

## Programmable Timing Control Hub™ for Mobile P4™ Systems

### Recommended Application:

CK410M clock, Intel Yellow Cover part

### Output Features:

- 2 - 0.7V current-mode differential CPU pairs
- 7 - 0.7V current-mode differential SRC pair for SATA and PCI-E
- 1 - 0.7V current-mode differential CPU/SRC selectable pair
- 4 - PCI (33MHz)
- 2 - PCICLK\_F, (33MHz) free-running
- 1 - USB, 48MHz
- 1 - DOT, 96MHz, 0.7V current differential pair
- 1 - REF, 14.318MHz

### Key Specifications:

- CPU outputs cycle-cycle jitter < 85ps
- SRC outputs cycle-cycle jitter < 125ps
- PCI outputs cycle-cycle jitter < 500ps
- +/- 300ppm frequency accuracy on CPU & SRC clocks
- +/- 100ppm frequency accuracy on USB clocks

### Pin Configuration

VDDPCI	1	56	PCICLK2
GND	2	55	PCI/SRC_STOP#
PCICLK3	3	54	CPU_STOP#
PCICLK4	4	53	FS_C/TEST_SEL
PCICLK5	5	52	REFOUT
GND	6	51	GND
VDDPCI	7	50	X1
ITP_EN/PCICLK_F0	8	49	X2
PCICLK_F1	9	48	VDDREF
Vtt_PwrGd#/PD	10	47	SDATA
VDD48	11	46	SCLK
USB_48MHz/FS_A	12	45	GND
GND	13	44	CPUCLKT0
DOTT_96MHz	14	43	CPUCLKC0
DOTC_96MHz	15	42	VDDCPU
FS_B/TEST_MODE	16	41	CPUCLKT1
SRCCLKT0	17	40	CPUCLKC1
SRCCLKC0	18	39	IREF
SRCCLKT1	19	38	GND
SRCCLKC1	20	37	VDDA
VDDSRC	21	36	CPUCLKT2_ITP/SRCCLKT7
SRCCLKT2	22	35	CPUCLKC2_ITP/SRCCLKC7
SRCCLKC2	23	34	VDDSRC
SRCCLKT3	24	33	SRCCLKT6
SRCCLKC3	25	32	SRCCLKC6
SRCCLKT4_SATA	26	31	SRCCLKT5
SRCCLKC4_SATA	27	30	SRCCLKC5
VDDSRC	28	29	GND

### 56-pin SSOP & TSSOP

0819H—02/17/06

### Features/Benefits:

- Supports tight ppm accuracy clocks for Serial-ATA and PCI-Express
- Supports spread spectrum modulation, 0 to -0.5% down spread
- Supports CPU clocks up to 400MHz
- Uses external 14.318MHz crystal, external crystal load caps are required for frequency tuning
- Supports undriven differential CPU, SRC pair in PD# for power management.

### Functionality

FS_C <sup>1</sup>	FS_B <sup>2</sup>	FS_A <sup>2</sup>	CPU MHz	SRC MHz	PCI MHz	REF MHz	USB MHz	DOT MHz
0	0	0	266.66	100.00	33.33	14.318	48.00	96.00
0	0	1	133.33	100.00	33.33	14.318	48.00	96.00
0	1	0	200.00	100.00	33.33	14.318	48.00	96.00
0	1	1	166.66	100.00	33.33	14.318	48.00	96.00
1	0	0	333.33	100.00	33.33	14.318	48.00	96.00
1	0	1	100.00	100.00	33.33	14.318	48.00	96.00
1	1	0	400.00	100.00	33.33	14.318	48.00	96.00
1	1	1	RESERVED			14.318	48.00	96.00

1. FS\_C is a three-level input. Please see  $V_{IL,FS}$  and  $V_{IH,FS}$  specifications in the Input/Supply/Common Output Parameters Table for correct values. Also refer to the Test Clarification Table.
2. FS\_B and FS\_A are low-threshold inputs. Please see the  $V_{IL,FS}$  and  $V_{IH,FS}$  specifications in the Input/Supply/Common Output Parameters Table for correct values.

**Pin Description**

PIN #	PIN NAME	PIN TYPE	DESCRIPTION
1	VDDPCI	PWR	Power supply for PCI clocks, nominal 3.3V
2	GND	PWR	Ground pin.
3	PCICLK3	OUT	PCI clock output.
4	PCICLK4	OUT	PCI clock output.
5	PCICLK5	OUT	PCI clock output.
6	GND	PWR	Ground pin.
7	VDDPCI	PWR	Power supply for PCI clocks, nominal 3.3V
8	ITP_EN/PCICLK_F0	I/O	Free running PCI clock not affected by PCI_STOP#. ITP_EN: latched input to select pin functionality 1 = CPU_ITP pair 0 = SRC pair
9	PCICLK_F1	OUT	Free running PCI clock not affected by PCI_STOP# .
10	Vtt_PwrGd#/PD	IN	Vtt_PwrGd# is an active low input used to determine when latched inputs are ready to be sampled. PD is an asynchronous active high input pin used to put the device into a low power state. The internal clocks, PLLs and the crystal oscillator are stopped.
11	VDD48	PWR	Power pin for the 48MHz output.3.3V
12	USB_48MHz/FS_A	I/O	Frequency select latch input pin / Fixed 48MHz USB clock output. 3.3V.
13	GND	PWR	Ground pin.
14	DOTT_96MHz	OUT	True clock of differential pair for 96.00MHz DOT clock.
15	DOTC_96MHz	OUT	Complement clock of differential pair for 96.00MHz DOT clock.
16	FS_B/TEST_MODE	IN	3.3V tolerant input for CPU frequency selection. Refer to input electrical characteristics for Vil_FS and Vih_FS values. TEST_MODE is a real time input to select between Hi-Z and REF/N divider mode while in test mode. Refer to Test Clarification Table.
17	SRCCLKT0	OUT	True clock of differential SRC clock pair.
18	SRCCLKC0	OUT	Complement clock of differential SRC clock pair.
19	SRCCLKT1	OUT	True clock of differential SRC clock pair.
20	SRCCLKC1	OUT	Complement clock of differential SRC clock pair.
21	VDDSRC	PWR	Supply for SRC clocks, 3.3V nominal
22	SRCCLKT2	OUT	True clock of differential SRC clock pair.
23	SRCCLKC2	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	SRCCLKT4_SATA	OUT	True clock of differential SRC/SATA pair.
27	SRCCLKC4_SATA	OUT	Complement clock of differential SRC/SATA pair.
28	VDDSRC	PWR	Supply for SRC clocks, 3.3V nominal

