Integrated Circuit Systems, Inc.

# ICS9131

## Advance Information

# 32 kHz Motherboard Frequency Generator

## General Description

The **ICS9131** offers a tiny footprint solution for generating a selectable CPU clock from a 32.768 kHz crystal. The device allows a variety of microprocessors to be clocked by changing the state of address lines FS0, FS1, and FS2. The **ICS9131** is the ideal solution for repacing high speed oscillators and for reducing clock speeds to save power in computers. The device provides smooth, glitch-free frequency transitions so that the CPU can continue to operate during slow down or speed up. The rate of frequency change makes the **ICS9161** compatible with all 386DX, 386SX, 486DX, 486DXZ, 486SX and Pentium™ microprocessors.

The **ICS9131** is driven from a single 32.768 kHz crystal. The only external components required are the crystal, crystal components, and decoupling capacitors. The device generates the 14.318 MHz system clock, eliminating the need for a 14.318 MHz crystal. High- Performance applications may require high speed clock termination components.

## VDD32 Supply

The **ICS9131** has a separate power supply for the 32.768 kHz oscillator circuitry. This allows the 32 kHz clock to run from a battery or other souce while the main power to the chip is disconnected. The VDD32 supply is guaranteed to operate down to + 2.0V, with the clock consuming less than 10µA at + 3.3V with the main VDD at 0V.

The frequencies and power down options in the **ICS9131** are mask programmable. Customer specific masks can be made and prototypes delivered within 6-8 weeks from receipt of order. ICS also offers standard versions, such as those described in this data sheet.

## Features

- Single 32.768 kHz crystal generates system clock and selectable CPU clock
- Generates CPU clocks from 8 MHz to 100 MHz.
- Operates from 3.3V or 5.0V supply
- Operates up to 66 MHz at 3.3V
- Separate VDD for 32 kHz clock enables it to run from battery
- STOPCLK feature allows for a smooth turn-on and turn-off of the CPU clock to static processors
- Output enable tristates outputs
- 16-pin PDIP or SOIC package

## Applications

Notebook/Palmtop Computers: The **ICS9131** works with + 3V and + 5V and a single 32.768 kHz crystal, making it the ideal solution for generating clocks in portables with minimum board space. The user can save power by using this single part instead of oscillators or other frequency generators. The **ICS9131** further reduces the current consumption by having the ability to completely shut-down the individual clocks when not in used, while still maintaining the separately powered 32.768 kHz clock.

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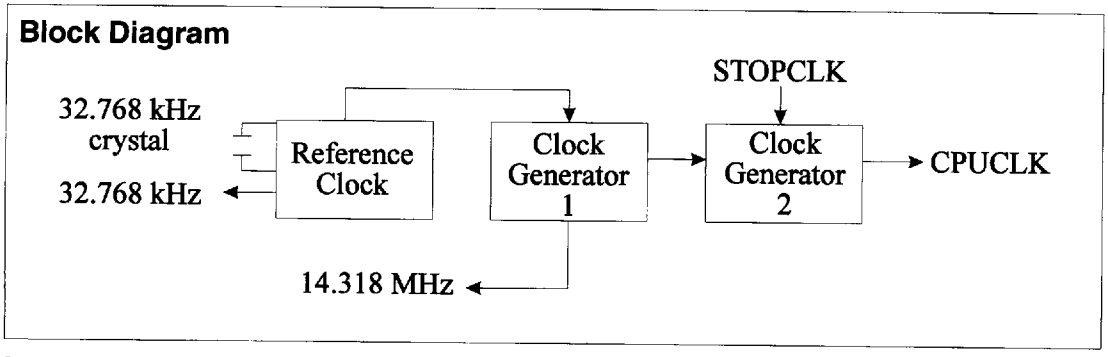
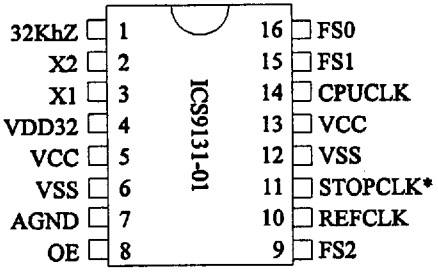
## Block Diagram




Pentium is a trademark of Intel.

