!\!\times$

ORDERING INFORMATION

| Device | Package |
|--------------|------------|
| SM5005A××V | 8-pin VSOP |
| CF5005A×× -1 | Chip form |

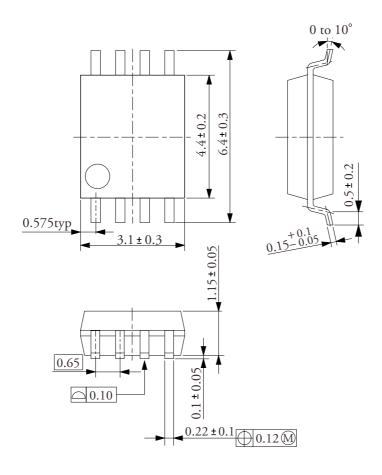
^{2.} Based on Preliminary Constants Data from Crystal MFG.

^{3.} Chip form only.

PACKAGE DIMENSIONS

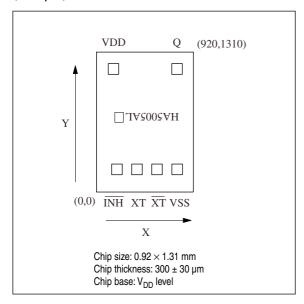
(Unit:mm)

• 8-pin VSOP



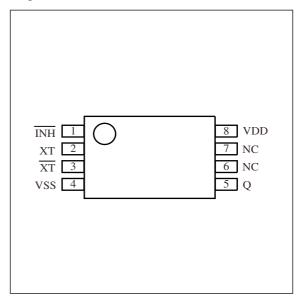
PAD LAYOUT

$(Unit: \mu m)$



PINOUT

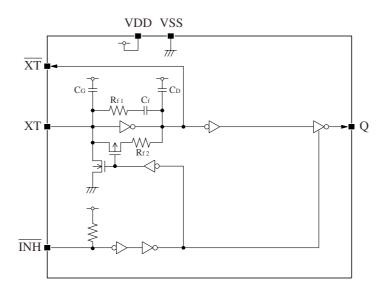
(Top View)



PIN DESCRIPTION and PAD DIMENSIONS

| Number | Name | I/O | Description | | | Description | | Pad dimen | sions [µm] |
|----------|------|-----|---|---|-----|-------------|--|-----------|------------|
| Nulliber | Name | 1/0 | | Description | | Y | | | |
| 1 | ĪNH | I | Output state control in resistor built in | Output state control input. Oscillator stopped when LOW. Power-saving pull-up resistor built in | | 212 | | | |
| 2 | XT | I | Amplifier input. | Crystal oscillator connection pins. | 385 | 212 | | | |
| 3 | ΧT | 0 | Amplifier output. | Crystal oscillator connected between XT and XT | 575 | 212 | | | |
| 4 | VSS | - | Ground | | 766 | 212 | | | |
| 5 | Q | 0 | Output. Output frequer | ncy (f _O) | 765 | 1152 | | | |
| 6 | NC | - | No connection | No connection | | - | | | |
| 7 | NC | - | No connection | | - | - | | | |
| 8 | VDD | - | Supply voltage | | 162 | 1152 | | | |

BLOCK DIAGRAM



SPECIFICATIONS

Absolute Maximum Ratings

 $V_{SS} = 0 V$

| Parameter | Symbol | Condition | Rating | Unit |
|-----------------------------|------------------|------------|-------------------------------|------|
| Supply voltage range | V _{DD} | | -0.5 to 7.0 | V |
| Input voltage range | V _{IN} | | -0.5 to V _{DD} + 0.5 | |
| Output voltage range | V _{OUT} | | -0.5 to V _{DD} + 0.5 | V |
| Operating temperature range | T _{opr} | | -40 to 85 | °C |
| Storage temperature range | т | Chip form | -65 to 150 | °C |
| Storage temperature range | T _{stg} | 8-pin VSOP | -40 to 125 | |
| Output current | l _{out} | | 25 | mA |
| Power dissipation | P _D | 8-pin VSOP | 300 | mW |

Recommended Operating Conditions

CF5005AL×

 $V_{SS} = 0 \text{ V}, \text{ f} \le 125 \text{MHz}$ unless otherwise noted.

