



## System Clock Chip for ATI RS480 K8-based Systems

### Recommended Application:

ATI RS480 systems using AMD K8 processors

### Output Features:

- 3 - 14.318 MHz REF clocks
- 1 - USB\_48MHz USB clock
- 1 - HyperTransport 66 MHz clock seed
- 1 - PCI 33 MHz clock seed
- 2 - Pairs of AMD K8 clocks
- 6 - Pairs of SRC/PCI Express\* clocks
- 2 - Pairs of ATIG (SRC/PCI Express) clocks

### Features:

- 2 - Programmable Clock Request pins for SRC clocks
- Spread Spectrum for EMI reduction
- Outputs may be disabled via SMBus
- External crystal load capacitors for maximum frequency accuracy

### Pin Configuration

X1	1	56	VDDREF
X2	2	55	GND
VDD48	3	54	**FS0/REF0
USB_48MHz	4	53	**FS1/REF1
GND	5	52	REF2
NC	6	51	VDDPCI
SCLK	7	50	PCICLK0
SDATA	8	49	GNDPCI
**FS2	9	48	VDDHTT
**CLKREQA#	10	47	HTTCLK0
**CLKREQB#	11	46	GNDHTT
SRCCLKT7	12	45	CPUCLK8T0
SRCCLKC7	13	44	CPUCLK8C0
VDDSRC	14	43	VDDCPU
GNDSRC	15	42	GNDCPU
SRCCLKT6	16	41	CPUCLK8T1
SRCCLKC6	17	40	CPUCLK8C1
SRCCLKT5	18	39	VDDA
SRCCLKC5	19	38	GND A
GNDSRC	20	37	IREF
VDDSRC	21	36	GNDSRC
SRCCLKT4	22	35	VDDSRC
SRCCLKC4	23	34	SRCCLKT0
SRCCLKT3	24	33	SRCCLKC0
SRCCLKC3	25	32	VDDATI
GNDSRC	26	31	GNDATI
ATIGCLKT1	27	30	ATIGCLKT0
ATIGCLKC1	28	29	ATIGCLKC0

**Note:** Pins preceded by '\*' have a 120 Kohm Internal Pull Down resistor

### 56 Pin SSOP/TSSOP

### Power Groups

Pin Number		Description
VDD	GND	
56	55	Xtal, REF
51	49	PCICLK output
48	46	HTTCLK output
43	42	CPU Outputs
14, 21, 32, 35	15, 20, 26, 31, 36	SRC outputs
39	38	Analog, CPU PLL
3	5	USB_48MHz output

### Functionality

FS2	FS1	FS0	CPU	HTT	PCI
			MHz	MHz	MHz
0	0	0	Hi-Z	Hi-Z	Hi-Z
0	0	1	X	X/3	X/6
0	1	0	180.00	60.00	30.00
0	1	1	220.00	73.12	36.56
1	0	0	100.00	66.66	33.33
1	0	1	133.33	66.66	33.33
1	1	1	200.00	66.66	33.33

## Pin Descriptions

PIN #	PIN NAME	PIN TYPE	DESCRIPTION
1	X1	IN	Crystal input, Nominally 14.318MHz.
2	X2	OUT	Crystal output, Nominally 14.318MHz
3	VDD48	PWR	Power pin for the 48MHz output.3.3V
4	USB_48MHz	OUT	48.00MHz USB clock
5	GND	PWR	Ground pin.
6	NC	N/A	No Connection.
7	SCLK	IN	Clock pin of SMBus circuitry, 5V tolerant.
8	SDATA	I/O	Data pin for SMBus circuitry, 5V tolerant.
9	**FS2	IN	Frequency select pin.
10	**CLKREQA#	IN	Output enable for PCI Express (SRC) outputs. SMBus selects which outputs are controlled. 0 = enabled, 1 = tri-stated
11	**CLKREQB#	IN	Output enable for PCI Express (SRC) outputs. SMBus selects which outputs are controlled. 0 = enabled, 1 = tri-stated
12	SRCCLKT7	OUT	True clock of differential SRC clock pair.
13	SRCCLKC7	OUT	Complement clock of differential SRC clock pair.
14	VDDSRC	PWR	Supply for SRC clocks, 3.3V nominal
15	GNDSRC	PWR	Ground pin for the SRC outputs
16	SRCCLKT6	OUT	True clock of differential SRC clock pair.
17	SRCCLKC6	OUT	Complement clock of differential SRC clock pair.
18	SRCCLKT5	OUT	True clock of differential SRC clock pair.
19	SRCCLKC5	OUT	Complement clock of differential SRC clock pair.
20	GNDSRC	PWR	Ground pin for the SRC outputs
21	VDDSRC	PWR	Supply for SRC clocks, 3.3V nominal
22	SRCCLKT4	OUT	True clock of differential SRC clock pair.
23	SRCCLKC4	OUT	Complement clock of differential SRC clock pair.
24	SRCCLKT3	OUT	True clock of differential SRC clock pair.
25	SRCCLKC3	OUT	Complement clock of differential SRC clock pair.
26	GNDSRC	PWR	Ground pin for the SRC outputs
27	ATIGCLKT1	OUT	True clock of differential SRC clock pair.
28	ATIGCLKC1	OUT	Complementary clock of differential SRC clock pair.

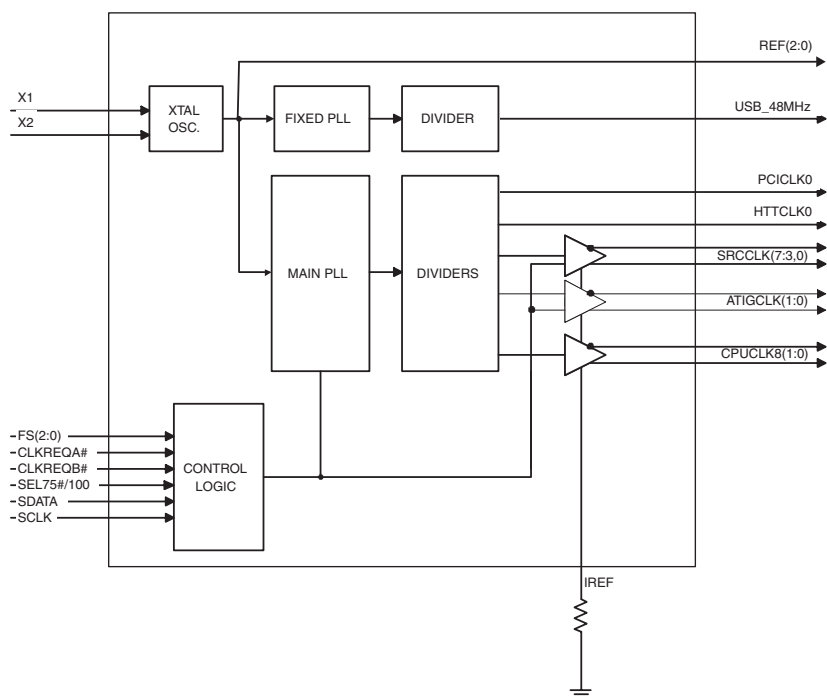
## Pin Descriptions (Continued)