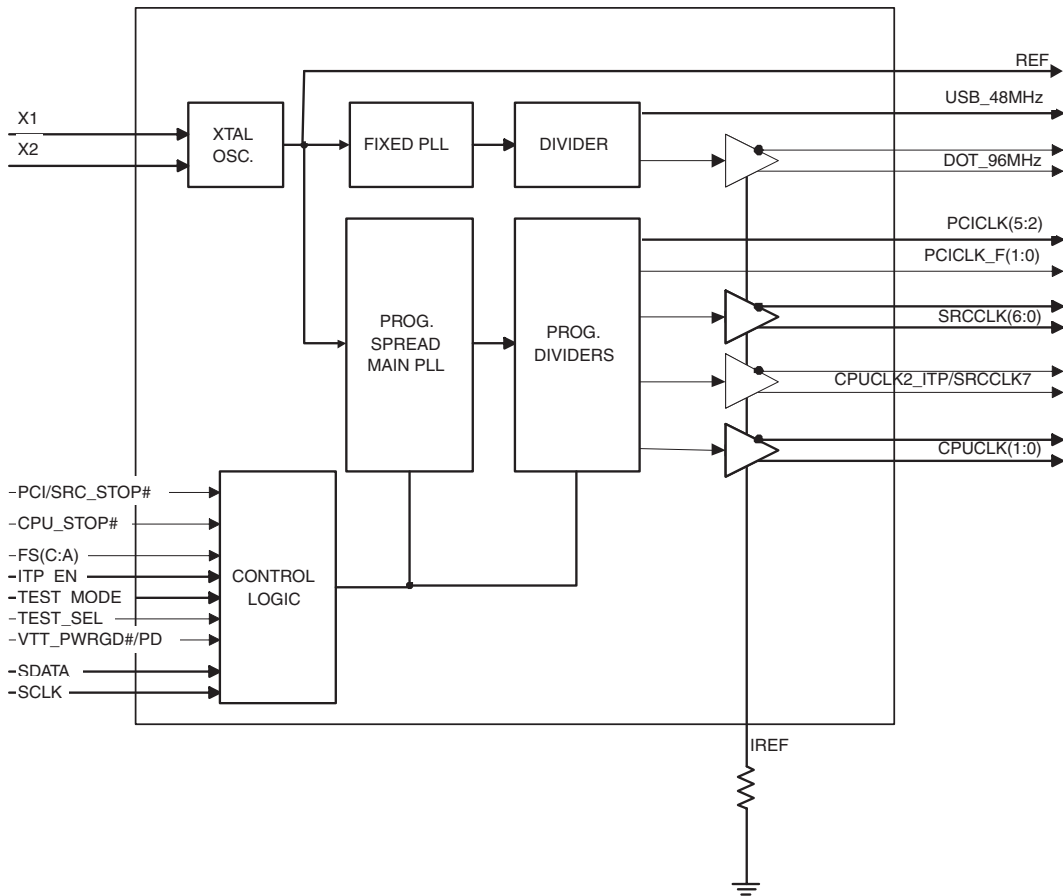
Pin Description (Continued)

PIN #	PIN NAME	TYPE	DESCRIPTION
29	GND	PWR	Ground pin.
30	SRCCLK5	OUT	Complement clock of differential SRC clock pair.
31	SRCCLKT5	OUT	True clock of differential SRC clock pair.
32	SRCCLK6	OUT	Complement clock of differential SRC clock pair.
33	SRCCLKT6	OUT	True clock of differential SRC clock pair.
34	VDDSRC	PWR	Supply for SRC clocks, 3.3V nominal
35	CPUCLK2_ITP/SRCCLK7	OUT	Complimentary clock of CPU_ITP/SRC differential pair CPU_ITP/SRC output. These are current mode outputs. External resistors are required for voltage bias. Selected by ITP_EN input.
36	CPUCLKT2_ITP/SRCCLKT7	OUT	True clock of CPU_ITP/SRC differential pair CPU_ITP/SRC output. These are current mode outputs. External resistors are required for voltage bias. Selected by ITP_EN input.
37	VDDA	PWR	3.3V power for the PLL core.
38	GNDA	PWR	Ground pin for the PLL core.
39	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.
40	CPUCLKC1	OUT	Complimentary clock of differential pair CPU outputs. These are current mode outputs. External resistors are required for voltage bias.
41	CPUCLKT1	OUT	True clock of differential pair CPU outputs. These are current mode outputs. External resistors are required for voltage bias.
42	VDDCPU	PWR	Supply for CPU clocks, 3.3V nominal
43	CPUCLKC0	OUT	Complimentary clock of differential pair CPU outputs. These are current mode outputs. External resistors are required for voltage bias.
44	CPUCLKT0	OUT	True clock of differential pair CPU outputs. These are current mode outputs. External resistors are required for voltage bias.
45	GND	PWR	Ground pin.
46	SCLK	IN	Clock pin of SMBus circuitry, 5V tolerant.
47	SDATA	I/O	Data pin for SMBus circuitry, 5V tolerant.
48	VDDREF	PWR	Ref, XTAL power supply, nominal 3.3V
49	X2	OUT	Crystal output, Nominally 14.318MHz
50	X1	IN	Crystal input, Nominally 14.318MHz.
51	GND	PWR	Ground pin.
52	REFOUT	OUT	Reference Clock output
53	FS_C/TEST_SEL	IN	3.3V tolerant input for CPU frequency selection. Low voltage threshold inputs, see input electrical characteristics for $V_{il\_FS}$ and $V_{ih\_FS}$ values. TEST_Sel: 3-level latched input to enable test mode. Refer to Test Clarification Table
54	CPU_STOP#	IN	Stops all CPUCLK, except those set to be free running clocks
55	PCI/SRC_STOP#	IN	Stops all PCICLKs and SRCCLKs besides the free-running clocks at logic 0 level, when input low
56	PCICLK2	OUT	PCI clock output.

