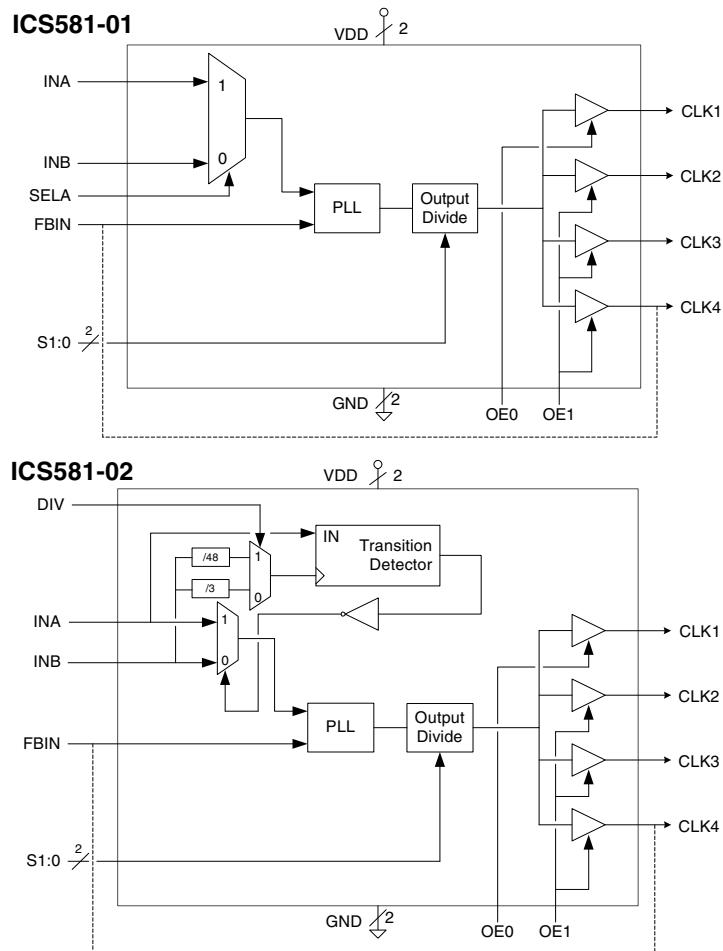


## Description

The ICS581-01/02 are glitch free, Phase Locked Loop (PLL) based clock multiplexers (mux) with zero delay from input to output. They each have four low skew outputs which can be configured as a single output, three outputs, or four outputs. The ICS581-01 allows user control over the mux switching, while the ICS581-02 has automatic switching between the two clock inputs.

The ICS581-01 and -02 are members of IDT's ClockBlocks™ family of clock generation, synchronization, and distribution devices. For a non-PLL based clock mux, see the ICS580-01.

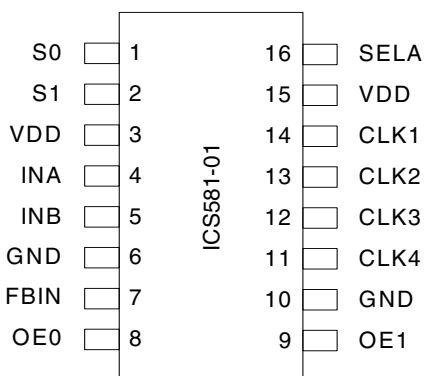
## Block Diagram



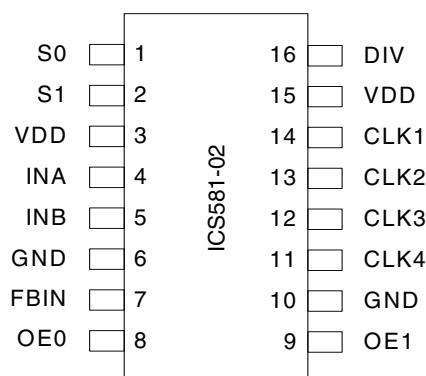
## Features

- 16-pin TSSOP package
- RoHS compliant packaging
- No short pulses or glitches on output
- Operates from 6 to 200 MHz
- Low skew outputs
- User controlled (-01) or automatic, timed mux switch (-02)
- Ideal for systems with back-up or redundant clocks
- Zero delay (input to output)
- 50% output duty cycle allows duty cycle correction
- SpreadSmart™ technology works with spread spectrum parts
- Industrial temperature of ICS581-02 available