PIN #	PIN NAME	Type	Pin Description
29	ATIGCLKC0	OUT	Complementary clock of differential SRC clock pair.
30	ATIGCLKT0	OUT	True clock of differential SRC clock pair.
31	GNDATI	PWR	Ground for ATI Gclocks, nominal 3.3V
32	VDDATI	PWR	Power supply ATI Gclocks, nominal 3.3V
33	SRCCLKC0	OUT	Complement clock of differential SRC clock pair.
34	SRCCLKT0	OUT	True clock of differential SRC clock pair.
35	VDDSRC	PWR	Supply for SRC clocks, 3.3V nominal
36	GNDSRC	PWR	Ground pin for the SRC outputs
37	IREF	OUT	This pin establishes the reference current for the differential current-mode output pairs. This pin requires a fixed precision resistor tied to ground in order to establish the appropriate current. 475 ohms is the standard value.
38	GND A	PWR	Ground pin for the PLL core.
39	VDD A	PWR	3.3V power for the PLL core.
40	CPUCLK8C1	OUT	Complementary clock of differential 3.3V push-pull K8 pair.
41	CPUCLK8T1	OUT	True clock of differential 3.3V push-pull K8 pair.
42	GND CPU	PWR	Ground pin for the CPU outputs
43	VDD CPU	PWR	Supply for CPU clocks, 3.3V nominal
44	CPUCLK8C0	OUT	Complementary clock of differential 3.3V push-pull K8 pair.
45	CPUCLK8T0	OUT	True clock of differential 3.3V push-pull K8 pair.
46	GND HTT	PWR	Ground pin for the HTT outputs
47	HTTCLK0	OUT	3.3V Hyper Transport output
48	VDD HTT	PWR	Supply for HTT clocks, nominal 3.3V.
49	GND PCI	PWR	Ground pin for the PCI outputs
50	PCICLK0	OUT	PCI clock output.
51	VDD PCI	PWR	Power supply for PCI clocks, nominal 3.3V
52	REF2	OUT	14.318 MHz reference clock.
53	**FS1/REF1	I/O	Frequency select latch input pin / 14.318 MHz reference clock.
54	**FS0/REF0	I/O	Frequency select latch input pin / 14.318 MHz reference clock.
55	GND	PWR	Ground pin.
56	VDDREF	PWR	Ref, XTAL power supply, nominal 3.3V

## General Description

The **ICS951412B** is a main clock synthesizer chip that provides all clocks required for ATI RS480-based systems. An SMBus interface allows full control of the device.

## Block Diagram



## Skew Characteristics

Parameter	Description	Test Conditons	Skew Window	Unit
$T_{sk\_CPU\_CPU}$	time independent skew not dependent on V, T changes	measured at x-ing of CPU,	250	ps
$T_{sk\_CPU\_PCI}$		measured at x-ing of CPU, 1.5V of PCI clock	2000	ps
$T_{sk\_PCI\_PCI}$		measured between rising edge at 1.5V	500	ps
$T_{sk\_PCI33-HT66}$		measured between rising edge at 1.5V	500	ps
$T_{sk\_CPU\_HT66}$		measured between rising edge at 1.5V	2000	ps
$T_{sk\_CPU\_HT66}$		measured at x-ing of CPU, 1.5V of PCI clock	500	ps
$T_{sk\_CPU\_CPU}$	time variant skew varies over V, T changes	measured at x-ing of CPU,	200	ps
$T_{sk\_CPU\_PCI}$		measured at x-ing of CPU, 1.5V of PCI clock	200	ps
$T_{sk\_PCI\_PCI}$		measured between rising edge at 1.5V	200	ps
$T_{sk\_PCI33-HT66}$		measured between rising edge at 1.5V	200	ps
$T_{sk\_CPU\_HT66}$		measured between rising edge at 1.5V	200	ps
$T_{sk\_CPU\_HT66}$		measured at x-ing of CPU, 1.5V of PCI clock	200	ps

## General SMBus serial interface information

### How to Write:

- Controller (host) sends a start bit.
- Controller (host) sends the write address  $D2_{(H)}$
- ICS clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- ICS clock will **acknowledge**
- Controller (host) sends the data byte count = X
- ICS clock will **acknowledge**
- Controller (host) starts sending **Byte N through Byte N + X - 1**  
(see Note 2)
- ICS clock will **acknowledge** each byte **one at a time**
- Controller (host) sends a Stop bit

Index Block Write Operation		
Controller (Host)		ICS (Slave/Receiver)
T	starT bit	
Slave Address $D2_{(H)}$		
WR	WRite	
		ACK
Beginning Byte = N		
		ACK
Data Byte Count = X		
		ACK
Beginning Byte N		
		ACK
○		
○		○
○		○
		○
Byte N + X - 1		
		ACK
P	stoP bit	

### How to Read:

- Controller (host) will send start bit.
- Controller (host) sends the write address  $D2_{(H)}$
- ICS clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- ICS clock will **acknowledge**
- Controller (host) will send a separate start bit.
- Controller (host) sends the read address  $D3_{(H)}$
- ICS clock will **acknowledge**
- ICS clock will send the data byte count = X
- ICS clock sends **Byte N + X - 1**
- ICS clock sends **Byte 0 through byte X (if  $X_{(H)}$  was written to byte 8)**
- Controller (host) will need to acknowledge each byte
- Controller (host) will send a not acknowledge bit
- Controller (host) will send a stop bit

