USER CONFIGURABLE CLOCK

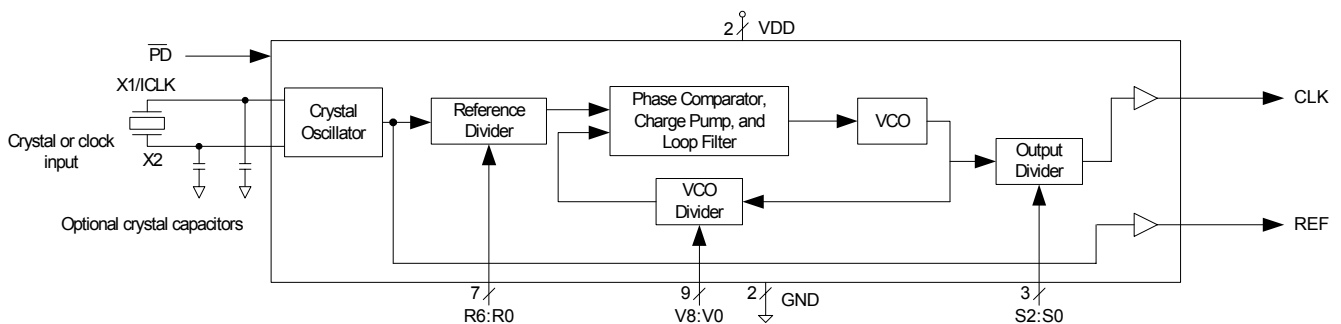# ICS525-01/02/11/12

Description

The ICS525-01/02/11/12 are the most flexible way to generate a high-quality, high-accuracy, high-frequency clock output from an inexpensive crystal or clock input. The user can configure the device to produce nearly any output frequency from any input frequency by grounding or floating the select pins. Neither microcontroller, software, nor device programmer are needed to set the frequency. Using Phase-Locked Loop (PLL) techniques, the device accepts a standard fundamental mode, inexpensive crystal to produce output clocks up to 250 MHz. It can also produce a highly accurate output clock from a given input clock, keeping them frequency locked together.

For similar capability with a serial interface, use the ICS307. For simple multipliers to produce common frequencies, refer to the ICS50x family of parts, which are smaller and more cost effective.
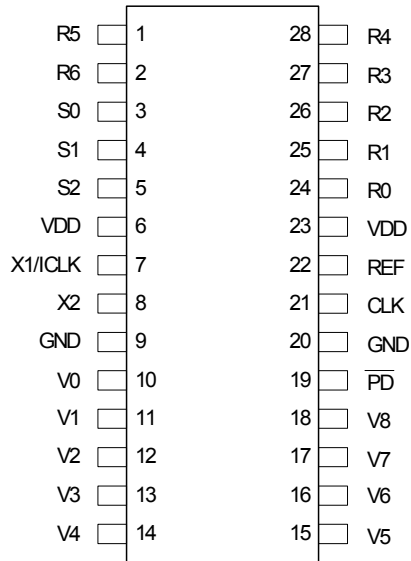
These products are intended for clock generation. They have low output jitter (variation in the output period), but input to output skew and jitter are not defined nor guaranteed. For applications which require defined input to output timing, use the ICS527-01.

Features

- Packaged as 28-pin SSOP (150 mil body)
- Industrial and commercial versions available in Pb (lead) free package
- User determines the output frequency by setting all internal dividers
- Eliminates need for custom oscillators
- No software needed
- Online calculator determines register settings
- Pull-ups on all select inputs
- Input crystal frequency of 5 - 27 MHz
- Input clock frequency of 2 - 50 MHz
- Very low jitter
- Duty cycle of 45/55 up to 200 MHz
- Operating voltage of 3.0 V or 5.5 V
- Ideal for oscillator replacement
- Industrial temperature version available
- For Zero Delay, refer to the ICS527

