## 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 overtone oscillator.

## FEATURES

- High-frequency operation
- 3rd overtone oscillation
- Capacitors $C_G$ , $C_D$ built-in
- Standby function (oscillator stops)
- Power-saving pull-up resistor built-in
- Inverter amplifier feedback resistor built-in
- CMOS input level
- 8mA ($V_{DD}$ = 2.7V) drive capability
- CMOS output duty level
- Output three-state function
- 2.25 to 3.6V supply voltage
- Oscillator frequency output
- 8-pin VSOP (SM5005A××V)
- Chip form (CF5005A××)

## SERIES CONFIGURATION

| Version[1] | Recommended operating frequency range[2] [MHz] | | gm ratio | Output duty level | Output current [mA] | Built-in capacitance [pF] | | $R_f$ [kΩ] |
|---|---|---|---|---|---|---|---|---|
| | $V_{DD}$ = 2.25 to 2.75V | $V_{DD}$ = 2.7 to 3.6V | | | | $C_G$ | $C_D$ | |
| 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 | – | 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××.
2. The recommended operating frequency is a yardstick value derived from the crystal used for NPC characteristics authentication. However, the oscillator frequency band is not guaranteed. Specifically, the characteristics can vary greatly due to crystal characteristics and mounting conditions, so the oscillation characteristics of components must be carefully evaluated.
3. Chip form only.

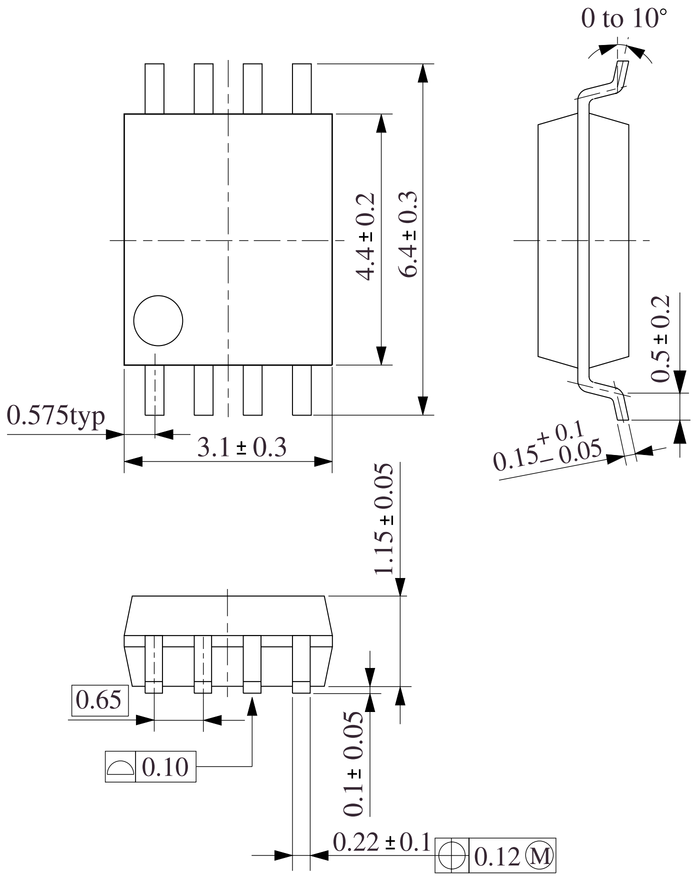
## ORDERING INFORMATION

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

## PACKAGE DIMENSIONS

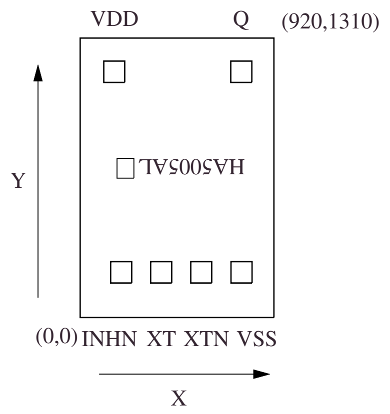
(Unit: mm)