Index Block Read Operation		
Controller (Host)		ICS (Slave/Receiver)
T	starT bit	
Slave Address $D2_{(H)}$		
WR	WRite	
		ACK
Beginning Byte = N		
		ACK
RT	Repeat starT	
Slave Address $D3_{(H)}$		
RD	ReaD	
		ACK
		Data Byte Count = X
ACK		
ACK		Beginning Byte N
		○
○		○
○		○
		Byte N + X - 1
N	Not acknowledge	
P	stoP bit	

**Table1: CPU Frequency Selection Table**

CPU SS_EN (B0:b4)	CPU FS3 (B0:b3)	CPU FS2	CPU FS1	CPU FS0	CPU (MHz)	HTT66 (MHz)	PCI33 (MHz)	Spread %
0	0	0	0	0	Hi-Z	Hi-Z	Hi-Z	None
0	0	0	0	1	X/6	X/12	X/24	None
0	0	0	1	0	180.00	60.00	30.00	None
0	0	0	1	1	220.00	73.33	36.67	None
0	0	1	0	0	100.00	66.67	33.33	None
0	0	1	0	1	133.33	66.67	33.33	None
0	0	1	1	0	166.67	66.67	33.33	None
0	0	1	1	1	200.00	66.67	33.33	None
0	1	0	0	0	186.00	62.00	31.00	None
0	1	0	0	1	214.00	71.33	35.67	None
0	1	0	1	0	190.00	63.33	31.67	None
0	1	0	1	1	210.00	70.00	35.00	None
0	1	1	0	0	102.00	68.00	34.00	None
0	1	1	0	1	136.00	68.00	34.00	None
0	1	1	1	0	170.00	68.00	34.00	None
0	1	1	1	1	204.00	68.00	34.00	None
1	0	0	0	0	169.58	56.53	28.26	-0.5%
1	0	0	0	1	229.43	76.48	38.24	-0.5%
1	0	0	1	0	179.55	59.85	29.93	-0.5%
1	0	0	1	1	219.45	73.15	36.58	-0.5%
1	0	1	0	0	99.75	66.50	33.25	-0.5%
1	0	1	0	1	133.00	66.50	33.25	-0.5%
1	0	1	1	0	166.25	66.50	33.25	-0.5%
1	0	1	1	1	199.50	66.50	33.25	-0.5%
1	1	0	0	0	185.54	61.85	30.92	-0.5%
1	1	0	0	1	106.73	71.16	35.58	-0.5%
1	1	0	1	0	189.53	63.18	31.59	-0.5%
1	1	0	1	1	209.48	69.83	34.91	-0.5%
1	1	1	0	0	101.75	67.83	33.92	-0.5%
1	1	1	0	1	135.66	67.83	33.91	-0.5%
1	1	1	1	0	169.58	67.83	33.92	-0.5%
1	1	1	1	1	203.49	67.83	33.92	-0.5%

**Table2: SRC & ATIG Frequency Selection Table**

Byte 5					SRC(7:3,0), ATIG(1:0) (MHz)	Spread %
Bit4 SRC Spread Enable	Bit3 SRC FS3	Bit2 SRC FS2	Bit1 SRC FS1	Bit0 SRC FS0		
0	0	0	0	0	100.00	0
0	0	0	0	1	100.00	0
0	0	0	1	0	100.00	0
0	0	0	1	1	100.00	0
0	0	1	0	0	101.00	0
0	0	1	0	1	101.00	0
0	0	1	1	0	101.00	0
0	0	1	1	1	101.00	0
0	1	0	0	0	102.00	0
0	1	0	0	1	102.00	0
0	1	0	1	0	102.00	0
0	1	0	1	1	102.00	0
0	1	1	0	0	104.00	0
0	1	1	0	1	104.00	0
0	1	1	1	0	104.00	0
0	1	1	1	1	104.00	0
1	0	0	0	0	99.75	-0.5%
1	0	0	0	1	99.75	-0.5%
1	0	0	1	0	99.75	-0.5%
1	0	0	1	1	99.75	-0.5%
1	0	1	0	0	100.74	-0.5%
1	0	1	0	1	100.74	-0.5%
1	0	1	1	0	100.74	-0.5%
1	0	1	1	1	100.74	-0.5%
1	1	0	0	0	101.74	-0.5%
1	1	0	0	1	101.74	-0.5%
1	1	0	1	0	101.74	-0.5%
1	1	0	1	1	101.74	-0.5%
1	1	1	0	0	103.74	-0.5%
1	1	1	0	1	103.74	-0.5%
1	1	1	1	0	103.74	-0.5%
1	1	1	1	1	103.74	-0.5%

**SMBus Table: Frequency Select Register**

Byte 0	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	FS Source	Latched Input or SMBus Frequency Select	RW	Latched Inputs	SMBus	0
Bit 6	-	CPU SS_EN	CPU Spread Enable	RW	OFF	ON	0
Bit 5	-	Reserved	Reserved	RW	Reserved	Reserved	X
Bit 4	-	CPU FS4	Freq Select Bit 4	RW	See Table 1: CPU Frequency Selection		0
Bit 3	-	CPU FS3	Freq Select Bit 3	RW			0
Bit 2	-	CPU FS2	Freq Select Bit 2	RW			Latched
Bit 1	-	CPU FS1	Freq Select Bit 1	RW			Latched
Bit 0	-	CPU FS0	Freq Select Bit 0	RW			Latched

Note: Byte 0 Bit 6, Byte 0 Bit 4 and Byte 5 Bit 4 must be set to '1' to fully enable spread.