Block Diagram

Pin Assignment

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          ┌──────────────┐
 R5   □  1│              │28  □  R4
 R6   □  2│              │27  □  R3
 S0   □  3│              │26  □  R2
 S1   □  4│              │25  □  R1
 S2   □  5│              │24  □  R0
 VDD  □  6│              │23  □  VDD
X1/ICLK□ 7│              │22  □  REF
 X2   □  8│              │21  □  CLK
 GND  □  9│              │20  □  GND
 V0   □ 10│              │19  □  PD
 V1   □ 11│              │18  □  V8
 V2   □ 12│              │17  □  V7
 V3   □ 13│              │16  □  V6
 V4   □ 14│              │15  □  V5
          └──────────────┘
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ICS525-01/-02/-11/-12

Pin Descriptions

Pin Number	Pin Name	Pin Type	Pin Description
1, 2, 24-28	R5, R6, R0-R4	I(PU)	Reference divider word input pins determined by user. Forms a binary number from 0 to 127.
3, 4, 5	S0, S1, S2	I(PU)	Select pins for output divider determined by user. See table on page 3
6, 23	VDD	Power	Connect to VDD.
7	X1/ICLK	X1	Crystal connection. Connect to a parallel resonant fundamental crystal or input clock.
8	X2	X2	Crystal connection. Connect to a crystal or leave unconnected for clock.
9, 20	GND	Power	Connect to ground.
10 - 18	V0 - V8	I(PU)	VCO divider word input pins determined by user. Forms a binary number from 0 to 511.
19	$\overline{PD}$	Input	Power-down. Active low. Turns off entire chip when low. Clock outputs tri-stated.
21	CLK	Output	Output clock determined by status of R0-R6, V-V8, S0-S2, and input frequency.
22	REF	Output	Reference output. Buffered crystal oscillator (or clock) output.

KEY: I(PU) = Input with internal pull-up resistor; X1, X2 = crystal connections

ICS525-01 Output Frequency and Output Divider Table

S2 Pin 5	S1 Pin 4	S0 Pin 3	CLK Output Divider	Output Frequency Range (MHz)			
				VDD = 5 V		VDD = 3.3 V	
				0 - 70° C	-40 to +85° C	0 - 70° C	-40 to +85° C
0	0	0	10	3–26	3–23	3–18	3–16
0	0	1	2	15–160	15–140	15–100	15–90
0	1	0	8	3.75–40	3.75–36	3.75–25	3.75–22
0	1	1	4	7.5–80	7.5–72	7.5–50	7.5–45
1	0	0	5	6–50	6–45	6–34	6–30
1	0	1	7	4–40	4–36	4–26	4–23
1	1	0	9	3.3–33.3	3.3–30	3.3–20	3.3–18
1	1	1	6	5–53	5–47	5–27	5–24

ICS525-02 Output Frequency and Output Divider Table

S2 Pin 5	S1 Pin 4	S0 Pin 3	CLK Output Divider	Output Frequency Range (MHz)	
				VDD = 5 V	VDD = 3.3 V
				-40 to +85° C	-40 to +85° C
0	0	0	6	5–67	5–40
0	0	1	2	15–200	15–120
0	1	0	8	3.75–50	3.75–30
0	1	1	4	7.5–100	7.5–60
1	0	0	5	6–80	6–48
1	0	1	7	4–57	4–34
1	1	0	1	30–250	30–200
1	1	1	3	10–133	10–80

ICS525-11 Output Frequency and Output Divider Table

S2 Pin 5	S1 Pin 4	S0 Pin 3	CLK Output Divider	Output Frequency Range (MHz)			
				VDD = 5 V		VDD = 3.3 V	
				0 - 70° C	-40 to +85° C	0 - 70° C	-40 to +85° C
0	0	0	10	0.75–6.5	0.75–5.75	0.75–4.5	0.75–4
0	0	1	2	3.75–40	3.75–35	3.75–25	3.75–22.5
0	1	0	8	0.94–10	0.94–9	0.94–6.25	0.94–5.5
0	1	1	4	1.875–20	1.875–18	1.875–12.5	1.875–11.25
1	0	0	5	1.5–12.5	1.5–11.25	1.5–8.5	1.5–7.5
1	0	1	7	1–10	1–9	1–6.5	1–5.75
1	1	0	9	0.83–8.33	0.83–7.5	0.83–5	0.83–4.5
1	1	1	6	1.25–13.25	1.25–11.75	1.25–6.75	1.25–6