## General Description

ICS954201 is a CK410M Yellow Cover clock synthesizer. ICS954201 provides a single-chip solution for mobile systems built with Intel P4-M processors and Intel mobile chipsets. ICS954201 is driven with a 14.318MHz crystal and generates CPU outputs up to 400MHz. It provides the tight ppm accuracy required by Serial ATA and PCI-Express.

## Block Diagram



## Power Groups

Pin Number		Description
VDD	GND	
48	51	Xtal, Ref
1,7	2,6	PCICLK outputs
21,28,34	29	SRCCLK outputs
37	38	Master clock, CPU Analog
11	13	DOT, USB, PLL_48
42	45	CPUCLK clocks

## General I<sup>2</sup>C serial interface information for the ICS954201

### How to Write:

- Controller (host) sends a start bit.
- Controller (host) sends the write address D2<sub>(H)</sub>
- 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 <sub>(H)</sub>			
WR	WRite		
		ACK	
Beginning Byte = N			
		ACK	
Data Byte Count = X			
		ACK	
Beginning Byte N		X Byte	
			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<sub>(H)</sub>
- 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<sub>(H)</sub>
- 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<sub>(H)</sub> 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 <sub>(H)</sub>			
WR	WRite		
		ACK	
Beginning Byte = N			
		ACK	
RT	Repeat starT		
Slave Address D3 <sub>(H)</sub>			
RD	ReaD		
		ACK	
		Data Byte Count = X	
ACK			
ACK		X Byte	
			Beginning Byte N
○			○
○			○
○			○
		Byte N + X - 1	
N	Not acknowledge		
P	stoP bit		

**Absolute Max**

Symbol	Parameter	Min	Max	Units
VDD_A	3.3V Core Supply Voltage		$V_{DD} + 0.5V$	V
VDD_In	3.3V Logic Input Supply Voltage	GND - 0.5	$V_{DD} + 0.5V$	V
Ts	Storage Temperature	-65	150	°C
Tambient	Ambient Operating Temp	0	70	°C
Tcase	Case Temperature		115	°C
ESD prot	Input ESD protection human body model	2000		V

**Electrical Characteristics - Input/Supply/Common Output Parameters**
 $T_A = 0 - 70^\circ\text{C}$ ; Supply Voltage  $V_{DD} = 3.3\text{ V} \pm 5\%$ 

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	$I_{IL1}$	$V_{IN} = 0\text{ V}$ ; Inputs with no pull-up resistors	-5			$\mu\text{A}$	1
	$I_{IL2}$	$V_{IN} = 0\text{ V}$ ; Inputs with pull-up resistors	-200			$\mu\text{A}$	1
Low Threshold Input High Voltage	$V_{IH\_FS}$	3.3 V $\pm 5\%$	0.7		$V_{DD} + 0.3$	V	1
Low Threshold Input Low Voltage	$V_{IL\_FS}$	3.3 V $\pm 5\%$	$V_{SS} - 0.3$		0.35	V	1
Operating Supply Current	$I_{DD3\_3OP}$	Full Active, $C_L = \text{Full load}$ ;		278	400	mA	
Powerdown Current	$I_{DD3\_3PD}$	all diff pairs driven		67	70	mA	
		all differential pairs tri-stated		4.8	12	mA	
Input Frequency <sup>3</sup>	$F_I$	$V_{DD} = 3.3\text{ V}$		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
Clock Stabilization <sup>1,2</sup>	$T_{STAB}$	From $V_{DD}$ Power-Up or de-assertion of PD# to 1st clock		1.3	1.8	ms	1,2
Modulation Frequency		Triangular Modulation	30		33	kHz	1
Tdrive_SRC		SRC output enable after PCI_STOP de-assertion		8	10	ns	1
Tdrive_PD		Differential output enable after PD# de-assertion			300	$\mu\text{s}$	1
Tfall_PD		PD# fall time of			5	ns	1
Trise_PD		PD# rise time of			5	ns	2
Tdrive_CPU_STOP		CPU output enable after CPU_STOP de-assertion		8	10	ns	1
Tfall_CPU_STOP		CPU_STOP fall time of			5	ns	1
Trise_CPU_STOP#		CPU_STOP rise time of			5	ns	2
SMBus Voltage	$V_{DD}$		2.7		5.5	V	1
Low-level Output Voltage	$V_{OL}$	SDATA, SCLK @ $I_{PULLUP}$			0.4	V	1
Current sinking	$I_{PULLUP}$	$V_{OL} = 0.4\text{ V}$	4			mA	1
SCLK/SDATA Clock/Data Rise Time	$T_{R12C}$	(Max $V_{IL} - 0.15$ ) to (Min $V_{IH} + 0.15$ )			1000	ns	1,3
SCLK/SDATA Clock/Data Fall Time	$T_{F12C}$	(Min $V_{IH} + 0.15$ ) to (Max $V_{IL} - 0.15$ )			300	ns	1,3