**SMBus Table: Output Control Register**

Byte 1	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	50	PCICLK0	Output Enable	RW	Disable	Enable	1
Bit 6	47	HTTCLK0	Output Enable	RW	Disable	Enable	1
Bit 5	4	USB_48MHz	Output Enable	RW	Disable	Enable	1
Bit 4	54	REF0	Output Enable	RW	Disable	Enable	1
Bit 3	53	REF1	Output Enable	RW	Disable	Enable	1
Bit 2	52	REF2	Output Enable	RW	Disable	Enable	1
Bit 1	45,44	CPUCLK8(0)	Output Enable	RW	Disable	Enable	1
Bit 0	41,40	CPUCLK8(1)	Output Enable	RW	Disable	Enable	1

**SMBus Table: CLKREQB# Output Control Register**

Byte 2	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	12,13	REQBSRC7	CLKREQB# Controls SRC7	RW	Does not control	Controls	0
Bit 6	16,17	REQBSRC6	CLKREQB# Controls SRC6	RW	Does not control	Controls	0
Bit 5	18,19	REQBSRC5	CLKREQB# Controls SRC5	RW	Does not control	Controls	0
Bit 4	22,23	REQBSRC4	CLKREQB# Controls SRC4	RW	Does not control	Controls	0
Bit 3	24,25	REQBSRC3	CLKREQB# Controls SRC3	RW	Does not control	Controls	0
Bit 2	-	Reserved	Reserved	RW	Reserved	Reserved	X
Bit 1	-	Reserved	Reserved	RW	Reserved	Reserved	X
Bit 0	34,33	REQBSRC0	CLKREQB# Controls SRC0	RW	Does not control	Controls	0



**SMBus Table: SRCCLK(7:3,0), CLKREQA# Output Control Register**

Byte 3	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	12,13	SRCCLK7	Master Output control. Enables or disables output, regardless of CLKREQ# inputs.	RW	Disable	Enable	1
Bit 6	16,17	SRCCLK6		RW	Disable	Enable	1
Bit 5	18,19	SRCCLK5		RW	Disable	Enable	1
Bit 4	22,23	SRCCLK4		RW	Disable	Enable	1
Bit 3	24,25	SRCCLK3		RW	Disable	Enable	1
Bit 2	34,33	SRCCLK0		RW	Disable	Enable	1
Bit 1	24,25	REQASRC3	CLKREQA# Controls SRC3	RW	Does not control	Controls	0
Bit 0	34,33	REQASRC0	CLKREQA# Controls SRC0	RW	Does not control	Controls	0

**SMBus Table: SRCCLK(3,0), ATIGCLK Output Control Register**

Byte 4	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	12,13	REQASRC7	CLKREQA# Controls SRC7	RW	Does not control	Controls	0
Bit 6	16,17	REQASRC6	CLKREQA# Controls SRC6	RW	Does not control	Controls	0
Bit 5	18,19	REQASRC5	CLKREQA# Controls SRC5	RW	Does not control	Controls	0
Bit 4	22,23	REQASRC4	CLKREQA# Controls SRC4	RW	Does not control	Controls	0
Bit 3	27,28	ATIGCLK1	Output Enable These outputs cannot be controlled by CLKREQ# pins.	RW	Disabled	Enabled	1
Bit 2	30,29	ATIGCLK0		RW	Disabled	Enabled	1
Bit 1	-	Reserved	Reserved	RW	Reserved	Reserved	0
Bit 0	4	USB_48Str	48MHz Strength Control	RW	1X	2X	0

**Note:** Do NOT simultaneously select CLKREQA# and CLKREQB# to control an SRC output.  
Behavior of the device is undefined under these conditions.

**SMBus Table: Output Drive and ATIG Frequency Control Register**

Byte 5	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	52	REF2Str	REF2 Strength Control	RW	1X	2X	0
Bit 6	-	Reserved	Reserved	RW	Reserved	Reserved	0
Bit 5	-	Reserved	Reserved	RW	Reserved	Reserved	0
Bit 4	-	SRC SSEN	SRC Spread Enable	RW	See Table 2: SRC Frequency Selection		0
Bit 3	-	SRCFS3	Freq Select Bit 3	RW			0
Bit 2	-	SRCFS2	Freq Select Bit 2	RW			0
Bit 1	-	SRCFS1	Freq Select Bit 1	RW			0
Bit 0	-	SRCFS0	Freq Select Bit 0	RW			0

**SMBus Table: Device ID Register**

Byte 6	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	DevID 7	Device ID MSB	R	-	-	0
Bit 6	-	DevID 6	Device ID 6	R	-	-	0
Bit 5	-	DevID 5	Device ID 5	R	-	-	0
Bit 4	-	DevID 4	Device ID4	R	-	-	1
Bit 3	-	DevID 3	Device ID3	R	-	-	0
Bit 2	-	DevID 2	Device ID2	R	-	-	0
Bit 1	-	DevID 1	Device ID1	R	-	-	1
Bit 0	-	DevID 0	Device ID LSB	R	-	-	0

**SMBus Table: Vendor ID Register**

Byte 7	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	RID3	Revision ID	R	-	-	X
Bit 6	-	RID2		R	-	-	X
Bit 5	-	RID1		R	-	-	X
Bit 4	-	RID0		R	-	-	X
Bit 3	-	VID3	VENDOR ID (0001 = ICS)	R	-	-	0
Bit 2	-	VID2		R	-	-	0
Bit 1	-	VID1		R	-	-	0
Bit 0	-	VID0		R	-	-	1

**SMBus Table: Byte Count Register**

Byte 8	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	BC7	Byte Count Programming b(7:0)	RW	Writing to this register will configure how many bytes will be read back, default is 9 bytes.		0
Bit 6	-	BC6		RW			0
Bit 5	-	BC5		RW			0
Bit 4	-	BC4		RW			0
Bit 3	-	BC3		RW			1
Bit 2	-	BC2		RW			0
Bit 1	-	BC1		RW			0
Bit 0	-	BC0		RW			1

**Bytes 9 to 21 are reserved**

## Absolute Maximum Ratings

Supply Voltage	3.8V
Logic Inputs	GND –0.5 V to $V_{DD} + 3.8$ V
Ambient Operating Temperature	0°C to +70°C
Storage Temperature	–65°C to +150°C
ESD Protection	Input ESD protection using human body model > 1KV

Stresses above those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These ratings are stress specifications only and functional operation of the device at these or any other conditions above those listed 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 - Input/Supply/Common Output Parameters