## Pin Assignment



16 pin 4.40 mil body (0.65 mm pitch) TSSOP



16 pin 4.40 mil body (0.65 mm pitch) TSSOP

## Clock Decoding

SEL A	CLK1-4
0	INB
1	INA

ICS581-01 only

## Timeout Selection

DIV	Nominal Timeout
0	3x period of INB
1	48x period of INB

ICS581-02 only

## Tri-State and Power Down

OE1	OE0	CLK1	CLK2-4	PLL
0	0	Z	Z	Off
0	1	On	Z	On
1	0	Z	On	On
1	1	On	On	On

ICS581-01/02

**Note:** Z indicates that the output is in a high impedance state

## Frequency Range Select

S1	S0	Input Range (MHz)
0	0	50 - 150
0	1	19 - 75
1	0	6 - 19
1	1	150 - 200

ICS581-01/02

## Pin Descriptions

Pin Number	Pin Name	Pin Type	Pin Description
1	S0	Input	Select 0 for frequency range. See table. Internal pull-up.
2	S1	Input	Select 1 for frequency range. See table. Internal pull-up.
3	VDD	Power	Power Supply. Connect to +3.3 V or +5 V.
4	INA	Input	Input Clock A.
5	INB	Input	Input Clock B.
6	GND	Power	Connect to ground.
7	FBIN	Input	Feedback input. Connect to a clock output.
8	OE0	Input	Output enable 0. See table. Internal pull-up.
9	OE1	Input	Output enable 1. See table. Internal pull-up.
10	GND	Power	Connect to ground.
11	CLK4	Output	Low skew clock output.
12	CLK3	Output	Low skew clock output.
13	CLK2	Output	Low skew clock output.
14	CLK1	Output	Low skew clock output.
15	VDD	Power	Power Supply. Connect to +3.3 V or +5 V.
16 (-01)	SEL A	Input	Mux select. Selects INA when high. Internal pull-up.
16 (-02)	DIV	Input	Timeout select. See table. Internal pull-up.

## Device Operation

The ICS581-01 and ICS581-02 are very similar. Following is a description of the operation of the ICS581-01 and the differences of the ICS581-02.

The ICS581-01 is a PLL-based, zero delay, clock multiplexer. The device consists of an input multiplexer controlled by SELA that selects between two clock inputs. The output of the mux drives the reference input of a phase locked loop. The other input to the PLL comes from a feedback input pin called FBIN. The output of the PLL drives four low skew outputs. These chip outputs are therefore buffered versions of the selected input clock with zero delay and 50/50 duty cycle.

For correct operation, one of the clock outputs must be connected to FBIN. In this datasheet, CLK4 is shown as the feedback, but any one of the four clock outputs can be used. If output termination resistors are used, the feedback should be connected before the resistor. It is a property of the PLL used on this chip that it will align rising edges on FBIN and

either INA or INB (depending on SELA). Since FBIN is connected to a clock output, this means that the outputs appear to align with the input with zero delay.

When the input select (SELA) is changed, the output clock will change frequency and/or phase until it lines up with the new input clock. This occurs in a smooth, gradual manner without any short pulses or glitches and will typically take a few tens of microseconds.

The part must be configured to operate in the correct frequency range. The table on page two gives the recommended range.

The four low skew outputs are controlled by two output enable pins that allow either one, three, or four simultaneous outputs. If both OE pins are low, the PLL is powered down.