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

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

<sup>3</sup>Input frequency should be measured at the REF output pin and tuned to ideal 14.31818MHz to meet



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

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Current Source Output Impedance	$Z_{O1}$	$V_O = V_x$	3000			$\Omega$	1
Voltage High	VHigh	Statistical measurement on single ended signal using oscilloscope	660	760	850	mV	1,3
Voltage Low	VLow		-150	2	150		1,3
Max Voltage	Vovs	Measurement on single ended signal using absolute value.		782	1150	mV	1
Min Voltage	Vuds		-300	-33			1
Crossing Voltage (abs)	Vcross (abs)		250	344	550	mV	1
Crossing Voltage (var)	d-Vcross	Variation of crossing over all edges		97	140	mV	1
Long Accuracy	ppm	see $T_{period}$ min-max values	-300		300	ppm	1,2
Average period	$T_{period}$	100.00MHz non-spread	9.9970	9.9999	10.0030	ns	2
		100.00MHz spread			10.0533	ns	2
Absolute min/max period	$T_{abs}$	100.00MHz non-spread	9.8720	9.9999	10.1280	ns	1,2
		100.00MHz spread			10.1783	ns	1,2
Rise Time	$t_r$	$V_{OL} = 0.175\text{V}$ , $V_{OH} = 0.525\text{V}$	175	260	700	ps	1
Fall Time	$t_f$	$V_{OH} = 0.525\text{V}$ , $V_{OL} = 0.175\text{V}$	175	212	700	ps	1
Rise Time Variation	d- $t_r$			20	125	ps	1
Fall Time Variation	d- $t_f$			13	125	ps	1
Duty Cycle	$d_{t3}$	Measurement from differential waveform	45	51	55	%	1
Skew	$t_{sk3}$	$V_T = 50\%$		87	250	ps	1
Jitter, Cycle to cycle	$t_{jyc-cyc}$	Measurement from differential waveform		37	125	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 REFOUT 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 - CPU 0.7V Current Mode Differential Pair**

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

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	727	850	mV	1,3
Voltage Low	VLow		-150	-2	150		1,3
Max Voltage	Vovs	Measurement on single ended signal using absolute value.		752	1150	mV	1
Min Voltage	Vuds		-300	-21			1
Crossing Voltage (abs)	Vcross (abs)		250	348	550	mV	1
Crossing Voltage (var)	d-Vcross	Variation of crossing over all edges		39	140	mV	1
Long Accuracy	ppm	see Tperiod min-max values	-300		300	ppm	1,2
Average period	$T_{\text{period}}$	400MHz non-spread	2.4993	2.4999	2.5008	ns	2
		400MHz spread	2.4993		2.5133	ns	2
		333.33MHz non-spread	2.9991	3.0000	3.0009	ns	2
		333.33MHz spread	2.9991		3.016	ns	2
		266.66MHz non-spread	3.7489	3.7509	3.7511	ns	2
		266.66MHz spread	3.7489		3.77	ns	2
		200MHz non-spread	4.9985	4.9998	5.0015	ns	2
		200MHz spread	4.9985		5.0266	ns	2
		166.66MHz non-spread	5.9982	6.0000	6.0018	ns	2
		166.66MHz spread	5.9982		6.0320	ns	2
		133.33MHz non-spread	7.4978	7.5017	7.5023	ns	2
		133.33MHz spread	7.4978		5.4000	ns	2
		100.00MHz non-spread	9.9970	10.0000	10.0030	ns	2
		100.00MHz spread	9.9970		10.0533	ns	2
Absolute min/max period	$T_{\text{abs}}$	400MHz non-spread	2.4143	2.4970	2.5750	ns	1,2
		400MHz spread			2.5983	ns	1,2
		333.33MHz non-spread	2.9141	2.9940	3.0859	ns	1,2
		333.33MHz spread			3.1010	ns	1,2
		266.66MHz non-spread	3.6639	3.7430	3.8361	ns	1,2
		266.66MHz spread			3.8550	ns	1,2
		200MHz non-spread	4.9135	4.9940	5.0865	ns	1,2
		200MHz spread			5.1116	ns	1,2
		166.66MHz non-spread	5.9132	5.9950	6.0868	ns	1,2
		166.66MHz spread			6.1170	ns	1,2
		133.33MHz non-spread	7.4128	7.4970	7.5873	ns	1,2
		133.33MHz spread			7.6250	ns	1,2
		100.00MHz non-spread	9.9120	10.0000	10.0880	ns	1,2
		100.00MHz spread			10.1383	ns	1,2
Rise Time	$t_r$	$V_{OL} = 0.175\text{V}$ , $V_{OH} = 0.525\text{V}$	175	230	700	ps	1
Fall Time	$t_f$	$V_{OH} = 0.525\text{V}$ , $V_{OL} = 0.175\text{V}$	175	206	700	ps	1
Rise Time Variation	$d-t_r$			15	125	ps	1
Fall Time Variation	$d-t_f$			14	125	ps	1
Duty Cycle	$d_{t3}$	Measurement from differential waveform	45	51	55	%	1
Skew	$t_{sk3}$	CPU(1:0), $V_T = 50\%$		7.5	100	ps	1
		CPU2_ITP, $V_T = 50\%$		145	150	ps	1
Jitter, Cycle to cycle	$t_{\text{jyc-cyc}}$	Differential waveform measurement, CPU(1:0)		36	85	ps	1
Jitter, Cycle to cycle	$t_{\text{jyc-cyc}}$	Differential waveform measurement, CPU2_ITP		96	125	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 REFOUT is at 14.31818MHz