• 8-pin VSOP



## PAD LAYOUT

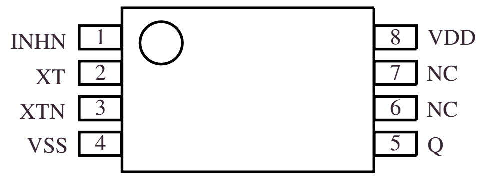
(Unit: μm)




Chip size: 0.92 × 1.31mm
Chip thickness: 300 ± 30μm
Chip base: $V_{DD}$ level

## PINOUT

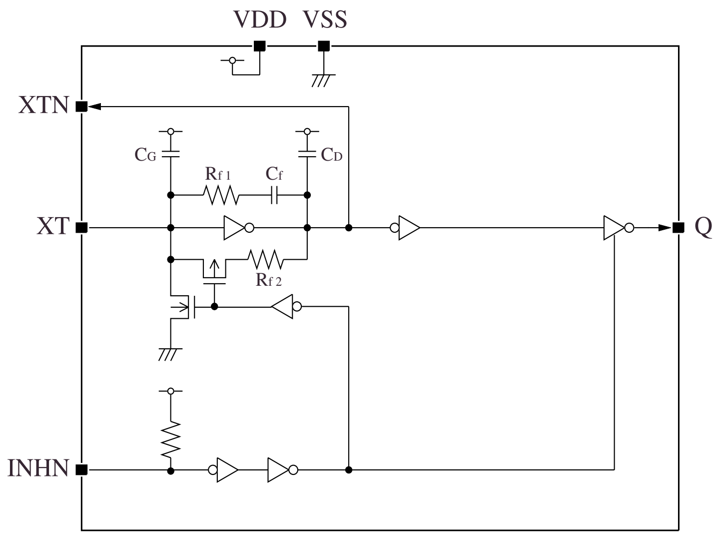
(Top view)




## PIN DESCRIPTION and PAD DIMENSIONS

| Number | Name | I/O | Description | | Pad dimensions [μm] | |
|---|---|---|---|---|---|---|
| | | | | | X | Y |
| 1 | INHN | I | Output state control input. Oscillator stopped when LOW. Power-saving pull-up resistor built in | | 195 | 212 |
| 2 | XT | I | Amplifier input. | Crystal oscillator connection pins. Crystal oscillator connected between XT and XTN | 385 | 212 |
| 3 | XTN | O | Amplifier output. | | 575 | 212 |
| 4 | VSS | – | Ground | | 766 | 212 |
| 5 | Q | O | Output. Output frequency ($f_O$) | | 765 | 1152 |
| 6 | NC | – | No connection | | – | – |
| 7 | NC | – | No connection | | – | – |
| 8 | VDD | – | Supply voltage | | 162 | 1152 |

## BLOCK DIAGRAM



# SPECIFICATIONS

## Absolute Maximum Ratings

$V_{SS}$ = 0V

| 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 | V |
| 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 | $T_{stg}$ | Chip form | –65 to 150 | °C |
| | | 8-pin VSOP | –40 to 125 | |
| Output current | $I_{OUT}$ | | 25 | mA |
| Power dissipation | $P_D$ | 8-pin VSOP | 300 | mW |

## Recommended Operating Conditions

### CF5005AL×

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

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Supply voltage | $V_{DD}$ | $C_L$ ≤ 15pF | 2.7 | – | 3.6 | V |
| | | $C_L$ ≤ 30pF | 3.0 | – | 3.6 | |
| Input voltage | $V_{IN}$ | | $V_{SS}$ | – | $V_{DD}$ | V |
| Operating temperature | $T_{OPR}$ | | –20 | – | 80 | °C |

### CF5005ALA/CF5005ALD/CF5005ALE

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

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| 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

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

| Parameter | Symbol | Condition | Rating | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Supply voltage | $V_{DD}$ | $C_L$ ≤ 15pF | 2.7 | – | 3.6 | V |
| Input voltage | $V_{IN}$ | | $V_{SS}$ | – | $V_{DD}$ | V |
| Operating temperature | $T_{OPR}$ | | –20 | – | 80 | °C |

