

## Description

Used in conjunction with an external pullable quartz crystal, this monolithic integrated circuit replaces more costly hybrid (canned) VCXO devices. The ICS726 is designed primarily for data and clock recovery applications such as ADSL modems, set-top box receivers, and telecom systems.

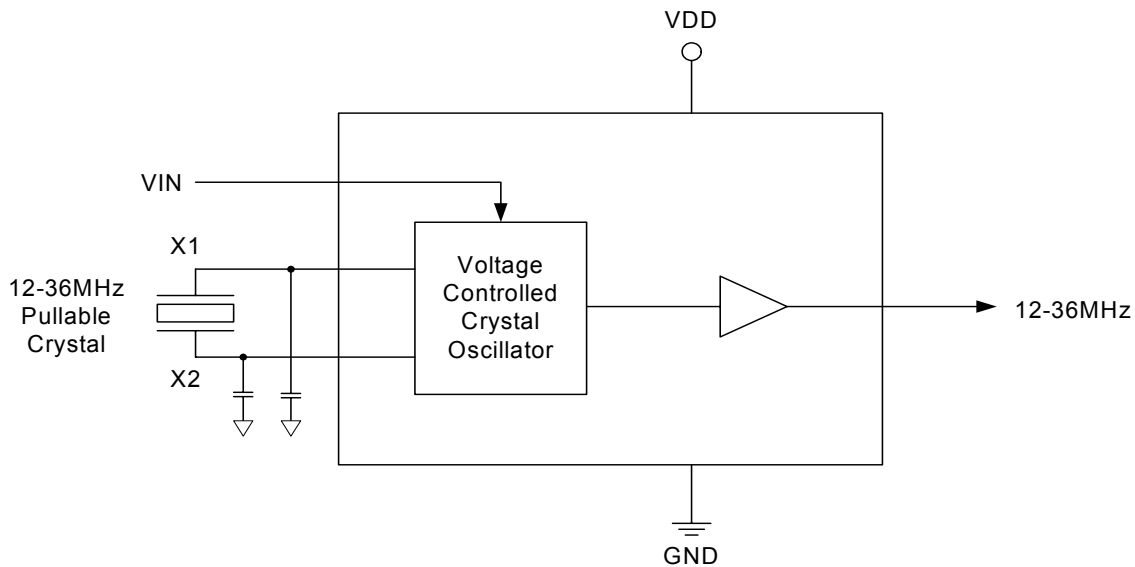
The frequency of the on-chip VCXO is adjusted by an external control voltage to the VIN pin. Since VIN is a high impedance input, it can be driven directly from an PWM RC integrator circuit. Frequency output increases with VIN voltage input. The usable range of VIN is 0 to 3.3 V.

## Features

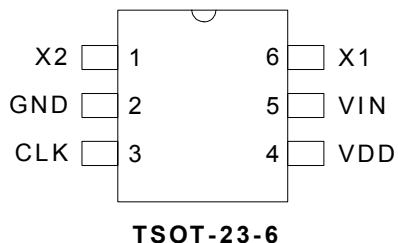
- Uses an inexpensive 12 to 36 MHz external crystal
- Output frequency range of 12 to 36 MHz
- On-chip VCXO with guaranteed pull range of  $\pm 115$  ppm minimum
- VCXO tuning voltage 0 to 3.3 V
- Packaged in 6-pin TSOT
- Available in Pb (lead) free package

**NOTE:** *This device is not recommended for new designs. Please see the ICS726AT for all new designs.*

## Block Diagram



## Pin Assignment



## Pin Descriptions

| Pin Number | Pin Name | Pin Type | Pin Description   |
|------------|----------|----------|---|
| 1          | X2       | Input    | Crystal connection. Connect to the external pullable crystal.   |
| 2          | GND      | Power    | Connect to ground.  |
| 3          | CLK      | Output   | VCXO CMOS level clock output at the frequency of the crystal.   |
| 4          | VDD      | Power    | Connect to +3.3 V (0.01uf decoupling capacitor recommended).  |
| 5          | VIN      | Input    | Voltage input to VCXO — 0 to 3.3 V analog input which controls the oscillation frequency of the VCXO. |
| 6          | X1       | Input    | Crystal connection. Connect to the external pullable crystal.   |

## External Component Selection

The ICS726 requires a minimum number of external components for proper operation.

### Decoupling Capacitor

A decoupling capacitor of 0.01 $\mu$ F must be connected between VDD (pin 4) and GND (pin 2), as close to these pins as possible. For optimum device performance, the decoupling capacitor should be mounted on the component side of the PCB. Avoid the use of vias in the decoupling circuit.