$T_A = 0 - 70^\circ\text{C}$ ; Supply Voltage  $V_{DD} = 3.3$  V  $\pm 5\%$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Input High Voltage	$V_{IH}$	3.3 V $\pm 5\%$	2		$V_{DD} + 0.3$	V	1
Input Low Voltage	$V_{IL}$	3.3 V $\pm 5\%$	$V_{SS} - 0.3$		0.8	V	1
Input High Current	$I_{IH}$	$V_{IN} = V_{DD}$	-5		5	$\mu\text{A}$	1
Input Low Current	$I_{IL1}$	$V_{IN} = 0$ V; Inputs with no pull-up resistors	-5			$\mu\text{A}$	1
	$I_{IL2}$	$V_{IN} = 0$ V; Inputs with pull-up resistors	-200			$\mu\text{A}$	1
Operating Current	$I_{DD3.3OP}$	all outputs driven			300	mA	
Input Frequency <sup>3</sup>	$F_i$	$V_{DD} = 3.3$ V		14.31818		MHz	3
Pin Inductance <sup>1</sup>	$L_{pin}$				7	nH	1
Input Capacitance <sup>1</sup>	$C_{IN}$	Logic Inputs			5	pF	1
	$C_{OUT}$	Output pin capacitance			6	pF	1
	$C_{INX}$	X1 & X2 pins			5	pF	1
Clk Stabilization <sup>1,2</sup>	$T_{STAB}$	From $V_{DD}$ Power-Up or de-assertion of PD# to 1st clock			3	ms	1,2
Modulation Frequency		Triangular Modulation	30		33	kHz	1
SMBus Voltage	$V_{DD}$		2.7		5.5	V	1
Low-level Output Voltage	$V_{OL}$	@ $I_{PULLUP}$			0.4	V	1
Current sinking at $V_{OL} = 0.4$ V	$I_{PULLUP}$		4			mA	1
SCLK/SDATA Clock/Data Rise Time <sup>3</sup>	$T_{RI2C}$	(Max $V_{IL} - 0.15$ ) to (Min $V_{IH} + 0.15$ )			1000	ns	1
SCLK/SDATA Clock/Data Fall Time <sup>3</sup>	$T_{FI2C}$	(Min $V_{IH} + 0.15$ ) to (Max $V_{IL} - 0.15$ )			300	ns	1

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>See timing diagrams for timing requirements.

<sup>3</sup>Input frequency should be measured at the REFOUT pin and tuned to ideal 14.31818MHz to meet ppm frequency accuracy on PLL outputs.

## Electrical Characteristics - K8 Push Pull Differential Pair

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3\text{ V} \pm 5\%$ ;  $C_L = \text{AMD64 Processor Test Load}$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Rising Edge Rate	$\delta V/\delta t$	Measured at the AMD64 processor's test load. 0 V +/- 400 mV (differential measurement)	2		10	V/ns	1
Falling Edge Rate	$\delta V/\delta t$		2		10	V/ns	1
Differential Voltage	$V_{DIFF}$	Measured at the AMD64 processor's test load. (single-ended measurement)	0.4	1.25	2.3	V	1
Change in $V_{DIFF\_DC}$ Magnitude	$\Delta V_{DIFF}$		-150		150	mV	1
Common Mode Voltage	$V_{CM}$		1.05	1.25	1.45	V	1
Change in Common Mode Voltage	$\Delta V_{CM}$		-200		200	mV	1
Jitter, Cycle to cycle	$t_{jyc-cyc}$	Measurement from differential waveform. Maximum difference of cycle time between 2 adjacent cycles.	0	100	200	ps	1
Jitter, Accumulated	$t_{ja}$	Measured using the JI2 software package with a Tek 7404 scope. TIE (Time Interval Error) measurement technique: Sample resolution = 50 ps, Sample Duration = 10 $\mu\text{s}$	-1000		1000		1,2,3
Duty Cycle	$d_{t3}$	Measurement from differential waveform	45		53	%	1
Output Impedance	$R_{ON}$	Average value during switching transition. Used for determining series termination value.	15	35	55	$\Omega$	1
Group Skew	$t_{src-skew}$	Measurement from differential waveform			250	ps	1

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>All accumulated jitter specifications are guaranteed assuming that REF is at 14.31818MHz

<sup>3</sup>Spread Spectrum is off

## Electrical Characteristics - SRC 0.7V Current Mode Differential Pair

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3\text{ V} \pm 5\%$ ;  $C_L = 2\text{pF}$ ,  $R_S = 33.2\Omega$ ,  $R_P = 49.9\Omega$ ,  $I_{REF} = 475\Omega$

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Current Source Output Impedance	$Z_O$	$V_O = V_x$	3000			$\Omega$	1
Voltage High	VHigh	Statistical measurement on single ended signal using oscilloscope math function.	660		850	mV	1,3
Voltage Low	VLow		-150		150		1,3
Max Voltage	Vovs	Measurement on single ended signal using absolute value.			1150	mV	1
Min Voltage	Vuds		-300				1
Crossing Voltage (abs)	Vcross(abs)		250	350	550	mV	1
Crossing Voltage (var)	d-Vcross	Variation of crossing over all edges		12	140	mV	1
Long Accuracy	ppm	see Tperiod min-max values	-300		300	ppm	1,2
Average period	Tperiod	75.00 MHz nominal	8.5684	8.5714	8.5744	ns	2
		75.00 MHz spread	8.5684		8.6244	ns	2
		100.00 MHz nominal	9.9970	10.0000	10.0030	ns	2
		100.00 MHz spread	9.9970		10.0530	ns	2
		116.67 MHz nominal	13.3303	13.3333	13.3363	ns	2
		116.67 MHz spread	13.3303		13.3863	ns	2
		133.33 MHz nominal	7.4972	7.5002	7.5032	ns	2
		133.33 MHz spread	7.4972		7.5532	ns	2
Absolute min period	Tabsmin	@ 100.00MHz nominal/spread	9.8720			ns	1,2
Rise Time	$t_r$	$V_{OL} = 0.175\text{V}$ , $V_{OH} = 0.525\text{V}$	175		700	ps	1
Fall Time	$t_f$	$V_{OH} = 0.525\text{V}$ $V_{OL} = 0.175\text{V}$	175		700	ps	1
Rise Time Variation	d- $t_r$			30	125	ps	1
Fall Time Variation	d- $t_f$			30	125	ps	1
Duty Cycle	$d_{t3}$	Measurement from differential waveform	45		55	%	1
Group Skew	$t_{src-skew}$	Measurement from differential waveform			250	ps	
Jitter, Cycle to cycle	$t_{jyc-cyc}$	Measurement from differential waveform			100	ps	1

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>All Long Term Accuracy and Clock Period specifications are guaranteed assuming that REF is at 14.31818MHz

<sup>3</sup> $I_{REF} = V_{DD}/(3 \times R_R)$ . For  $R_R = 475\Omega$  (1%),  $I_{REF} = 2.32\text{mA}$ .  $I_{OH} = 6 \times I_{REF}$  and  $V_{OH} = 0.7\text{V}$  @  $Z_O = 50\Omega$ .