# ICS9131

## Pin Configuration




**Ordering Information**
ICS9131-01CN (DIP)
ICS9131-01CM (SOIC)

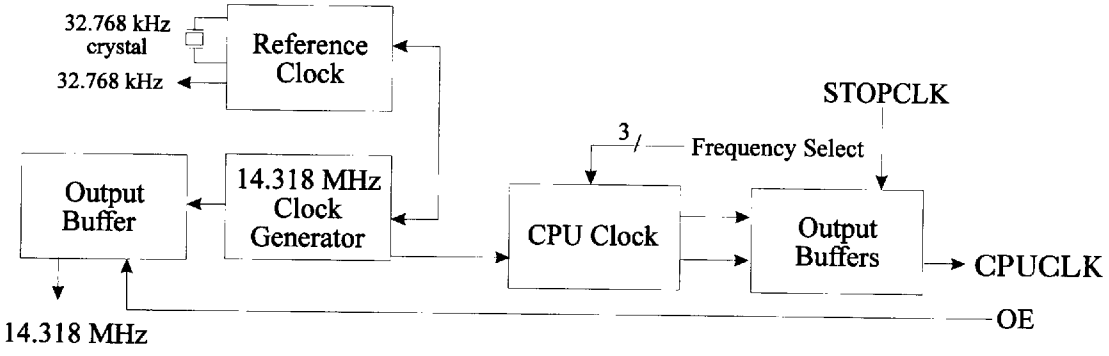
## Decoding Table for CPU Clock

| FS2 | FS1 | FS0 | CPUCLK | ACTUALS |
|---|---|---|---|---|
| 0 | 0 | 0 | 16 | 16.004 |
| 0 | 0 | 1 | 25 | 25.059 |
| 0 | 1 | 0 | 33.3 | 33.412 |
| 0 | 1 | 1 | 40 | 40.095 |
| 1 | 0 | 0 | 50 | 50.119 |
| 1 | 0 | 1 | 60 | 60.142 |
| 1 | 1 | 0 | 66.6 | 66.484 |
| 1 | 1 | 1 | 80 | 80.190 |

## Pin Descriptions

| PIN NUMBER | PIN NAME | TYPE | DESCRIPTION |
|---|---|---|---|
| 1 | 32 kHz | OUTPUT | 32.768 kHz output |
| 2 | X2 | OUTPUT | Connect 32 kHz crystal |
| 3 | X1 | INPUT | Connect 32 kHz crystal |
| 4 | VDD32 | | Power Supply for 32 kHz oscillator |
| 5 | VCC | | Power Supply (+ 3.3V - 5.0V) |
| 6 | VSS | | Ground |
| 7 | AGND | | Analog Ground |
| 8 | OE | INPUT | OE tristates outputs when low |
| 9 | FS2 | INPUT | CPU clock frequency select 2 |
| 10 | REFCLK | OUTPUT | 14.318 MHz output |
| 11 | STOPCLK* | INPUT | Stops CPU Clock when low |
| 12 | VSS | | Ground |
| 13 | VCC | | Power supply (+ 3.3V-5.0V) |
| 14 | CPUCLK | OUTPUT | CPU Clock output (see Decoding table) |
| 15 | FS1 | INPUT | CPU clock frequency select 1 |
| 16 | FS0 | INPUT | CPU clock frequency select 0 |