### Series Termination Resistor

When the PCB trace between the clock output (CLK, pin 3) and the load is over 1 inch, series termination should be used. To series terminate a 50 $\Omega$  trace (a commonly used trace impedance) place a 33 $\Omega$  resistor in series with the clock line, as close to the clock output pin as possible. The nominal impedance of the clock output is 20 $\Omega$ .

### Quartz Crystal

The ICS726 VCXO function consists of the external crystal and the integrated VCXO oscillator circuit. To assure the best system performance (frequency pull range) and reliability, a crystal device with the recommended parameters (shown below) must be used, and the layout guidelines discussed in the following section shown must be followed.

The frequency of oscillation of a quartz crystal is determined by its "cut" and by the load capacitors connected to it. The ICS726 incorporates on-chip variable load capacitors that "pull" (change) the frequency of the crystal. The crystal specified for use with the ICS726 is designed to have zero frequency error when the total of on-chip + stray capacitance is 14 pF.

### Required Crystal Parameters:

|                              |                          |
|------------------------------|--------------------------|
| Nominal Frequency            | as required MHz          |
| Initial Accuracy at 25° C    | -20 min/+20 max ppm      |
| Temperature Stability        | -30 min/+30 max ppm      |
| Aging, 1st year              | -5 min/+5 max ppm        |
| Aging, 10 years              | -20 min/+20 max ppm      |
| Operating Temp. Range, °C    | 0 min/+25 typ/+70 max or |
| Operating Temp. Range, °C    | -40 min/+25 typ/+85 max  |
| Load Capacitance             | 10 pf                    |
| Shunt Capacitance, C0        | 7 pF Max                 |
| C0/C1 Ratio                  | 270 Max                  |
| Equivalent Series Resistance | 35 $\Omega$ Max          |

The third overtone mode of the crystal and all spurs must be >100 ppm distant from the 3x fundamental resonance measured with a physical load of 10 pF.

The external crystal must be connected as close to the chip as possible and should be on the same side of the PCB as the ICS726. There should be no vias between the crystal pins and the X1 and X2 device pins. There should be no signal traces underneath or close to the crystal. See application note MAN05.

### Crystal Tuning Load Capacitors

The crystal traces should include pads for small fixed capacitors, one between X1 and ground, and another between X2 and ground. The need for these capacitors is determined at system prototype evaluation, and is influenced by the particular crystal used (manufacture and frequency) and by PCB layout. The typical required capacitor value is 1 to 4 pF.

The procedure for determining the value of these capacitors can be found in application note MAN05.

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS726. These ratings, which are standard values for ICS commercially rated parts, are stress ratings only. 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 can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

| Item                          | Rating              |
|-------------------------------|---------------------|
| Supply Voltage, VDD           | 7 V                 |
| All Inputs and Outputs        | -0.5 V to VDD+0.5 V |
| Ambient Operating Temperature | 0 to +70° C         |
| Storage Temperature           | -65 to +150° C      |
| Soldering Temperature         | 260° C              |

## Recommended Operating Conditions

| Parameter   | Min.            | Typ. | Max.  | Units |
|---|-----------------|------|-------|-------|
| Ambient Operating Temperature                     | 0               |      | +70   | °C    |
| Power Supply Voltage (measured in respect to GND) | +3.15           |      | +3.45 | V     |
| Reference crystal parameters                      | Refer to page 3 |      |       |       |

## DC Electrical Characteristics

VDD=3.3 V ±5% , Ambient temperature 0 to +70° C, unless stated otherwise

| Parameter                        | Symbol          | Conditions               | Min.    | Typ. | Max. | Units |
|----------------------------------|-----------------|--------------------------|---------|------|------|-------|
| Operating Voltage                | VDD             |                          | 3.15    |      | 3.45 | V     |
| Output High Voltage              | V <sub>OH</sub> | I <sub>OH</sub> = -12 mA | 2.4     |      |      | V     |
| Output Low Voltage               | V <sub>OL</sub> | I <sub>OL</sub> = 12 mA  |         |      | 0.4  | V     |
| Output High Voltage (CMOS Level) | V <sub>OH</sub> | I <sub>OH</sub> = -4 mA  | VDD-0.4 |      |      | V     |
| Operating Supply Current         | IDD             | Output = 12 MHz, no load |         | 5    |      | mA    |
| Short Circuit Current            | I <sub>OS</sub> |                          |         | ±50  |      | mA    |
| VIN, VCXO Control Voltage        | V <sub>IA</sub> |                          | 0       |      | 3.3  | V     |

