

# FTG for VIA™ K7 Series Chipset with Programmable Output Frequency

## Features

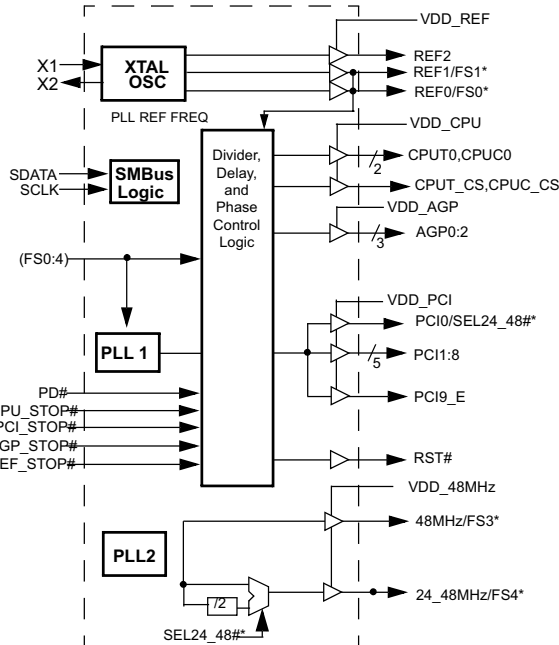
- Single chip FTG solution for VIA™ K7 Series chipsets
- Programmable clock output frequency with less than 1 MHz increment
- Integrated fail-safe Watchdog timer for system recovery
- Automatically switch to HW selected or SW programmed clock frequency when watchdog timer time-out
- Capable of generate system RESET after a watchdog timer time-out occurs or a change in output frequency via SMBus interface
- Support SMBus byte read/write and block read/ write operations to simplify system BIOS development
- Vendor ID and Revision ID support
- Programmable drive strength for PCI output clocks
- Programmable output skew between CPU, AGP and PCI
- Maximized EMI suppression using Cypress's Spread Spectrum technology

- Low jitter and tightly controlled clock skew
- Two pairs of differential CPU clocks
- Eleven copies of PCI clocks
- Three copies of 66-MHz outputs
- Two copies of 48-MHz outputs
- Three copies of 14.31818-MHz reference clocks
- One RESET output for system recovery
- Power management control support

## Key Specifications

CPU Outputs Cycle-to-cycle Jitter: .....	250 ps
48-MHz, 3V66, PCI Outputs	
Cycle-to-cycle Jitter: .....	500 ps
CPU, 3V66 Output Skew: .....	200 ps
48-MHz Output Skew: .....	250 ps
PCI Output Skew: .....	500 ps

## Block Diagram



## Pin Configuration <sup>[1]</sup>

VDD_REF	1	48	REF0/FS0*
GND_REF	2	47	REF1/FS1*
X1	3	46	REF2
X2	4	45	REF_STOP#*
VDD_48MHz	5	44	AGP_STOP#*
*FS2/48MHz	6	43	GND_CPU
*FS3/24_48MHz	7	42	CPUT0
GND_48MHz	8	41	CPU0
*FS4/PCI F	9	40	VDD_CPU
*SEL24_48#/PCI0	10	39	CPUT_CS
PCI1	11	38	CPUC_CS
GND_PCI	12	37	GND_CPU
PCI2	13	36	CPU_STOP#*
PCI3	14	35	PCI_STOP#*
VDD_PCI	15	34	PD#*
PCI4	16	33	VDD_CORE
PCI5	17	32	GND_CORE
PCI6	18	31	SDATA
GND_PCI	19	30	SCLK
PCI7	20	29	GND_AGP
PCI8	21	28	AGP2
PCI9_E	22	27	AGP1
VDD_PCI	23	26	AGP0
RST#	24	25	VDD_AGP

**Note:**

1. Internal 100K pull-up resistors present on inputs marked with \*. Design should not rely solely on internal pull-up resistor to set I/O pins HIGH.