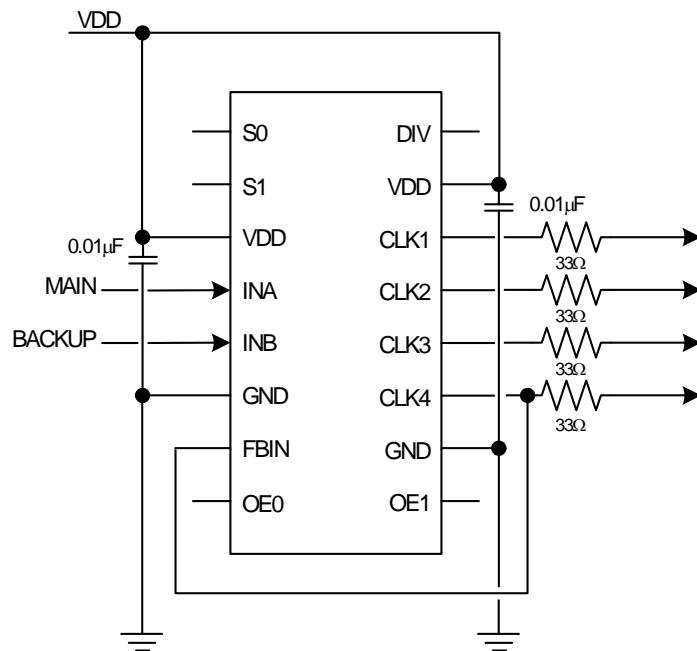
Note that the clock driving the FBIN pin must not be tri-stated unless the PLL is powered down. Otherwise the

PLL will run in an open loop.

The ICS581-02 is identical to the ICS581-01 except for the switching of the input mux. On the ICS581-02, the switching is automatically controlled by a transition detector. The transition detector monitors the clock on INA. If this clock stops, the output of the detector, NO\_INA goes high, which then selects clock input INB to the mux. The definition of the clock stopping is determined by a timeout selected by input DIV. If DIV is low, NO\_INA will go high after no transitions have occurred on INA for nominally three cycles of the clock on INB. If DIV is high, the timeout is nominally 48 cycles of INB. When INA restarts, the mux immediately switches back to the INA selection with no timeout.

## Application Example

A typical application for the ICS581-02 is to provide a backup clock for a system. The backup reliable clock would be connected to INB while the main clock would be connected to INA. If the main clock failed, the ICS581-02 would automatically be switched to the backup clock. The following example shows the connection for this.



In this example, the clocks are 155 MHz and so the frequency range is address 11. Both S0 and S1 are left unconnected, causing the on-chip pull-ups to produce the required high inputs. The same is true for OE0, OE1, and DIV. In this example, CLK4 is used as the feedback. Note that the feedback path is before the series resistor.

## External Components

The ICS581-01 and ICS581-02 require two  $0.01\mu\text{F}$  capacitors between VDD and GND, one on each side of the chip. These must be close to the chip to minimize lead inductance. Series termination resistors of  $33\Omega$  should be used on the outputs, should also be close to the chip, and the feedback path should be a direct connection from a clock output to a FBIN pin, routed directly under the chip to minimize trace length. This should be connected before the series termination resistor.

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS581-01/02. These ratings, which are standard values for IDT 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 (ICS581-01, ICS581-02)	0 to +70°C
Ambient Operating Temperature (ICS581-01I, ICS581-02I)	-40 to +85°C
Storage Temperature	-65 to +150°C
Junction Temperature	125°C
Soldering Temperature	260°C

## Recommended Operation Conditions

Parameter	Min.	Typ.	Max.	Units
Ambient Operating Temperature (ICS581-01, ICS581-02)	0		+70	°C
Ambient Operating Temperature (ICS581-01I, ICS581-02I)	-40		+85	°C
Power Supply Voltage (measured in respect to GND)	+3.0		+5.5	V

## DC Electrical Characteristics

Unless stated otherwise,  $\text{VDD} = 3.3 \text{ V} \pm 5\%$ , Ambient Temperature -40 to +85°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Operating Voltage	VDD		3.0		5.5	V
Supply Current	IDD	100 MHz, no load		26		mA
Input High Voltage	$V_{IH}$	Non-clock inputs	2			V
Input Low Voltage	$V_{IL}$	Non-clock inputs			0.8	V
Input High Voltage	$V_{IH}$	INA, INB, FBIN	$(\text{VDD}/2)+1$	$\text{VDD}/2$		V
Input Low Voltage	$V_{IL}$	INA, INB, FBIN		$\text{VDD}/2$	$(\text{VDD}/2)-1$	V