## Electrical Characteristics - PCI33, HTT66 Clocks

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3\text{V} \pm 5\%$ ;  $C_L = 30\text{ pF}$  (unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Long Accuracy	ppm	see Tperiod min-max values	-300		300	ppm	1,2
PCI33 Clock period	$T_{\text{period}}$	33.33MHz output nominal	29.9910		30.0090	ns	2
		33.33MHz output spread	29.9910		30.1598	ns	2
HTT66 Clock period	$T_{\text{period}}$	66.67MHz output nominal	14.9955		15.0045	ns	2
		66.67MHz output spread	14.9955		15.0799	ns	2
Output High Voltage	$V_{OH}$	$I_{OH} = -1\text{ mA}$	2.4			V	1
Output Low Voltage	$V_{OL}$	$I_{OL} = 1\text{ mA}$			0.55	V	1
Output High Current	$I_{OH}$	$V_{OH} @ \text{MIN} = 1.0\text{ V}$	-33		-46	mA	1
		$V_{OH} @ \text{MAX} = 3.135\text{ V}$	-50		-80	mA	1
Output Low Current	$I_{OL}$	$V_{OL} @ \text{MIN} = 1.95\text{ V}$	47		64	mA	1
		$V_{OL} @ \text{MAX} = 0.4\text{ V}$	58		91	mA	1
Edge Rate	$\delta V / \delta t$	Rising edge rate	1		4	V/ns	1
Edge Rate	$\delta V / \delta t$	Falling edge rate	1		4	V/ns	1
Rise Time	$t_{r1}$	$V_{OL} = 0.4\text{ V}, V_{OH} = 2.4\text{ V}$	0.5		2	ns	1
Fall Time	$t_{f1}$	$V_{OH} = 2.4\text{ V}, V_{OL} = 0.4\text{ V}$	0.5		2	ns	1
Duty Cycle	$d_{t1}$	$V_T = 1.5\text{ V}$	45		55	%	1
Skew	$t_{sk1}$	$V_T = 1.5\text{ V}$			500	ps	1
Jitter, Cycle to cycle	$t_{j\text{cyc-cyc}}$	$V_T = 1.5\text{ V}$			180	ps	1

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>All Long Term Accuracy and Clock Period specifications are guaranteed with the assumption that REF is at 14.31818MHz

## Electrical Characteristics - 48MHz, USB

$T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3 \text{ V} \pm 5\%$ ;  $C_L = 10\text{-}20 \text{ pF}$  (unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Long Accuracy	ppm	see Tperiod min-max values	-200		200	ppm	1,2
Clock period	$T_{\text{period}}$	48.00MHz output nominal	20.8257		20.8340	ns	2
Output High Voltage	$V_{OH}$	$I_{OH} = -1 \text{ mA}$	2.4			V	1
Output Low Voltage	$V_{OL}$	$I_{OL} = 1 \text{ mA}$			0.55	V	1
Output High Current	$I_{OH}$	$V_{OH} @ \text{MIN} = 1.0 \text{ V}$	-33		-46	mA	1
		$V_{OH} @ \text{MAX} = 3.135 \text{ V}$	-50		-80	mA	1
Output Low Current	$I_{OL}$	$V_{OL} @ \text{MIN} = 1.95 \text{ V}$	47		64	mA	1
		$V_{OL} @ \text{MAX} = 0.4 \text{ V}$	58		91	mA	1
Edge Rate	$\delta V / \delta t$	Rising edge rate	1		2	V/ns	1
Edge Rate	$\delta V / \delta t$	Falling edge rate	1		2	V/ns	1
Rise Time	$t_{r1}$	$V_{OL} = 0.4 \text{ V}, V_{OH} = 2.4 \text{ V}$	1	1.43	2	ns	1
Fall Time	$t_{f1}$	$V_{OH} = 2.4 \text{ V}, V_{OL} = 0.4 \text{ V}$	1	1.33	2	ns	1
Duty Cycle	$d_{t1}$	$V_T = 1.5 \text{ V}$	45	50	55	%	1
Jitter, Cycle to cycle	$t_{j\text{cyc-cyc}}$	$V_T = 1.5 \text{ V}$			150	ps	1

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>All Long Term Accuracy and Clock Period specifications are guaranteed with the assumption that REF is at 14.31818MHz

## Electrical Characteristics - REF-14.318MHz

$T_A = 0 - 70^{\circ}\text{C}$ ;  $V_{DD} = 3.3 \text{ V} \pm 5\%$ ;  $C_L = 10\text{-}20 \text{ pF}$  (unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Long Accuracy	ppm	see Tperiod min-max values	-300		300	ppm	1
Clock period	$T_{\text{period}}$	14.318MHz output nominal	69.8270		69.8550	ns	2
Output High Voltage	$V_{OH}$	$I_{OH} = -1 \text{ mA}$	2.4			V	1
Output Low Voltage	$V_{OL}$	$I_{OL} = 1 \text{ mA}$			0.4	V	1
Output High Current	$I_{OH}$	$V_{OH} @ \text{MIN} = 1.0 \text{ V}$	-29		-41	mA	1
		$V_{OH} @ \text{MAX} = 3.135 \text{ V}$	-45		-71	mA	1
Output Low Current	$I_{OL}$	$V_{OL} @ \text{MIN} = 1.95 \text{ V}$	39		54	mA	1
		$V_{OL} @ \text{MAX} = 0.4 \text{ V}$	49		77	mA	1
Edge Rate	$\delta V / \delta t$	Rising edge rate	1		4	V/ns	1
Edge Rate	$\delta V / \delta t$	Falling edge rate	1		4	V/ns	1
Rise Time	$t_{r1}$	$V_{OL} = 0.4 \text{ V}$ , $V_{OH} = 2.4 \text{ V}$	1		2	ns	1
Fall Time	$t_{f1}$	$V_{OH} = 2.4 \text{ V}$ , $V_{OL} = 0.4 \text{ V}$	1		2	ns	1
Skew	$t_{sk1}$	$V_T = 1.5 \text{ V}$			500	ps	1
Duty Cycle	$d_{t1}$	$V_T = 1.5 \text{ V}$	45	50	55	%	1
Jitter, Cycle to cycle	$t_{j\text{cyc-cyc}}$	$V_T = 1.5 \text{ V}$			300	ps	1