<sup>3</sup> $I_{REF} = V_{DD}/(3xR_R)$ . 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 - PCICLK/PCICLK\_F**
 $T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3\text{ V} \pm 5\%$ ;  $C_L = 10\text{-}20\text{ pF}$  (unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Long Accuracy	ppm	see Tperiod min-max values	-300	35	300	ppm	1,2
Clock period	$T_{\text{period}}$	33.33MHz output non-spread	29.9910	29.9989	30.0090	ns	2
		33.33MHz output spread		30.0752	30.1598	ns	2
Absolute min/max period	$T_{\text{abs}}$	33.33MHz output non-spread	29.4910		30.5090	ns	1,2
		33.33MHz output spread			30.6598	ns	1,2
Output High Voltage	$V_{OH}$	$I_{OH} = -1\text{ mA}$	2.4	3.25		V	1
Output Low Voltage	$V_{OL}$	$I_{OL} = 1\text{ mA}$		0.05	0.55	V	1
Output High Current	$I_{OH}$	$V_{OH} @ \text{MIN} = 1.0\text{ V}$	-33	-62		mA	1
		$V_{OH} @ \text{MAX} = 3.135\text{ V}$		-10	-33	mA	1
Output Low Current	$I_{OL}$	$V_{OL} @ \text{MIN} = 1.95\text{ V}$	30	61		mA	1
		$V_{OL} @ \text{MAX} = 0.4\text{ V}$		23	38	mA	1
Edge Rate		Rising edge rate	1	1.60	4	V/ns	1
Edge Rate		Falling edge rate	1	1.71	4	V/ns	1
Rise Time	$t_{r1}$	$V_{OL} = 0.4\text{ V}$ , $V_{OH} = 2.4\text{ V}$	0.5	1.25	2	ns	1
Fall Time	$t_{f1}$	$V_{OH} = 2.4\text{ V}$ , $V_{OL} = 0.4\text{ V}$	0.5	1.17	2	ns	1
Duty Cycle	$d_{t1}$	$V_T = 1.5\text{ V}$	45	50	55	%	1
Skew	$t_{sk1}$	$V_T = 1.5\text{ V}$		81	500	ps	1
Jitter	$t_{jyc-cyc}$	$V_T = 1.5\text{ V}$		250	500	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 REFOUT 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	-100	0.25	100	ppm	1,2
Clock period	$T_{\text{period}}$	48.00000 MHz output	20.8313	20.8333	20.8354	ns	2
Absolute min/max period	$T_{\text{abs}}$	48.00000 MHz output	20.4813		21.1854	ns	1,2
Output High Voltage	$V_{OH}$	$I_{OH} = -1\text{ mA}$	2.4	3.25		V	1
Output Low Voltage	$V_{OL}$	$I_{OL} = 1\text{ mA}$		0.05	0.55	V	1
Output High Current	$I_{OH}$	$V_{OH} @ \text{MIN} = 1.0\text{ V}$	-29	-53		mA	1
		$V_{OH} @ \text{MAX} = 3.135\text{ V}$		-6.2	-23	mA	1
Output Low Current	$I_{OL}$	$V_{OL} @ \text{MIN} = 1.95\text{ V}$	29	61		mA	1
		$V_{OL} @ \text{MAX} = 0.4\text{ V}$		23	27	mA	1
Edge Rate		Rising edge rate	1	1.53	2	V/ns	1
Edge Rate		Falling edge rate	1	1.68	2	V/ns	1
Rise Time	$t_{r1}$	$V_{OL} = 0.4\text{ V}$ , $V_{OH} = 2.4\text{ V}$	1	1.31	2	ns	1
Fall Time	$t_{f1}$	$V_{OH} = 2.4\text{ V}$ , $V_{OL} = 0.4\text{ V}$	1	1.19	2	ns	1
Duty Cycle	$d_{t1}$	$V_T = 1.5\text{ V}$	45	52	55	%	1
Jitter, Cycle to cycle	$t_{jyc-cyc}$	$V_T = 1.5\text{ V}$		139	350	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 REFOUT is at 14.31818MHz

**Electrical Characteristics - DOT, 96MHz 0.7V Current Mode Differential Pair**
 $T_A = 0 - 70^\circ\text{C}$ ;  $V_{DD} = 3.3\text{ V} \pm 5\%$ ;  $C_L = 2\text{pF}$ ,  $R_S = 33.2\Omega$ ,  $R_P = 49.9\Omega$ ,  $I_{REF} = 475\mu\text{A}$ 