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Capacitance	$C_{IN}$			5		pF
Output High Voltage	$V_{OH}$	$I_{OH} = -12 \text{ mA}$	$VDD-0.5$			V
Output Low Voltage	$V_{OL}$	$I_{OL} = 12 \text{ mA}$			0.5	V
Short Circuit Current	$I_{OS}$			$\pm 70$		mA
On-chip Pull-up Resistor	$R_{PU}$		$S1=0, OE1=0, SELA, DIV$ pins	250		k $\Omega$

## AC Electrical Characteristics

Unless stated otherwise,  $VDD = 3.3 \text{ V} \pm 5\%$ , Ambient Temperature -40 to +85° C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Frequency	$f_{IN}$		6		200	MHz
Input Clock Duty Cycle		at $VDD/2$	30		70	%
Skew	$t_{SKEW}$	selected input clock to FBIN, Note 1	-250	0	250	ps
		between any output clocks, Note 2	-250	0	250	ps
Transition Detector Timeout ICS581-02 only		$DIV = 0$	2	3	4	INB periods
		$DIV = 1$	32	48	64	INB periods
Frequency Transition Time	$t_{TRAN}$	50 to 150 MHz, Note 3, 4		70	200	$\mu\text{s}$
		100 to 100 MHz, Note 3, 5		4	10	$\mu\text{s}$
Output Clock Rise Time	$t_{OR}$	0.8 V to 2.0 V		1	2	ns
Output Clock Fall Time	$t_{OF}$	2.0 V to 0.8 V		1	2	ns
Output Clock Duty Cycle		less than 133 MHz at $VDD/2$ , no load	45		55	%
		greater than 133 MHz at $VDD/2$ , no load	40		60	%
		with $S0=S1=1$ at $VDD/2$ , no load	40		60	%
Absolute Output Clock Period Jitter	$t_{JA}$	Deviation from mean		$\pm 150$		ps
One Sigma Output Clock Period Jitter	$t_{JA}$			40		ps

Note 1: Assumes clocks with same rise times, measured at  $VDD/2$ .

Note 2: Assumes identically loaded outputs with identical rise times, measured at  $VDD/2$ . The maximum skew between any two clocks is 250 ps not 500 ps.

Note 3: Time taken for output to lock to new clock when mux selection changed from INA to INB.

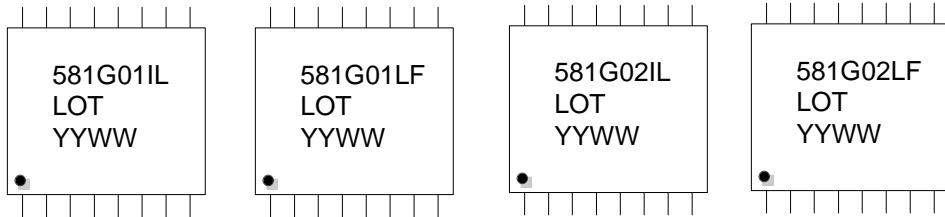
Note 4. With 50 MHz on INA and 150 MHz on INB.

Note 5: With 100 MHz on both INA and INB, 180° out of phase.

## Thermal Characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Thermal Resistance Junction to Ambient	$\theta_{JA}$	Still air		78		°C/W
	$\theta_{JA}$	1 m/s air flow		70		°C/W
	$\theta_{JA}$	3 m/s air flow		68		°C/W
Thermal Resistance Junction to Case	$\theta_{JC}$			37		°C/W