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

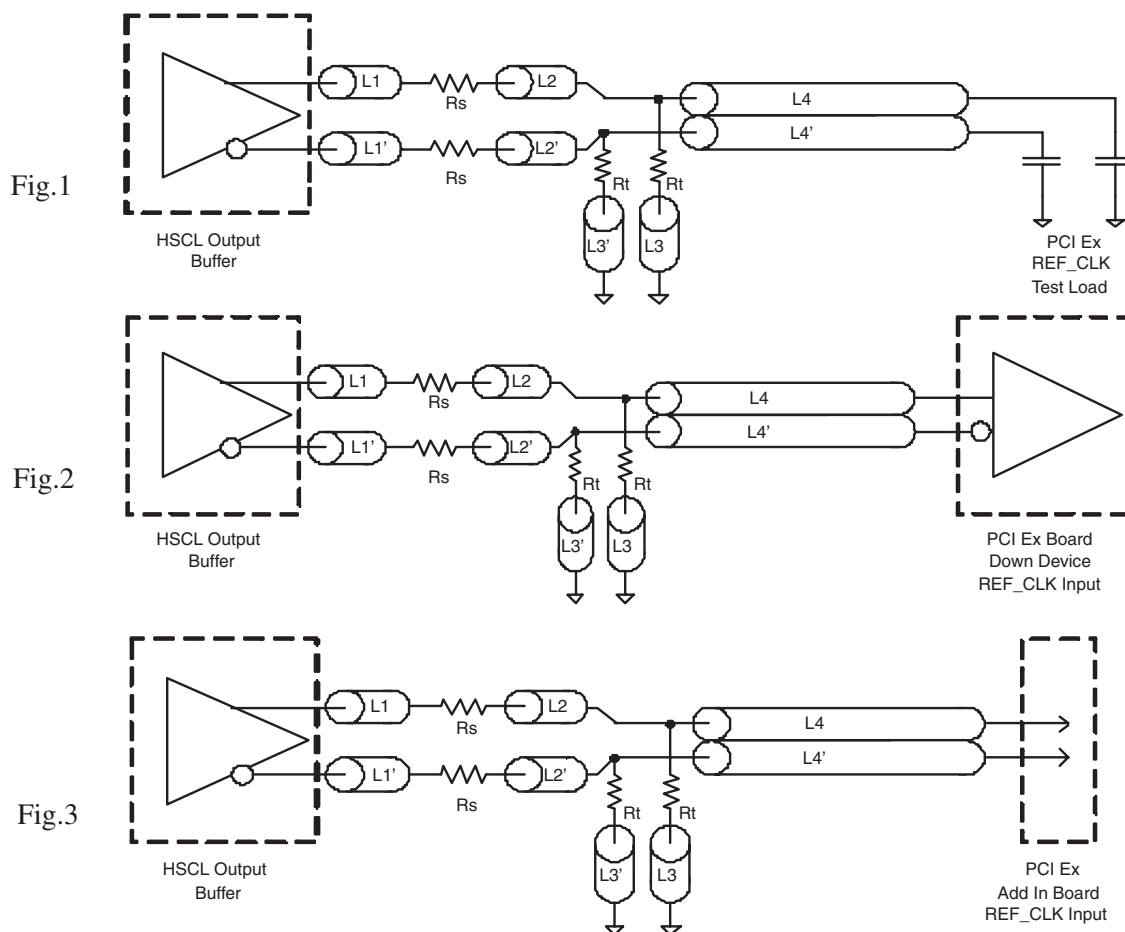
<sup>2</sup> All Long Term Accuracy and Clock Period specifications are guaranteed with the assumption that REF is at 14.31818MHz



SRC Reference Clock				
Common Recommendations for Differential Routing		Dimension or Value	Unit	Figure
L1 length, Route as non	-coupled 50 ohm trace.	0.5 max	inch	2, 3
L2 length, Route as non	-coupled 50 ohm trace.	0.2 max	inch	2, 3
L3 length, Route as non	-coupled 50 ohm trace.	0.2 max	inch	2, 3
Rs		33	ohm	2, 3
Rt		49.9	ohm	2, 3

Down Device Differential Routing		Dimension or Value	Unit	Figure
L4 length, Route as coupled differential trace.	<b>microstrip</b> 100 ohm	2 min to 16 max	inch	2
L4 length, Route as coupled differential trace.	<b>stripline</b> 100 ohm	1.8 min to 14.4 max	inch	2

Differential Routing to PCI Express Connector		Dimension or Value	Unit	Figure
L4 length, Route as coupled differential trace.	<b>microstrip</b> 100 ohm	0.25 to 14 max	inch	3
L4 length, Route as coupled differential trace.	<b>stripline</b> 100 ohm	0.225 min to 12.6 max	inch	3