| Parameter | Symbol | Condition | | Unit | | |
|-----------------------|------------------|-----------------------|-----------------|------|-----------------|-------|
| raidilietei | Symbol | Condition | min | typ | max | Oilit |
| O. and the second | V _{DD} | C _L ≤ 15pF | 2.7 | - | 3.6 | V |
| Supply voltage | | C _L ≤ 30pF | 3.0 | - | 3.6 |] |
| Input voltage | V _{IN} | | V _{SS} | - | V _{DD} | V |
| Operating temperature | T _{OPR} | | -20 | - | 80 | °C |

CF5005ALA/CF5005ALD/CF5005ALE

 $V_{SS} = 0 \text{ V}, f \le 70 \text{MHz}$ unless otherwise noted.

| Parameter | Symbol Condition — | | | Unit | | |
|-----------------------|--------------------|-----------------------|-----------------|------|-----------------|------|
| raiametei | Syllibol | Condition | min | typ | max | Oill |
| Supply voltage | V _{DD} | C _L ≤ 30pF | 2.25 | - | 2.75 | V |
| Input voltage | V _{IN} | | V _{SS} | - | V _{DD} | V |
| Operating temperature | T _{OPR} | | -20 | - | 80 | °C |

SM5005AL×V

 $V_{SS} = 0 \text{ V}, f \le 125 \text{MHz}$ unless otherwise noted.

| Parameter | Symbol | Condition | | Unit | | |
|-----------------------|------------------|-----------------------|-----------------|------|-----------------|-------|
| Parameter | Symbol | Condition | | typ | max | Offic |
| Supply voltage | V _{DD} | C _L ≤ 15pF | 2.7 | - | 3.6 | V |
| Input voltage | V _{IN} | | V _{SS} | - | V _{DD} | ٧ |
| Operating temperature | T _{OPR} | | -20 | - | 80 | °C |

SM5005A series

Electrical Characteristics

 $V_{\rm DD}$ = 2.7 to 3.6 V, $V_{\rm SS}$ = 0 V, Ta = -20 to 80 °C unless otherwise noted.

| D | O b l | Condition | | | | Rating | | 1114 |
|---------------------------|------------------|--|---|---|--------------------|--------|--------------------|------|
| Parameter | Symbol | | | | min | typ | max | Unit |
| HIGH-level output voltage | V _{OH} | Q: Measurement cct 1 | 1, V _{DD} = 2.7 V, I _{OH} = 8 | mA | 2.2 | 2.4 | - | ٧ |
| LOW-level output voltage | V _{OL} | Q: Measurement cct 2 | 2, V _{DD} = 2.7 V, I _{OL} = 8 i | mA | - | 0.3 | 0.4 | ٧ |
| Output leakage current | 1 | Q: Measurement cct 2 | 2, INH = LOW, | $V_{OH} = V_{DD}$ | - | - | 10 | |
| Output leakage current | l _Z | V _{DD} = 3.6 V | | V _{OL} = V _{SS} | - | _ | 10 | μA |
| HIGH-level input voltage | V _{IH} | ĪNH | | | 0.7V _{DD} | ı | - | V |
| LOW-level input voltage | V _{IL} | ĪNH | | _ | - | - | 0.3V _{DD} | ٧ |
| | | INH = open, | C _L = 30 pF | CF5005AL× | _ | 40 | 100 | |
| Current consumption | I _{DD} | Measurement cct 3, load cct 1, V _{DD} = 3.0 V to 3.6 V f = 125 MHz | C _L = 15 pF | SM5005AL×V CF5005AL× | - | 25 | 60 | mA |
| Standby current | I _{ST} | INH = LOW, Measure | ment cct 3 | • | - | - | 10 | μA |
| INH pull-up resistance | R _{UP1} | Measurement cct 4, II | NH = LOW | | 0.4 | _ | 4 | MΩ |
| INFI pull-up resistance | R _{UP2} | Measurement cct 4, II | NH = 0.7 V _{DD} | | 50 | _ | 150 | kΩ |
| | | | | SM5005ALAV CF5005ALA | 1.76 | 2.2 | 2.64 | |
| | I B., I | Design value, determined by the internal wafer pattern | inad by the internal | SM5005ALBV CF5005ALB | 2.64 | 3.3 | 3.96 | |
| AC feedback resistance | | | med by the internal | SM5005ALCV CF5005ALC | 2.64 | 3.3 | 3.96 | kΩ |
| | | | | CF5005ALD | 2.80 | 3.5 | 4.20 | |
| | | | | CF5005ALE | 4.48 | 5.6 | 6.72 | |
| DC feedback resistance | R _{f2} | Measurement cct 5 | | • | 50 | - | 150 | kΩ |
| AC feedback capacitance | C _f | Design value, determ | ined by the internal wa | fer pattern | 9.3 | 10 | 10.7 | pF |
| | | Design value, determ | ined by the internal | SM5005ALAV CF5005ALA CF5005ALD CF5005ALE | 7.44 | 8 | 8.56 | |
| | C _G | wafer pattern | med by the internal | SM5005ALBV CF5005ALB | 5.58 | 6 | 6.42 | pF |
| | | | | SM5005ALCV CF5005ALC | 2.79 | 3 | 3.21 | |
| Built-in capacitance | | | | SM5005ALAV CF5005ALA CF5005ALD | 9.3 | 10 | 10.7 | |
| | C _D | Design value, determi wafer pattern | ined by the internal | SM5005ALBV CF5005ALB | 5.58 | 6 | 6.42 | pF |
| | | | | SM5005ALCV CF5005ALC | 2.79 | 3 | 3.21 | |
| | | | | CF5005ALE | 13.95 | 15 | 16.05 | |