## Block Diagram for ICS9133-01

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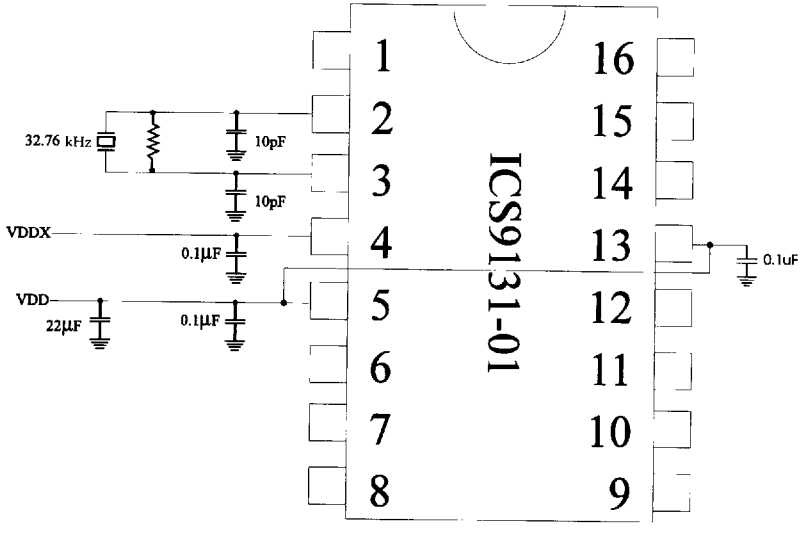
## Recommended External Circuit




Notes:
1) The external components shown should be placed as close to the device as possible.
2) Pins 5 and 13 should be connected together externally. One decoupling capacitor may suffice for both pins.
3) May be part of system decoupling.
4) A 10Ω 3µF low pass filter maybe required.

# ICS9131

## Absolute Maximum Ratings

VDD referenced to GND ..... 7V
Operating temperature under bias ..... 0°C to + 70°C
Storage temperature ..... -40°C to + 150°C
Voltage on I/O pins referenced to GND..... GND -0.5V to VDD+ 0.5V
Power dissipation..... 0.5 Watts

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

## Electrical Characteristics

$V_{DD}$ = + 3.0 to 3.7V, $T_A$= 0°C to 70°C unless otherwise stated)

| DC Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
| Input Low Voltage | $V_{IL}$ | $V_{DD}$= 3.3V | - | - | 0.2$V_{DD}$ | V |
| Input High Voltage | $V_{IH}$ | $V_{DD}$= 3.3V | 0.7$V_{DD}$ | - | - | V |
| Input Low Current | $I_{IL}$ | $V_{IN}$= 0V | - | - | -2* | µA |
| Input High Current | $I_{IH}$ | $V_{IN}$= $V_{DD}$ | - | - | 2* | µA |
| Output Low Voltage | $V_{OL}$ | $I_{OL}$= 4mA | - | - | 0.1 | V |
| Output High Voltage | $V_{OH}$ | $I_{OH}$= -1mA, $V_{DD}$= 3.3V | $V_{DD}$-.1V | - | - | V |
| Output High Voltage | $V_{OH}$ | $I_{OH}$= -4mA, $V_{DD}$= 3.3V | - | - | - | V |
| Output High Voltage | $V_{OH}$ | $I_{OH}$= -8mA | 2.4 | - | - | V |
| Output Frequency Change over Supply and Temperature | $F_D$ | With respect to typical frequency | - | .005 | 0.05 | % |
| Short circuit current | $I_{SC}$ | Each output clock | | 15 | | mA |
| Supply Current | $I_{CC}$ | No load, 40 MHz | | 10 | | mA |
| Pull-up resistor value | $R_{PU}$ | | | 620 | | kΩ |

## Electrical Characteristics

$V_{DD}$ = + 3.0 to 3.7V, $T_A$= 0°C to 70°C unless otherwise stated)

| AC Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
| Input Clock Rise Time | $t_{ICr}$ | | - | - | 5 | µs |
| Input Clock Fall Time | $t_{ICf}$ | | | - | 5 | µs |
| Output Rise time, 0.8 to 2.0V | $t_r$ | 15 pf load | - | 1.5 | 2 | ns |
| Rise time, 20% to 80% $V_{DD}$ | $t_r$ | 15 pf load | - | 2.5 | 4 | ns |
| Output Fall time, 2.0 to 0.8V | $t_f$ | 15 pf load | - | 1.5 | 2 | ns |
| Fall time, 80% to 20% $V_{DD}$ | $t_f$ | 15 pf load | - | 2.5 | 4 | ns |
| Duty cycle | $d_t$ | 15 pf load | 43/57 | 48/52 | 57/43 | % |
| Duty cycle, reference clocks | $d_t$ | 15 pf load (Note 1) | 40/60 | 43/57 | 60/40 | % |
| Jitter, one sigman | $t_{jis}$ | As compared with clock period | - | 1 | 3 | % |
| Jitter, absolute | $t_{jab}$ | | | 2 | 5 | % |
| Input Frequency | $f_i$ | | 25 | 32.768 | 40 | kHz |
| Clock skew between any Clock # 2 outputs | $T_{ak}$ | | | 100 | 500 | ps |
| Power up time | $t_{pu}$ | From off to 40 MHz | | 10 | | ms |

Note 1: 32 kHz output duty cycle is dependent on crystal used.