## Electrical Characteristics

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

| Parameter | Symbol | Condition | | | Rating min | Rating typ | Rating max | Unit |
|---|---|---|---|---|---|---|---|---|
| HIGH-level output voltage | $V_{OH}$ | Q: Measurement cct 1, $V_{DD}$ = 2.7V, $I_{OH}$ = 8mA | | | 2.2 | 2.4 | – | V |
| LOW-level output voltage | $V_{OL}$ | Q: Measurement cct 2, $V_{DD}$ = 2.7V, $I_{OL}$ = 8mA | | | – | 0.3 | 0.4 | V |
| Output leakage current | $I_Z$ | Q: Measurement cct 2, INHN = LOW, $V_{DD}$ = 3.6V | | $V_{OH}$ = $V_{DD}$ | – | – | 10 | μA |
| | | | | $V_{OL}$ = $V_{SS}$ | – | – | 10 | |
| HIGH-level input voltage | $V_{IH}$ | INHN | | | 0.7$V_{DD}$ | – | – | V |
| LOW-level input voltage | $V_{IL}$ | INHN | | | – | – | 0.3$V_{DD}$ | V |
| Current consumption | $I_{DD}$ | INHN = open, Measurement cct 3, load cct 1, $V_{DD}$ = 3.0V to 3.6V f = 125MHz | $C_L$ = 30pF | CF5005AL× | – | 40 | 100 | mA |
| | | | $C_L$ = 15pF | SM5005AL×V<br>CF5005AL× | – | 25 | 60 | |
| Standby current | $I_{ST}$ | INHN = LOW, Measurement cct 3 | | | – | – | 10 | μA |
| INHN pull-up resistance | $R_{UP1}$ | Measurement cct 4, INHN = LOW | | | 0.4 | – | 4 | MΩ |
| | $R_{UP2}$ | Measurement cct 4, INHN = 0.7$V_{DD}$ | | | 50 | – | 150 | kΩ |
| AC feedback resistance | $R_{f1}$ | Design value. A monitor pattern on a wafer is tested. | | SM5005ALAV<br>CF5005ALA | 1.76 | 2.2 | 2.64 | kΩ |
| | | | | SM5005ALBV<br>CF5005ALB | 2.64 | 3.3 | 3.96 | |
| | | | | SM5005ALCV<br>CF5005ALC | 2.64 | 3.3 | 3.96 | |
| | | | | 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. A monitor pattern on a wafer is tested. | | | 9.3 | 10 | 10.7 | pF |
| Built-in capacitance | $C_G$ | Design value. A monitor pattern on a wafer is tested. | | SM5005ALAV<br>CF5005ALA<br>CF5005ALD<br>CF5005ALE | 7.44 | 8 | 8.56 | pF |
| | | | | SM5005ALBV<br>CF5005ALB | 5.58 | 6 | 6.42 | |
| | | | | SM5005ALCV<br>CF5005ALC | 2.79 | 3 | 3.21 | |
| | $C_D$ | Design value. A monitor pattern on a wafer is tested. | | SM5005ALAV<br>CF5005ALA<br>CF5005ALD | 9.3 | 10 | 10.7 | pF |
| | | | | SM5005ALBV<br>CF5005ALB | 5.58 | 6 | 6.42 | |
| | | | | SM5005ALCV<br>CF5005ALC | 2.79 | 3 | 3.21 | |
| | | | | CF5005ALE | 13.95 | 15 | 16.05 | |

## Switching Characteristics

### 3V operation

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

| Parameter | Symbol | Condition | | | Rating | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | min | typ | max | |
| Output rise time | $t_{r1}$ | Measurement cct 3, load cct 1, 0.1$V_{DD}$ to 0.9$V_{DD}$ | $C_L$ = 15pF, $V_{DD}$ = 2.7V to 3.6V | SM5005AL×V CF5005AL× | – | 1 | 3 | ns |
| | $t_{r2}$ | | $C_L$ = 30pF, $V_{DD}$ = 3.0V to 3.6V | CF5005AL× | – | 1.5 | 4 | |
| Output fall time | $t_{f1}$ | Measurement cct 3, load cct 1, 0.9$V_{DD}$ to 0.1$V_{DD}$ | $C_L$ = 15pF, $V_{DD}$ = 2.7V to 3.6V | SM5005AL×V CF5005AL× | – | 1 | 3 | ns |
| | $t_{f2}$ | | $C_L$ = 30pF, $V_{DD}$ = 3.0V to 3.6V | CF5005AL× | – | 1.5 | 4 | |
| Output duty cycle[1] | Duty | Measurement cct 3, load cct 1, Ta = 25°C, $V_{DD}$ = 3.0V | $C_L$ = 30pF, f ≤ 125MHz | CF5005AL× | 45 | – | 55 | % |
| | | | $C_L$ = 15pF, f ≤ 107MHz | SM5005AL×V | 45 | – | 55 | |
| | | | $C_L$ = 15pF, 107MHz < f < 125MHz | | 40 | – | 60 | |
| Output disable delay time[2] | $t_{PLZ}$ | Measurement cct 6, Ta = 25°C, $V_{DD}$ = 2.7V, $C_L$ ≤ 15pF | | | – | – | 100 | ns |
| Output enable delay time[2] | $t_{PZL}$ | Measurement cct 6, Ta = 25°C, $V_{DD}$ = 2.7V, $C_L$ ≤ 15pF | | | – | – | 100 | ns |