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Current Source Output Impedance	$Z_o^1$	$V_o = V_x$	3000			$\Omega$	1
Voltage High	VHigh	Statistical measurement on single ended signal using oscilloscope	660	749	850	mV	1,3
Voltage Low	VLow		-150	1.5	150		1,3
Max Voltage	Vovs	Measurement on single ended signal using absolute value.		778	1150	mV	1
Min Voltage	Vuds		-300	-51			1
Crossing Voltage (abs)	Vcross (abs)		250	358	550	mV	1
Crossing Voltage (var)	d-Vcross	Variation of crossing over all edges		26	140	mV	1
Long Accuracy	ppm	see $T_{period}$ min-max values	-100		100	ppm	1,2
Average period	$T_{period}$	96.00MHz	10.4156	10.4167	10.4177	ns	2
Absolute min/max period	$T_{abs}$	96.00MHz	10.1656	10.4100	10.6677	ns	1,2
Rise Time	$t_r$	$V_{OL} = 0.175\text{V}$ , $V_{OH} = 0.525\text{V}$	175	210	700	ps	1
Fall Time	$t_f$	$V_{OH} = 0.525\text{V}$ , $V_{OL} = 0.175\text{V}$	175	180	700	ps	1
Rise Time Variation	d- $t_r$			23	125	ps	1
Fall Time Variation	d- $t_f$			50	125	ps	1
Duty Cycle	$d_{t3}$	Measurement from differential waveform	45	49	55	%	1
Jitter, Cycle to cycle	$t_{jyc-cyc}$	Measurement from differential waveform		98	250	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 REFOUT 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 - 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 $T_{period}$ min-max values	-300		300	ppm	1
Clock period	$T_{period}$	14.318MHz output nominal	69.8270	69.841	69.8550	ns	1
Output High Voltage	$V_{OH}$	$I_{OH} = -1\text{ mA}$	2.4	3.25		V	1
Output Low Voltage	$V_{OL}$	$I_{OL} = 1\text{ mA}$		0.05	0.4	V	1
Output High Current (1X)	$I_{OH}$	$V_{OH} @ \text{MIN} = 1.0\text{ V}$	-33	-53		mA	1
		$V_{OH} @ \text{MAX} = 3.135\text{ V}$		-6	-33	mA	1
Output Low Current (1X)	$I_{OL}$	$V_{OL} @ \text{MIN} = 1.95\text{ V}$	30	60.9		mA	1
		$V_{OL} @ \text{MAX} = 0.4\text{ V}$		23	38	mA	1
Output High Current (2X)	$I_{OH}$	$V_{OH} @ \text{MIN} = 1.0\text{ V}$	-33	-110		mA	1
		$V_{OH} @ \text{MAX} = 3.135\text{ V}$		-12	-33	mA	1
Output Low Current (2X)	$I_{OL}$	$V_{OL} @ \text{MIN} = 1.95\text{ V}$		110		mA	1
		$V_{OL} @ \text{MAX} = 0.4\text{ V}$		47		mA	1
Rise Time	$t_{r1}$	$V_{OL} = 0.4\text{ V}$ , $V_{OH} = 2.4\text{ V}$	1	1.7	2	ns	1
Fall Time	$t_{f1}$	$V_{OH} = 2.4\text{ V}$ , $V_{OL} = 0.4\text{ V}$	1	1.9	2	ns	1,2
Duty Cycle	$d_{t1}$	$V_T = 1.5\text{ V}$	45	54	55	%	1,2
Jitter	$t_{jyc-cyc}$	$V_T = 1.5\text{ V}$		197	1000	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 REFOUT is at 14.31818MHz

**SMBus Table: Output Control Register**

Byte 0	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	CPUCLK2_ITP/SRCCLK7 Enable	Output Enable	RW	DISABLE	ENABLE	1
Bit 6	-	SRCCLK6 Enable	Output Enable	RW	DISABLE	ENABLE	1
Bit 5	-	SRCCLK5 Enable	Output Enable	RW	DISABLE	ENABLE	1
Bit 4	-	SRCCLK4 Enable	Output Enable	RW	DISABLE	ENABLE	1
Bit 3	-	SRCCLK3 Enable	Output Enable	RW	DISABLE	ENABLE	1
Bit 2	-	SRCCLK2 Enable	Output Enable	RW	DISABLE	ENABLE	1
Bit 1	-	SRCCLK1 Enable	Output Enable	RW	DISABLE	ENABLE	1
Bit 0	-	SRCCLK0 Enable	Output Enable	RW	DISABLE	ENABLE	1

**SMBus Table: Spreading and Device Behavior Control Register**

Byte 1	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7		PCI_F0 Enable	Output Enable	RW	Disable	Enable	1
Bit 6		DOT_96MHz Enable	Output Enable	RW	Disable	Enable	1
Bit 5		USB_48MHz Enable	Output Enable	RW	Disable	Enable	1
Bit 4		REFOUT Enable	Output Enable	RW	Disable	Enable	1
Bit 3		RESERVED					1
Bit 2		CPUCLK1	Output Enable	RW	Disable	Enable	1
Bit 1		CPUCLK0	Output Enable	RW	Disable	Enable	1
Bit 0		Spread Spectrum Mode	Spread Off	RW	SPREAD OFF	SPREAD ON	0

**SMBus Table: Output Control Register**

Byte 2	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7		PCICLK5	Output Enable	RW	Disable	Enable	1
Bit 6		PCICLK4	Output Enable	RW	Disable	Enable	1
Bit 5		PCICLK3	Output Enable	RW	Disable	Enable	1
Bit 4		PCICLK2	Output Enable	RW	Disable	Enable	1
Bit 3		RESERVED					1
Bit 2		RESERVED					1
Bit 1		RESERVED					1
Bit 0		PCI_F1 Enable	Output Enable	RW	Disable	Enable	1