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# ICS9131

## Electrical Characteristics

$V_{DD}$ = + 5V± 10%, $T_A$= 0°C to 70°C unless otherwise stated)

| DC Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
| Input Low Voltage | $V_{IL}$ | $V_{DD}$= 3.3V | - | - | 0.2$V_{DD}$ | V |
| Input High Voltage | $V_{IH}$ | $V_{DD}$= 3.3V | 0.7$V_{DD}$ | - | - | V |
| Input Low Current | $I_{IL}$ | $V_{IN}$= 0V | - | - | -2* | µA |
| Input High Current | $I_{IH}$ | $V_{IN}$= $V_{DD}$ | - | - | 2* | µA |
| Output Low Voltage | $V_{OL}$ | $I_{OL}$= 4mA | - | - | 0.1 | V |
| Output High Voltage | $V_{OH}$ | $I_{OH}$= -1mA, $V_{DD}$= 3.3V | $V_{DD}$-.1V | - | - | V |
| Output High Voltage | $V_{OH}$ | $I_{OH}$= -4mA, $V_{DD}$= 3.3V | - | - | - | V |
| Output High Voltage | $V_{OH}$ | $I_{OH}$= -8mA | 2.4 | - | - | V |
| Output Frequency Change over Supply and Temperature | $F_D$ | With respect to typical frequency | - | .005 | 0.05 | % |
| Short circuit current | $I_{SC}$ | Each output clock | | 33 | | mA |
| Supply Current | $I_{CC}$ | No load, 40 MHz | | 17 | | mA |
| Pull-up resistor value | $R_{PU}$ | | | 380 | | kΩ |

## Electrical Characteristics

$V_{DD}$ = + 5Væ10%, $T_A$= 0°C to 70°C unless otherwise stated)

| AC Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
| Input Clock Rise Time | $t_{ICr}$ | | - | - | 5 | µs |
| Input Clock Fall Time | $t_{ICf}$ | | | - | 5 | µs |
| Output Rise time, 0.8 to 2.0V | $t_r$ | 15 pf load | - | 1 | 1.5 | ns |
| Rise time, 20% to 80% $V_{DD}$ | $t_r$ | 15 pf load | - | 2 | 3 | ns |
| Output Fall time, 2.0 to 0.8V | $t_f$ | 15 pf load | - | 1 | 1.5 | ns |
| Fall time, 80% to 20% $V_{DD}$ | $t_f$ | 15 pf load | - | 2 | 3 | ns |
| Duty cycle | $d_t$ | 15 pf load | 43/57 | 48/52 | 57/43 | % |
| Duty cycle, reference clocks | $d_t$ | 15 pf load (Note 1) | 40/60 | 43/57 | 60/40 | % |
| Jitter, one sigman | $t_{jis}$ | As compared with clock period | - | 1 | 3 | % |
| Jitter, absolute | $t_{jab}$ | | | 2 | 5 | % |
| Input Frequency | $f_i$ | | 25 | 32.768 | 40 | kHz |
| Clock skew between any Clock # 2 outputs | $T_{ak}$ | | | 100 | 500 | ps |
| Power up time | $t_{pu}$ | From off to 80 MHz | | 10 | | ms |

Note 1: 32 kHz output duty cycle is dependent on crystal used.

## Stop Clock Feature

The **ICS9131** incorporates a unique stop clock feature compatible with static logic processors. When the stop clock pin goes low, the CPUCLK will go low after the next occuring falling edge. When STOPCLK again goes high, CPUCLK resumes on the next rising edge of the internal clock. This feature enables fast, glitch-free starts and stops of the CPUCLK and is useful in Energy Star motherboard applications.



## 32 kHz Supply Current