ICS525-12 Output Frequency and Output Divider Table

S2 Pin 5	S1 Pin 4	S0 Pin 3	CLK Output Divider	Output Frequency Range (MHz)	
				VDD = 5 V	VDD = 3.3 V
				-40 to +85° C	-40 to +85° C
0	0	0	6	1.25–16.75	1.25–10
0	0	1	2	3.75–50	3.75–30
0	1	0	8	0.94–12.5	0.94–7.5
0	1	1	4	1.875–25	1.875–15
1	0	0	5	1.5–20	1.5–12
1	0	1	7	1–14.25	1–8.5
1	1	0	1	7.5–62.5	7.5–50
1	1	1	3	2.5–33.25	2.5–20

External Components/Crystal Selection

Decoupling Capacitors

The ICS525-01/02/11/12 requries two 0.01μF decoupling capacitors to be connected between VDD and GND, one on each side of the chip. The capacitor must be connected close to the device to minimize lead inductance.

External Resistors

A 33Ω series termination resistor should be used on the CLK and REF pins.

Crystal Load Capacitors

The approximate total on-chip capacitance for a crystal is 16 pF, so a parallel resonant, fundamental mode crystal with this value of load (correlation) capacitance should be used. For crystals with a specified load capacitance greater than 16 pF, crystal capacitors may be connected from each of the pins X1 and X2 to Ground as shown in the block diagram. The value (in pF) of these crystal caps should be (CL -16)*2, where CL is the crystal load capacitance in pF. These external capacitors are only required for applications where the exact frequency is critical. For a clock input, connect to X1 and leave X2 unconnected (no capacitors on either).

Determining the Output Frequency

Users have full control in setting the desired output frequency over the range shown in the tables on pages 3-4. To replace a standard oscillator, users should connect the divider select input pins directly to ground (or VDD, although this is not required because of internal pull-ups) during Printed Circuit Board layout. The ICS525 will automatically produce the correct frequency when all components are soldered. It is also possible to connect the inputs to parallel I/O ports to switch frequencies. By choosing divides carefully, the number of inputs which need to be changed can be minimized. Observe the restrictions on allowed values of VDW and RDW.

Configuration Pin Settings

The output of the ICS525 can be determined by the following simple equation:

$$\text{CLK Frequency} = \text{Input Frequency} \times 2x\frac{(VDW + 8)}{(RDW + 2) \bullet OD}$$

Where:

Reference Divider Word (RDW) = 0 to 127 (0 not permitted for ICS525-01/-11)

VCO Divider Word (VDW) = 0 to 511 (0, 1, 2, 3 not permitted for ICS525-01/-11)

Output Divider (OD) = values on pages 3-4

Also, the following operating ranges should be observed:

1. The output frequency must be in the ranges listed on pages 3-4.

2. The phase detector frequency must be above 200 kHz.

$$200kHz < \frac{InputFrequency}{(RDW + 2)}$$

Since all of the inputs have pull-up resistors, it is only necessary to ground the pins that need to be set to zero.

Which Part to Use?

The ICS525-01 is the original configurable clock.

The ICS525-02 has a higher maximum output grequency and a slightly different set of output dividers.

The ICS525-11 has the same divider set as the -01 but is optimized for low frequency operation.

The ICS525-12 has the same divider set as the -02 but is optimized for low frequency operation.

To determine the best combination of VCO, reference, and output divide, use the ICS525 Calculator on our web site.

Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the ICS525-01/02/11/12. 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, Commercial	0 to +70° C
Ambient Operating Temperature, Industrial	-40 to +85° C
Storage Temperature	-65° C to 150° C
Junction Temperature	125° C
Soldering Temperature	260° C (max. of 10 seconds)

DC Electrical Characteristics

Unless stated otherwise, **VDD = 3.3 V**

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Operating Voltage	VDD		3.0		5.5	V
Operating Supply Current	IDD	60 MHz out, no load, 15 MHz crystal, ICS525-01/02 only		8		mA
Operating Supply Current	IDD	40 MHz out, 15 MHz crystal, ICS525-11/12 only		6		mA
Operating Supply Current, Power-down	IDD	Pin 19 = 0, Note 1		4		µA
Input High Voltage	V_{IH}		2			V
Input Low Voltage	V_{IL}				0.8	V
Input High Voltage, X1/ICLK only	V_{IH}	ICLK (pin7)	VDD/2+1	VDD/2		V
Input Low Voltage, X1/ICLK only	V_{IL}	ICLK (pin7)		VDD/2	VDD/2-1	V
Output High Voltage	V_{OH}	I_{OH} = -12 mA	VDD-0.4			V
Output Low Voltage	V_{OL}	I_{OL} = 12 mA			0.4	V

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Short Circuit Current		CLK and REF outputs		±55		mA
Input Capacitance	C_{IN}	V, R, S pins and pin 19		4		pF
On-chip Pull-up Resistor	R_{PU}	V, R, S pins and pin 19		270		kΩ

AC Electrical Characteristics

Unless stated otherwise, **VDD = 3.3 V**

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Frequency	F_{IN}	Crystal input	5		27	MHz
		Clock input	2		50	MHz
Output Clock Rise Time		0.8 to 2.0 V		1		ns
Output Clock Fall Time		2.0 to 0.8 V		1		ns
Output Clock Duty Cycle, OD = 2, 4, 6, 8, or 10		At VDD/2	45	49 to 51	55	%
Output Clock Duty Cycle, OD = 3, 5, 7, or 9		At VDD/2	40		60	%
Output Clock Duty Cycle, OD = 1 (-02 and -12 only)		At VDD/2	35		65	
Power-down Time, PD low to clocks stopped					50	ns
Power-up Time, PD high to clocks stable					10	ms
Absolute Clock Period Jitter, ICS525-01, Note 2	t_{ja}	Deviation from mean		±140		ps
One Sigma Clock Period Jitter, ICS525-01, Note 2	t_{js}	One Sigma		45		ps
Absolute Clock Period Jitter, ICS525-02, Note 2	t_{ja}	Deviation from mean		±85		ps
One Sigma Clock Period Jitter, ICS525-02, Note 2	t_{js}	One Sigma		30		ps
Absolute Clock Period Jitter, ICS525-11, Note 2	t_{ja}	Deviation from mean		±160		ps
One Sigma Clock Period Jitter, ICS525-11, Note 2	t_{js}	One Sigma		40		ps
Absolute Clock Period Jitter, ICS525-12, Note 2	t_{ja}	Deviation from mean		±160		ps
One Sigma Clock Period Jitter, ICS525-12, Note 2	t_{js}	One Sigma		40		ps

NOTE 1: Phase relationship between input and output can change at power-up. For a fixed phase relationship, see the ICS527.

NOTE 2: For 16 MHz, 100 MHz output. Use the -02 for lowest jitter.

Package Outline and Package Dimensions (28-pin SSOP, 150 mil Body)

Package dimensions are kept current with JEDEC Publication No. 95, MO-153
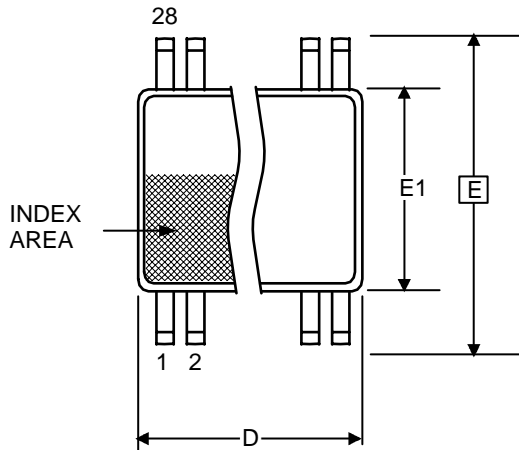
Symbol	Millimeters		Inches*	
	Min	Max	Min	Max
A	1.35	1.75	.053	.069
A1	0.10	0.25	.0040	.010
A2	--	1.50	--	.059
b	0.20	0.30	.008	.012
C	0.18	0.25	.007	.010
D	9.80	10.00	.386	.394
E	5.80	6.20	.228	.244
E1	3.80	4.00	.150	.157
e	0.635 Basic		0.025 Basic	
L	0.40	1.27	.016	.050
α	0°	8°	0°	8°
aaa	--	0.10	--	0.004