**SMBus Table: SRC Stop Control Register**

Byte 3	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	36,35	SRCCLK7	Allow assertion of PCI_STOP# or setting of PCI_STOP control bit in SMBus register to stop SRC clocks	RW	Free-Running	Stoppable	0
Bit 6	33,32	SRCCLK6		RW	Free-Running	Stoppable	0
Bit 5	31,30	SRCCLK5		RW	Free-Running	Stoppable	0
Bit 4	26,27	SRCCLK4		RW	Free-Running	Stoppable	0
Bit 3	24,25	SRCCLK3		RW	Free-Running	Stoppable	0
Bit 2	22,23	SRCCLK2		RW	Free-Running	Stoppable	0
Bit 1	19,20	SRCCLK1		RW	Free-Running	Stoppable	0
Bit 0	17,18	SRCCLK0		RW	Free-Running	Stoppable	0

**SMBus Table: Stop and Output Control Register**

Byte 4	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7			RESERVED				X
Bit 6	14,15	DOT_96MHz	Driven in PD	RW	Driven	Hi-Z	0
Bit 5			RESERVED				0
Bit 4	9	PCI_F1	Allow assertion of PCI_STOP# or setting of PCI_STOP control bit in SMBus register to stop PCICLK_F outputs	RW	Free-Running	Stoppable	0
Bit 3	8	PCI_F0		RW	Free-Running	Stoppable	0
Bit 2	36,35	CPUCLK2_ITP	Allow assertion of CPU_STOP# to stop CPUCLK outputs	RW	Free-Running	Stoppable	1
Bit 1	41,40	CPUCLK1		RW	Free-Running	Stoppable	1
Bit 0	44,43	CPUCLK0		RW	Free-Running	Stoppable	1

**SMBus Table: Output Control Register**

Byte 5	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	SRCCLK(7:0)	SRC_STOP Drive Mode	Driven in PCI/SRC_STOP#	RW	Driven	Hi-Z	0
Bit 6	36,35	CPUCLK2_ITP_STOP Drive Mode	Driven in CPU_STOP#	RW	Driven	Hi-Z	0
Bit 5	41,40	CPUCLK1_STOP Drive Mode		RW	Driven	Hi-Z	0
Bit 4	44,43	CPUCLK0_STOP Drive Mode		RW	Driven	Hi-Z	0
Bit 3	SRCCLK(7:0)	SRC_PD Drive Mode	Driven in Powerdown (PD)	RW	Driven	Hi-Z	0
Bit 2	36,35	CPUCLK2_ITP_PD Drive Mode		RW	Driven	Hi-Z	0
Bit 1	41,40	CPUCLK1_PD Drive Mode		RW	Driven	Hi-Z	0
Bit 0	44,43	CPUCLK0_PDDrive Mode		RW	Driven	Hi-Z	0

**SMBus Table: Test and Readback Control Register**

Byte 6	Pin #	Name	Control Function	Type	0	1	PWD	
Bit 7	-	Test Mode Selection	Test Mode Selection	RW	Hi-Z	REF/N	0	
Bit 6	-	Test Clock Mode Entry	Test Mode	RW	Disable	Enable	0	
Bit 5	-	RESERVED						0
Bit 4	-	REFOUT STRENGTH	Strength Prog	RW	1X	2X	1	
Bit 3	-	PCI/SRC_STOP	Stop all PCI and SRC clocks	RW	Enabled	Disabled	1	
Bit 2	-	FS_C	readback	R	-	-	LATCHED	
Bit 1	-	FS_B	readback	R	-	-	LATCHED	
Bit 0	-	FS_A	readback	R	-	-	LATCHED	

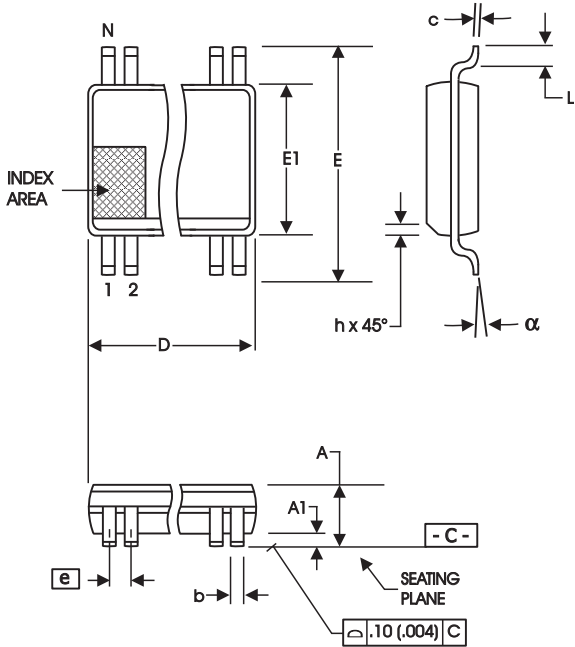
**SMBus Table: Vendor & Revision ID Register**

Byte 7	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	RID3	REVISION ID	R	-	-	0
Bit 6	-	RID2		R	-	-	0
Bit 5	-	RID1		R	-	-	0
Bit 4	-	RID0		R	-	-	1
Bit 3	-	VID3	VENDOR ID	R	-	-	0
Bit 2	-	VID2		R	-	-	0
Bit 1	-	VID1		R	-	-	0
Bit 0	-	VID0		R	-	-	1