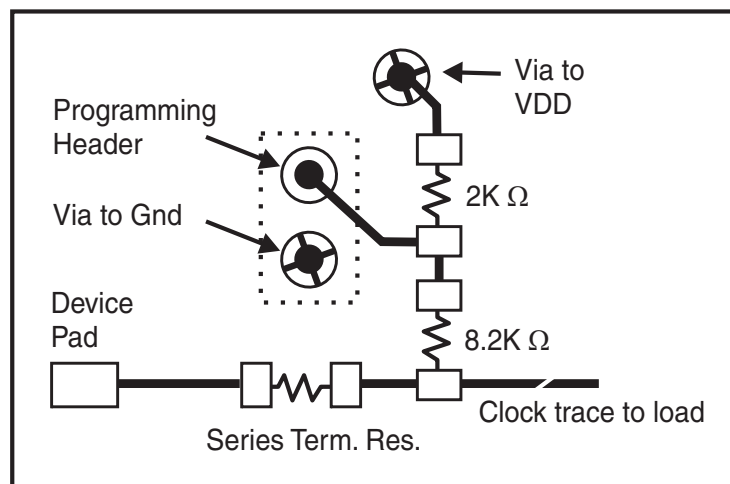


## Shared Pin Operation - Input/Output Pins

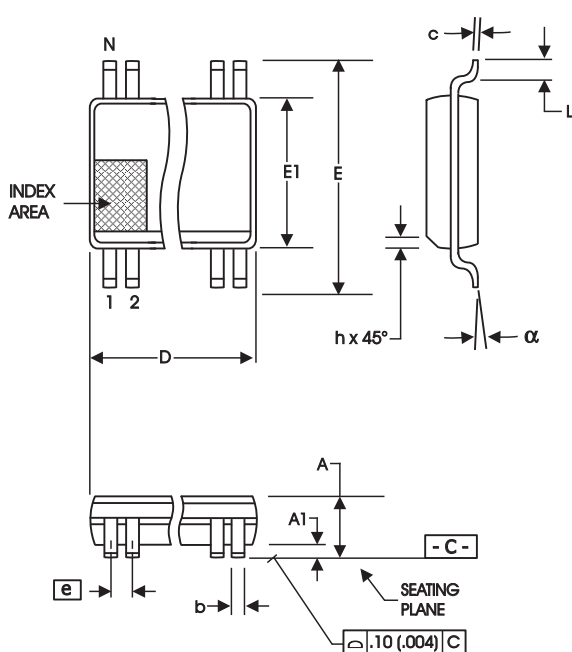
The I/O pins designated by (input/output) on the **ICS951412B** serve as dual signal functions to the device. During initial power-up, they act as input pins. The logic level (voltage) that is present on these pins at this time is read and stored into a 5-bit internal data latch. At the end of Power-On reset, (see AC characteristics for timing values), the device changes the mode of operations for these pins to an output function. In this mode the pins produce the specified buffered clocks to external loads.

To program (load) the internal configuration register for these pins, a resistor is connected to either the VDD (logic 1) power supply or the GND (logic 0) voltage potential. A 10 Kilohm (10K) resistor is used to provide both the solid CMOS programming voltage needed during the power-up programming period and to provide an insignificant load on the output clock during the subsequent operating period.

Figure 1 shows a means of implementing this function when a switch or 2 pin header is used. With no jumper is installed the pin will be pulled high. With the jumper in place the pin will be pulled low. If programmability is not necessary, than only a single resistor is necessary. The programming resistors should be located close to the series termination resistor to minimize the current loop area. It is more important to locate the series termination resistor close to the driver than the programming resistor.



**Fig. 1**



56-Lead, 300 mil Body, 25 mil, SSOP

SYMBOL	In Millimeters COMMON DIMENSIONS		In Inches COMMON DIMENSIONS	
	MIN	MAX	MIN	MAX
A	2.41	2.80	.095	.110
A1	0.20	0.40	.008	.016
b	0.20	0.34	.008	.0135
c	0.13	0.25	.005	.010
D	SEE VARIATIONS		SEE VARIATIONS	
E	10.03	10.68	.395	.420
E1	7.40	7.60	.291	.299
e	0.635 BASIC		0.025 BASIC	
h	0.38	0.64	.015	.025
L	0.50	1.02	.020	.040
N	SEE VARIATIONS		SEE VARIATIONS	
a	0°	8°	0°	8°

VARIATIONS

N	D mm.		D (inch)	
	MIN	MAX	MIN	MAX
56	18.31	18.55	.720	.730

Reference Doc.: JEDEC Publication 95, MO-118

10-0034

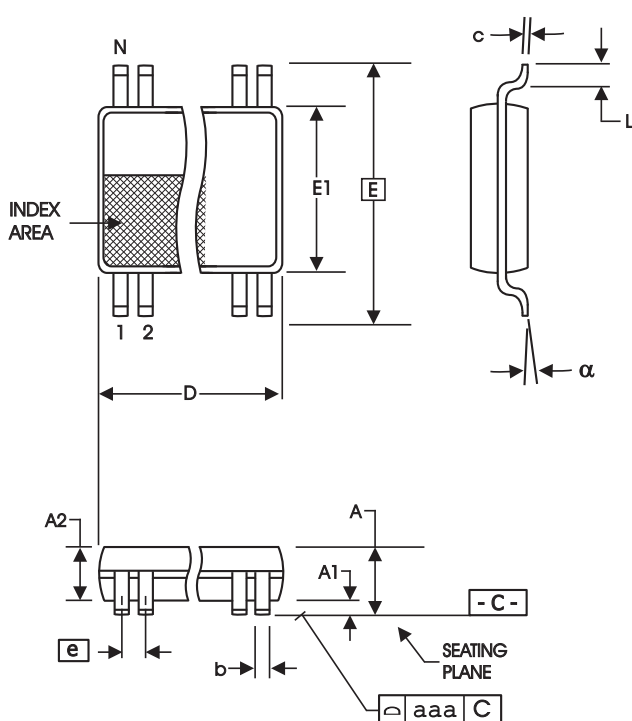
## Ordering Information

ICS951412BFLFT

Example:

ICS XXXX B F - L F T

- Designation for tape and reel packaging
- Lead Free, RoHS Compliant
- Package Type  
F = SSOP
- Revision Designator
- Device Type (consists of 3 or 4 digit numbers)
- Prefix  
ICS, AV = Standard Device



**56-Lead 6.10 mm. Body, 0.50 mm. Pitch TSSOP**  
(240 mil) (20 mil)

SYMBOL	In Millimeters		In Inches	
	COMMON DIMENSIONS		COMMON DIMENSIONS	
	MIN	MAX	MIN	MAX
A	--	1.20	--	.047
A1	0.05	0.15	.002	.006
A2	0.80	1.05	.032	.041
b	0.17	0.27	.007	.011
c	0.09	0.20	.0035	.008
D	SEE VARIATIONS		SEE VARIATIONS	
E	8.10 BASIC		0.319 BASIC	
E1	6.00	6.20	.236	.244
e	0.50 BASIC		0.020 BASIC	
L	0.45	0.75	.018	.030
N	SEE VARIATIONS		SEE VARIATIONS	
a	0°	8°	0°	8°
aaa	--	0.10	--	.004

**VARIATIONS**

N	D mm.		D (inch)	
	MIN	MAX	MIN	MAX
56	13.90	14.10	.547	.555

Reference Doc.: JEDEC Publication 95, MO-153

10-0039

## Ordering Information

### ICS951412BGLFT

Example:

**ICS XXXX B G - L F T**

Designation for tape and reel packaging  
Lead Free, RoHS Compliant

Package Type  
G = TSSOP

Revision Designator

Device Type (consists of 3 or 4 digit numbers)

Prefix  
ICS, AV = Standard Device

**Revision History**

Rev.	Issue Date	Description	Page #
A	6/12/2006	Initial Release	-

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