*For reference only. Controlling dimensions in mm.
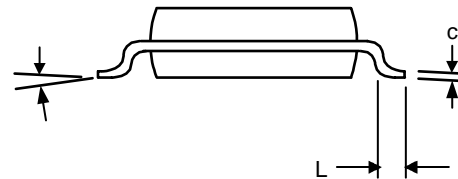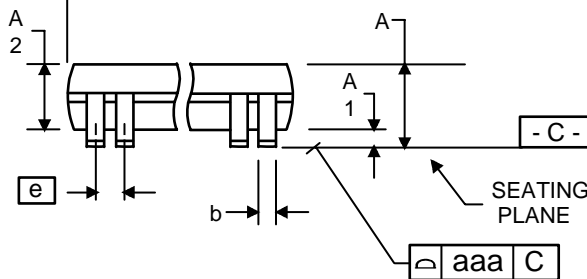
Ordering Information

Part / Order Number	Marking	Shipping Packaging	Package	Temperature
525-01R	ICS525-01R	Tubes	28-pin SSOP	0 to +70°C
525-01RT	ICS525-01R	Tape and Reel	28-pin SSOP	0 to +70°C
525-01RLF	ICS525-01RLF	Tubes	28-pin SSOP	0 to +70°C
525-01RLFT	ICS525-01RLF	Tape and Reel	28-pin SSOP	0 to +70°C
525-01RI	ICS525-01RI	Tubes	28-pin SSOP	-40 to +85°C
525-01RIT	ICS525-01RI	Tape and Reel	28-pin SSOP	-40 to +85°C
525-01RILF	ICS525-01RILF	Tubes	28-pin SSOP	-40 to +85°C
525-01RILFT	ICS525-01RILF	Tape and Reel	28-pin SSOP	-40 to +85°C
525R-02	ICS525R-02	Tubes	28-pin SSOP	0 to +70°C
525R-02T	ICS525R-02	Tape and Reel	28-pin SSOP	0 to +70°C
525R-02LF	ICS525R-02LF	Tubes	28-pin SSOP	0 to +70°C
525R-02LFT	ICS525R-02LF	Tape and Reel	28-pin SSOP	0 to +70°C
525R-02I	ICS525R-02I	Tubes	28-pin SSOP	-40 to +85°C
525R-02IT	ICS525R-02I	Tape and Reel	28-pin SSOP	-40 to +85°C
525R-02ILF	ICS525R-02ILF	Tubes	28-pin SSOP	-40 to +85°C
525R-02ILFT	ICS525R-02ILF	Tape and Reel	28-pin SSOP	-40 to +85°C
525R-11	525-11R	Tubes	28-pin SSOP	0 to +70°C
525R-11T	525-11R	Tape and Reel	28-pin SSOP	0 to +70°C
525R-11LF	525R-11LF	Tubes	28-pin SSOP	0 to +70°C
525R-11LFT	525R-11LF	Tape and Reel	28-pin SSOP	0 to +70°C
525RI-11	ICS525RI-11	Tubes	28-pin SSOP	-40 to +85°C
525RI-11T	ICS525RI-11	Tape and Reel	28-pin SSOP	-40 to +85°C
525RI-11LF	ICS525RI-11LF	Tubes	28-pin SSOP	-40 to +85°C
525RI-11LFT	ICS525RI-11LF	Tape and Reel	28-pin SSOP	-40 to +85°C
525RI-12	ICS525RI-12	Tubes	28-pin SSOP	-40 to +85°C
525RI-12T	ICS525RI-12	Tape and Reel	28-pin SSOP	-40 to +85°C
525RI-12LF	ICS525RI-12LF	Tubes	28-pin SSOP	-40 to +85°C
525RI12LFT	ICS525RI-12LF	Tape and Reel	28-pin SSOP	-40 to +85°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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