**Test Clarification Table**

Comments	HW		SW		OUTPUT
	FS_C/TEST_SEL	FS_B/TEST_MODE	TEST ENTRY BIT	REF/N or HI-Z	
	HW PIN	HW PIN	B6b6	B6b7	
	0	X	0	X	NORMAL
<ul style="list-style-type: none"> <li>• FS_C/TEST_SEL is a 3-level latched input. <ul style="list-style-type: none"> <li>o Power-up w/ V &gt;= 2.0V to select TEST</li> <li>o Power-up w/ V &lt; 2.0V to have pin function as FS_C.</li> </ul> </li> <li>• When pin is FS_C, VIH_FS and VIL_FS levels apply.</li> <li>• FS_B/TEST_MODE is a low-threshold input <ul style="list-style-type: none"> <li>o VIH_FS and VIL_FS levels apply.</li> <li>o TEST_MODE is a real time input</li> </ul> </li> <li>• TEST_SEL can be invoked after power up through SMBus B6b6. <ul style="list-style-type: none"> <li>o If TEST is selected by B6b6, only B6b7 controls TEST_MODE. The FS_B/TEST_Mode pin is not used.</li> </ul> </li> <li>• Power must be cycled to exit TEST.</li> </ul>	1	0	X	0	HI-Z
	1	0	X	1	REF/N
	1	1	X	0	REF/N
	1	1	X	1	REF/N
	0	X	1	0	HI-Z
	0	X	1	1	REF/N

B6b6: 1= ENTER TEST MODE, Default = 0 (NORMAL OPERATION)  
B6b7: 1= REF/N, Default = 0 (HI-Z)



**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

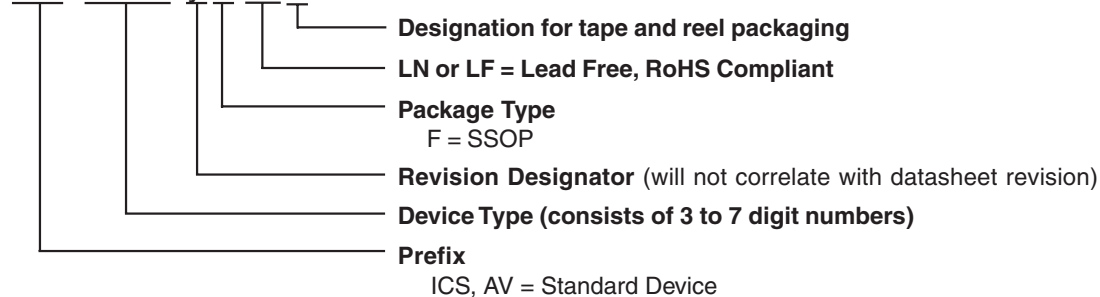
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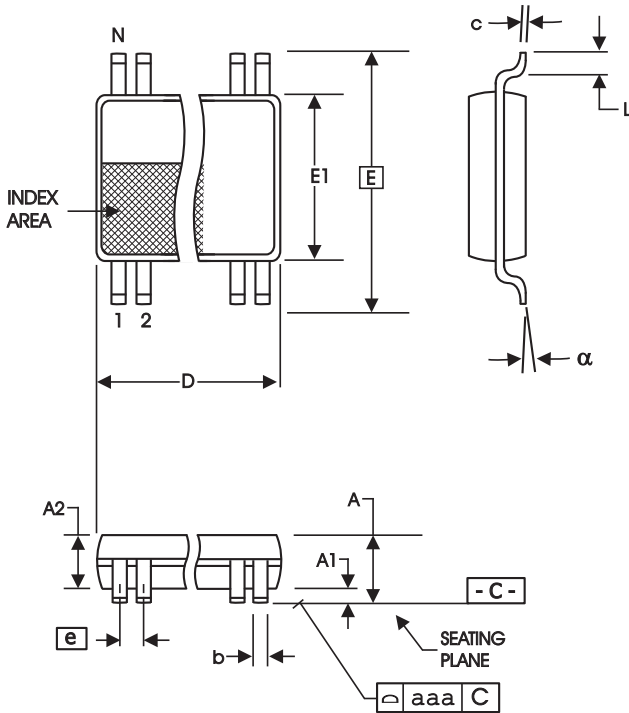
## Ordering Information

**ICS954201yFLxT**

Example:

**ICS XXXX y F Lx T**





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

SYMBOL	In Millimeters		In Inches	
	COMMON DIMENSIONS	COMMON DIMENSIONS	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

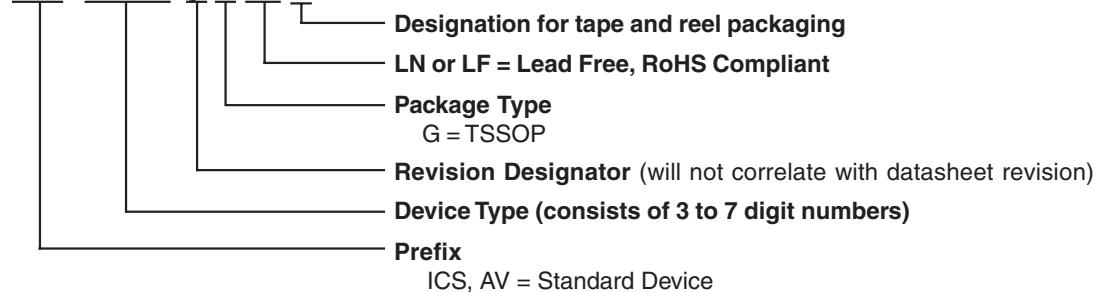
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**Ordering Information**

**ICS954201yGLxT**

Example:

**ICS XXXX y G LxT**





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### Revision History

Rev.	Issue Date	Description	Page #
H	2/17/2006	Updated Lead Free Ordering Information.	14-15