## Marking Diagrams

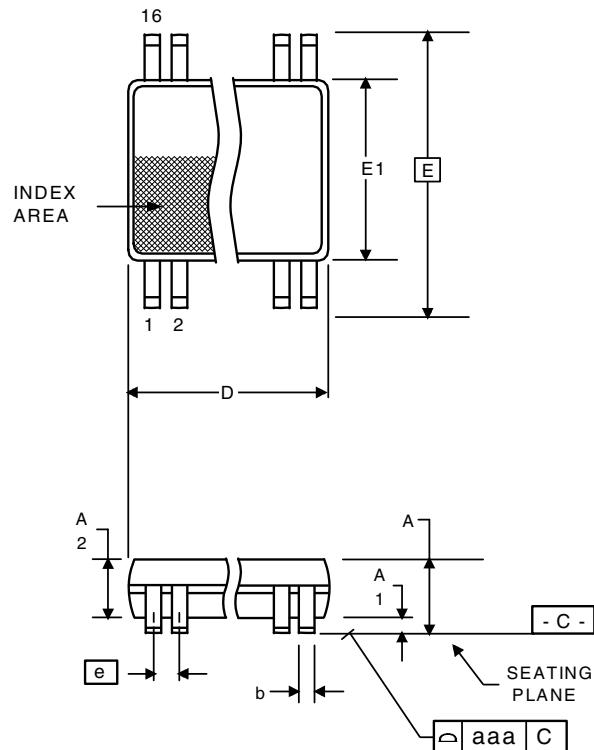


### Notes:

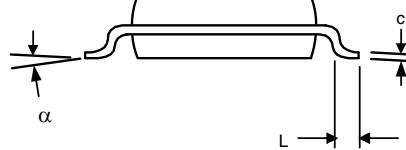
1. "LOT" is the lot number/sequence.
2. "YYWW" is the last two digits of the year and the week number that the part was assembled.
3. Bottom marking: country of origin if not USA.

## Package Outline and Package Dimensions (16-pin TSSOP, 4.40 mm Body, 0.65 mm Pitch)

Package dimensions are kept current with JEDEC Publication No. 95, MO-153



Symbol	Millimeters		Inches	
	Min	Max	Min	Max
A	--	1.20	--	0.047
A1	0.05	0.15	0.002	0.006
A2	0.80	1.05	0.032	0.041
b	0.19	0.30	0.007	0.012
C	0.09	0.20	0.0035	0.008
D	4.90	5.1	0.193	0.201
E	6.40 BASIC		0.252 BASIC	
E1	4.30	4.50	0.169	0.177
e	0.65 Basic		0.0256 Basic	
L	0.45	0.75	0.018	0.030
alpha	0°	8°	0°	8°
aaa	--	0.10	--	0.004



## Ordering Information

Part / Order Number	Marking	Shipping Packaging	Package	Temperature
581G-01ILF	See page 7	Tubes	16-pin TSSOP	-40 to +85° C
581G-01ILFT		Tape and Reel	16-pin TSSOP	-40 to +85° C
581G-01LF		Tubes	16-pin TSSOP	0 to +70° C
581G-01LFT		Tape and Reel	16-pin TSSOP	0 to +70° C
581G-02ILF		Tubes	16-pin TSSOP	-40 to +85° C
581G-02ILFT		Tape and Reel	16-pin TSSOP	-40 to +85° C
581G-02LF		Tubes	16-pin TSSOP	0 to +70° C
581G-02LFT		Tape and Reel	16-pin TSSOP	0 to +70° C

**"LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.**

While the information presented herein has been checked for both accuracy and reliability, Integrated Device Technology (IDT) assumes no responsibility for either its use or for the infringement of any patents or other rights of third parties, which would result from its use. No other circuits, patents, or licenses are implied. This product is intended for use in normal commercial applications. Any other applications such as those requiring extended temperature range, high reliability, or other extraordinary environmental requirements are not recommended without additional processing by IDT. IDT reserves the right to change any circuitry or specifications without notice. IDT does not authorize or warrant any IDT product for use in life support devices or critical medical instruments.

ICS581-01/02

ZERO DELAY GLITCH-FREE CLOCK MULTIPLEXER

ZDB AND MULTIPLEXER

## IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES ("RENESAS") PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

### Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan  
[www.renesas.com](http://www.renesas.com)

### Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

### Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit [www.renesas.com/contact-us/](http://www.renesas.com/contact-us/).