## AC Electrical Characteristics

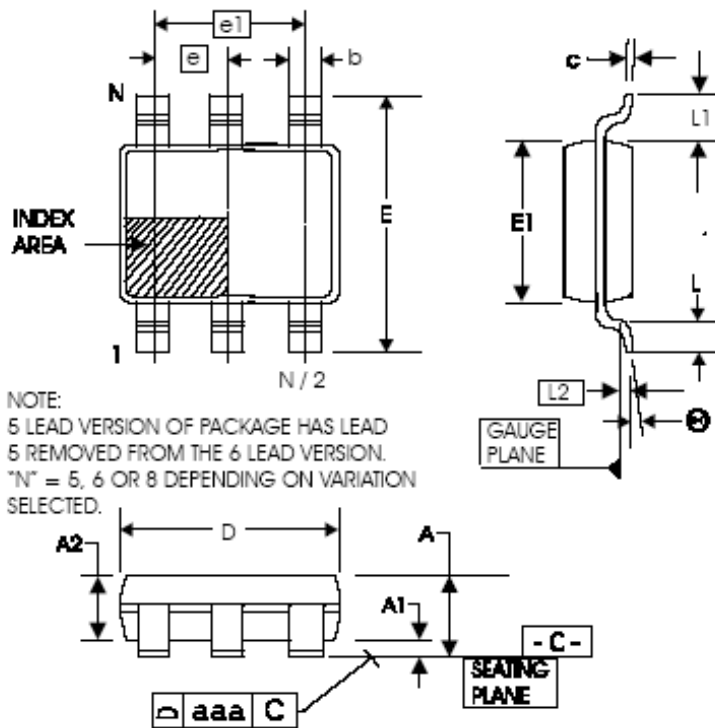
VDD = 3.3 V ±5%, Ambient Temperature 0 to +70° C, unless stated otherwise

| Parameter                         | Symbol          | Conditions                               | Min. | Typ. | Max. | Units |
|-----------------------------------|-----------------|--|------|------|------|-------|
| Output Frequency                  | F <sub>O</sub>  |  | 12   |      | 36   | MHz   |
| Crystal Pullability, Note 2       | F <sub>P</sub>  | 0V ≤ VIN ≤ 3.3 V, Note 1                 | ±115 |      |      | ppm   |
| VCXO Gain                         |                 | VIN = VDD/2 ± 1 V, Note 1                |      | 140  |      | ppm/V |
| Output Rise Time                  | t <sub>OR</sub> | 0.8 to 2.0 V, C <sub>L</sub> =15 pF      |      | 0.8  | 1.5  | ns    |
| Output Fall Time                  | t <sub>OF</sub> | 2.0 to 0.8 V, C <sub>L</sub> =15 pF      |      | 0.8  | 1.5  | ns    |
| Output Clock Duty Cycle           | t <sub>D</sub>  | Measured at 1.4 V, C <sub>L</sub> =15 pF | 40   | 50   | 60   | %     |
| Maximum Output Jitter, short term | t <sub>J</sub>  | C <sub>L</sub> =15 pF                    |      | 100  |      | ps    |

Note 1: External crystal device must conform with Pullable Crystal Specifications listed on page 3.

## Package Outline and Package Dimensions (6-pin TSOT)

Package dimensions are kept current with JEDEC Publication No. 95



| Symbol | Millimeters |      |
|--------|-------------|------|
|        | Min         | Max  |
| A      | —           | 1.00 |
| A1     | 0.01        | 0.10 |
| A2     | 0.84        | 0.90 |
| b      | 0.30        | 0.45 |
| c      | 0.12        | 0.20 |
| D      | 2.90 BASIC  |      |
| E      | 2.80 BASIC  |      |
| E1     | 1.60 BASIC  |      |
| e      | 0.95 BASIC  |      |
| e1     | 1.90 BASIC  |      |
| L      | 0.30        | 0.50 |
| L1     | 0.60 REF.   |      |
| L2     | 0.25 BASIC  |      |
| θ      | 0°          | 8°   |
| aaa    | —           | 0.10 |

## Ordering Information

| Part / Order Number | Marking | Shipping Packaging | Package    | Temperature |
|---------------------|---------|--------------------|------------|-------------|
| 726TT               | 726T    | Tape and Reel      | 6-pin TSOT | 0 to +70° C |
| 726TLFT             | 26TL    | Tape and Reel      | 6-pin TSOT | 0 to +70° C |

Parts that are ordered with a "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.

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ICS726

12 TO 36 MHZ 6TSOT VCXO

VCXO

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