1. The duty cycle characteristic is checked the sample chips of each production lot.
2. Oscillator stop function is built-in. When INHN goes LOW, normal output stops. When INHN goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

### 2.5V operation (CF5005ALA, CF5005ALD, CF5005ALE)

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

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

1. The duty cycle characteristic is checked the sample chips of each production lot.
2. Oscillator stop function is built-in. When INHN goes LOW, normal output stops. When INHN goes HIGH, normal output is not resumed until after the oscillator start-up time has elapsed.

# FUNCTIONAL DESCRIPTION

## Standby Function

The oscillator stops when INHN goes LOW. When the oscillator stops, the oscillator output on Q goes high impedance.

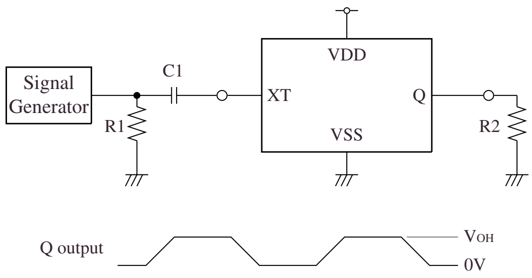
| INHN | Q | Oscillator |
|---|---|---|
| HIGH (or open) | $f_O$ output frequency | Normal operation |
| LOW | High impedance | Stopped |

## Power-saving Pull-up Resistor

The INHN pull-up resistance changes in response to the input level (HIGH or LOW). When INHN goes LOW (standby state), the pull-up resistance becomes large to reduce the current consumption during standby.