Switching Characteristics

3V operation

 $V_{SS} = 0$ V, Ta = -20 to 80 °C unless otherwise noted.

| Parameter | Symbol | | Condition | | | Rating | | Unit |
|--|------------------|--|--|-------------------------|----|--------|-----|-------|
| Farameter | Syllibol | | Condition | | | | max | Ullit |
| Output rice time | t _{r1} | Measurement cct 3, | C _L = 15 pF, V _{DD} = 2.7V to 3.6V | SM5005AL×V CF5005AL× | - | 1 | 3 | no |
| Output rise time | t _{r2} | load cct 1, 0.1V _{DD} to 0.9V _{DD} | C _L = 30 pF, V _{DD} = 3.0V to 3.6V | CF5005AL× | - | 1.5 | 4 | ns |
| Output fall time | t _{f1} | Measurement cct 3, | C _L = 15 pF, V _{DD} = 2.7V to 3.6V | SM5005AL×V CF5005AL× | - | 1 | 3 | |
| Output fall time | t _{f2} | load cct 1, 0.9V _{DD} to 0.1V _{DD} | C _L = 30 pF, V _{DD} = 3.0V to 3.6V | CF5005AL× | - | 1.5 | 4 | ns |
| | | Measurement cct 3, | C _L = 30 pF, f ≤ 125 MHz | CF5005AL× | 45 | _ | 55 | |
| Output duty cycle ¹ | Duty | load cot 1 C. – 15 pF | 45 | _ | 55 | % | | |
| | | | 1 - 1 - | SIVIOUOALXV | 40 | - | 60 | |
| Output disable delay time ² | t _{PLZ} | Measurement cct 6, Ta = 25 °C, V_{DD} = 2.7 V, $C_L \le$ 15 pF | | | - | - | 100 | ns |
| Output enable delay time ² | t _{PZL} | Measurement cct 6, Ta | $a = 25 ^{\circ}\text{C}, \text{V}_{\text{DD}} = 2.7 \text{V}, \text{C}_{\text{L}} \leq$ | 15 pF | - | _ | 100 | ns |

^{1.} Monitored in sample lots.

2.5V operation (CF5005ALA, CF5005ALD, CF5005ALE)

 $V_{SS} = 0$ V, Ta = -20 to 80 °C unless otherwise noted.

| Parameter | Symbol | Condition | | Rating | | | |
|--|------------------|--|-----|--------|-----|------|--|
| Parameter Symbol Condition | | Condition | min | typ | max | Unit | |
| Output rise time | t _{r3} | Measurement cct 3, load cct 1, $0.1V_{DD}$ to $0.9V_{DD}$, $C_L = 30$ pF, $V_{DD} = 2.25V$ to $2.75V$ | - | 2 | 6 | ns | |
| Output fall time | t _{f3} | Measurement cct 3, load cct 1, $0.9V_{DD}$ to $0.1V_{DD}$, $C_L = 30$ pF, $V_{DD} = 2.25V$ to $2.75V$ | - | 2 | 6 | ns | |
| Output duty cycle ¹ | Duty | Measurement cct 3, load cct 1, Ta = 25 °C, V_{DD} = 2.5 V, C_L = 30 pF, f \leq 70 MHz | 40 | - | 60 | % | |
| Output disable delay time ² | t _{PLZ} | Measurement cct 6, Ta = 25 $^{\circ}$ C, V _{DD} = 2.25 V, C _L \leq 15 pF | - | - | 300 | ns | |
| Output enable delay time ² | t _{PZL} | Measurement cct 6, Ta = 25 $^{\circ}$ C, V _{DD} = 2.25 V, C _L \leq 15 pF | - | _ | 300 | ns | |

^{1.} Monitored in sample lots.