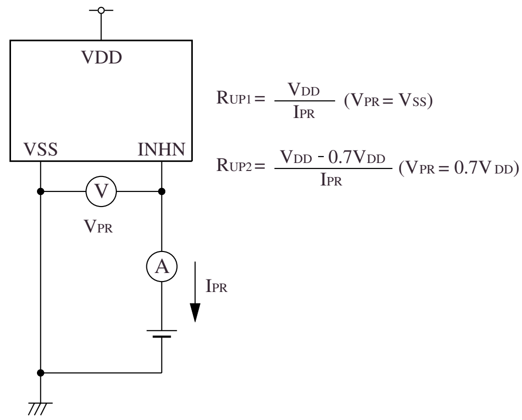
# MEASUREMENT CIRCUITS

## Measurement cct 1

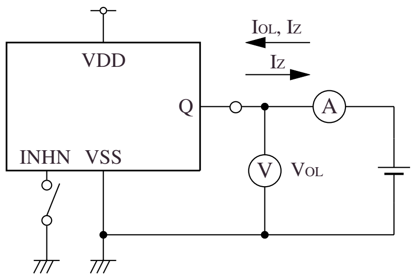



2.5$V_{P-P}$ , 10MHz sine wave input signal
C1 : 0.001μF
R1 : 50Ω
R2 : 275Ω

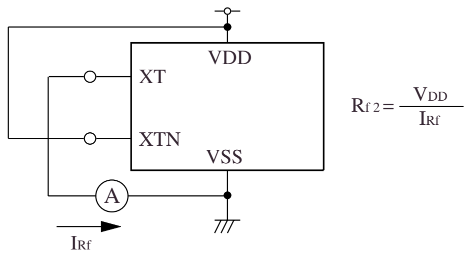
## Measurement cct 4



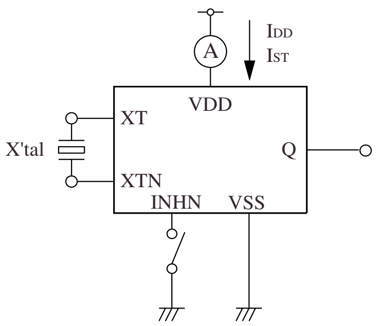

## Measurement cct 2



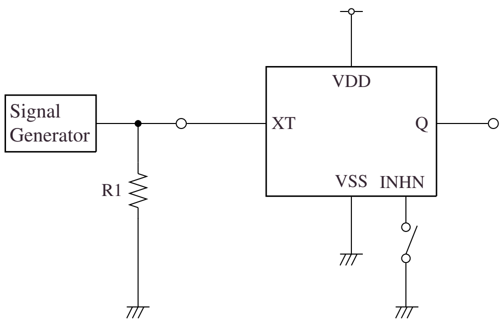

## Measurement cct 5




## Measurement cct 3

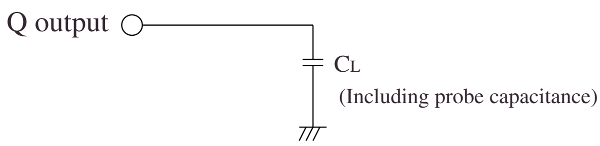



## Measurement cct 6




R1 : 50Ω

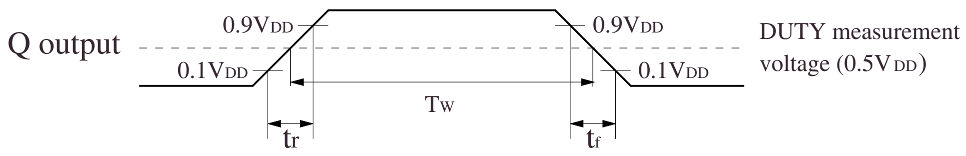
## Load cct 1



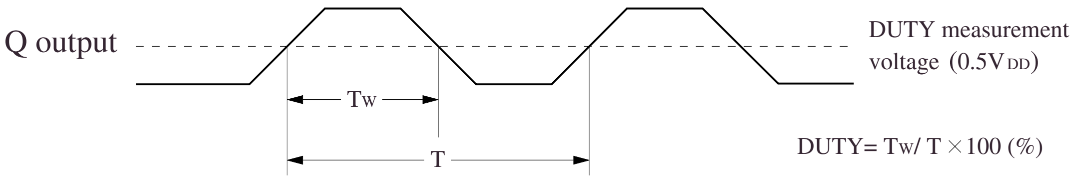

$C_L$ = 15pF: $t_{r1}$, $t_{f1}$, $I_{DD}$ (SM5005AL×V, CF5005AL×)
$C_L$ = 30pF: $t_{r2}$ , $t_{f2}$ , $t_{r3}$ , $t_{f3}$ , $I_{DD}$ (CF5005AL×)

## Switching Time Measurement Waveform

### Output duty level (CMOS)

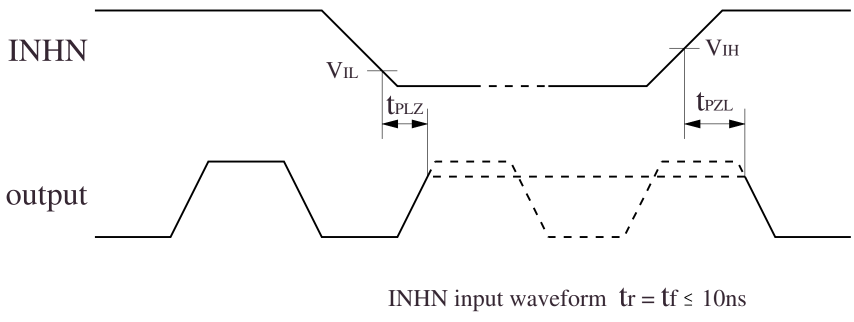



### Output duty cycle (CMOS)




## 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.



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NC9805GE 2006.04