^{2.} Oscillator stop function is built-in. When $\overline{\text{INH}}$ goes LOW, normal output stops. When $\overline{\text{INH}}$ goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

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FUNCTIONAL DESCRIPTION

Standby Function

The oscillator stops when $\overline{\text{INH}}$ goes LOW. When the oscillator stops, the oscillator output on Q goes high impedance.

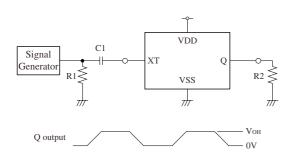
| ĪNH | Q | Oscillator |
|----------------|---------------------------------|------------------|
| HIGH (or open) | f _O output frequency | Normal operation |
| LOW | High impedance | Stopped |

Power-save Pull-up Resistance

The $\overline{\text{INH}}$ pull-up resistance changes in response to the input level (HIGH or LOW). When $\overline{\text{INH}}$ goes LOW (standby state), the pull-up resistance becomes large to reduce the current consumption during standby.

MEASUREMENT CIRCUITS

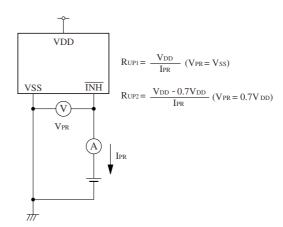
Measurement cct 1



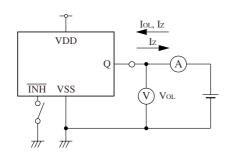
 $2.5 V_{P-P}$, 10MHz sine wave input signal C1 : $0.001 \mu F$

C1 : 0.001μ R1 : 50Ω R2 : 275Ω

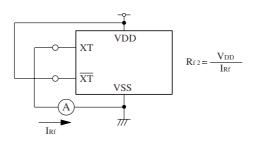
Measurement cct 4



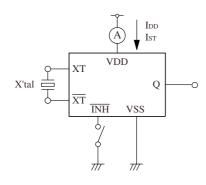
Measurement cct 2



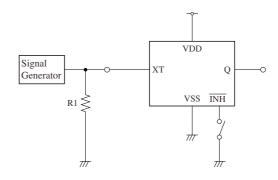
Measurement cct 5



Measurement cct 3

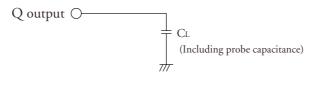


Measurement cct 6



R1:50 Ω

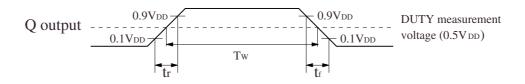
Load cct 1



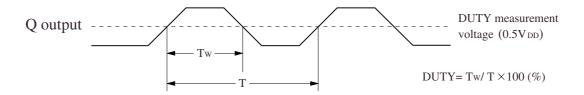
$$\begin{split} &C_L = 15pF; t_{r1}, t_{f1}, I_{DD} \text{ (SM5005AL\timesV, CF5005AL\times)} \\ &C_L = 30pF; t_{r2}, t_{f2}, t_{f3}, t_{f3}, I_{DD} \text{ (CF5005AL\times)} \end{split}$$

Switching Time Measurement Waveform

Output duty level (CMOS)

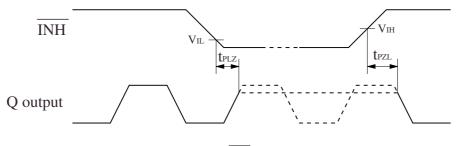


Output duty cycle (CMOS)



Output Enable/Disable Delay

The following figure shows the oscillator timing during normal operation. Note that when the device is in standby, the oscillator stops. When standby is released, the oscillator starts and stable oscillator output occurs after a short delay.



 $\overline{\text{INH}}$ input waveform $\text{tr} = \text{tf} \leq 10 \text{ns}$

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NIPPON PRECISION CIRCUITS INC.

4-3, Fukuzumi 2-chome, Koto-ku, Tokyo 135-8430, Japan Telephone: +81-3-3642-6661 Facsimile: +81-3-3642-6698 http://www.npc.co.jp/ Email: sales@npc.co.jp

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