**Pin Definitions**

Pin Name	Pin No.	Pin Type	Pin Description
REF0/FS0	48	I/O	<b>Reference Clock Output 0/Frequency Select 0:</b> 3.3V 14.318-MHz clock output. REF0 will be disabled when REF_STOP# is active. This pin also serves as the select strap to determines device operating frequency as described in <i>Table 5</i> .
REF1/FS1	47	I/O	<b>Reference Clock Output 0/Frequency Select 1:</b> 3.3V 14.318-MHz clock output. REF1 will be disabled when REF_STOP# is active. This pin also serves as the select strap to determines device operating frequency as described in <i>Table 5</i> .
REF2	46	I/O	<b>Reference Clock Output 2:</b> 3.3V 14.318-MHz clock output. REF2 will be disabled when REF_STOP# is active.
X1	3	I	<b>Crystal Input:</b> This pin has dual functions. It can be used as an external 14.318-MHz crystal connection or as an external reference frequency input.
X2	4	I	<b>Crystal Output:</b> An input connection for an external 14.318-MHz crystal connection. If using an external reference, this pin must be left unconnected.
PCI_F/FS4	9	I	<b>Free-Running PCI Clock/Frequency Select 4:</b> 3.3V 33-MHz free running PCI clock output. This pin also serves as the select strap to determines device operating frequency as described in <i>Table 5</i> .
PCI_0/SEL24_48#	10	I/O	<b>PCI Clock 0/Select 24 or 48 MHz:</b> 3.3V 33-MHz PCI clock outputs. This output will be disabled when PCI_STOP# is active. This pin also serves as the select strap to determine device operating frequency of 24_48MHz output.
PCI1:8	11, 13, 14, 16, 17, 18, 20, 21	O	<b>PCI Clock 1 through 8:</b> 3.3V 33-MHz PCI clock outputs. PCI1:8 will be disabled when PCI_STOP# is active.
PCI9_E	22	O	<b>Early PCI Clock 9:</b> 3.3V 33-MHz PCI clock outputs. PCI9_E will be disabled when PCI_STOP# is active.
AGP0:2	26, 27, 28	O	<b>AGP Clock 0 through 2:</b> 3.3V 66-MHz clock outputs. The operating frequency is controlled by FS0:4 (see <i>Table 5</i> ). AGP0:2 will be disabled when AGP_STOP# is active.
48MHz/FS2	6	I/O	<b>48-MHz Output/Frequency Selection 3:</b> 3.3V 48-MHz non-spread spectrum output. 48MHz will be disabled when REF_STOP# is active. This pin also serves as the select strap to determine device operating frequency as described in <i>Table 5</i> .
24_48MHz/FS3	7	I/O	<b>24 or 48-MHz Output/Select 24 or 48 MHz:</b> 3.3V 24 or 48-MHz non-spread spectrum output. 24_48MHz will be disabled when REF_STOP# is active. This pin also serves as the select strap to determine device operating frequency as described in <i>Table 5</i> .
RST#	24	O (open-drain)	<b>Reset#:</b> Open-drain RESET# output.
CPUT0, CPUC0	42, 41	O (open-drain)	<b>CPU Clock Output 0:</b> CPUT0 and CPUC0 are the differential CPU clock outputs for the K7 processor. They are open-drain outputs.
CPUT_CS, CPUC_CS	39, 38	O	<b>CPU Clock Output for Chipset:</b> CPUT_CS and CPUC_CS are the differential CPU clock outputs for the chipset. They are push-pull outputs. These outputs will be disabled when CPU_STOP# is active.
CPU_STOP#	36	I	<b>CPU STOP Input:</b> This input will disable CPUT_CS and CPUC_CS when it is active.
PCI_STOP#	35	I	<b>PCI STOP Input:</b> This input will disable PCI0:8 and PCI9_E when it is active.
AGP_STOP#	44	I	<b>AGP STOP Input:</b> This input will disable AGP0:2 when it is active.
REF_STOP#	45	I	<b>REF STOP Input:</b> This input will disable REF0:2, 24_48MHz and 48 MHz outputs when it is active.

**Pin Definitions** (continued)

Pin Name	Pin No.	Pin Type	Pin Description
PD#	34	I	<b>Power-Down Input:</b> This input will trigger the clock generator into Power Down mode when it is active.
SDATA	31	I/O	Data pin for SMBus circuitry.
SCLK	30	I	Clock pin for SMBus circuitry.
VDD_CPU	40	P	<b>2.5V Power Connection:</b> Power supply for CPU output buffers. Connect to 2.5V.
VDDQ_AGP	25	P	<b>3.3V Power Connection:</b> Power supply for AGP output buffers. Connect to 3.3V.
VDDQ_PCI	15, 23	P	<b>3.3V Power Connection:</b> Power supply for PCI output buffers. Connect to 3.3V.
VDDQ_48MHz	5	P	<b>3.3V Power Connection:</b> Power supply for 48 MHz output buffers. Connect to 3.3V.
VDD_REF	1	P	<b>3.3V Power Connection:</b> Power supply for reference output buffers. Connect to 3.3V.
VDD_Core	33	P	<b>3.3V Power Connection:</b> Power supply for PLL core. Connect to 3.3V.
GND_REF, GND_48MHz, GND_PCI, GND_AGP, GND_Core, GND_CPU	2, 8, 29, 32, 37, 43	G	<b>Ground Connections:</b> Connect all ground pins to the common system ground plane.

**Serial Data Interface**

The W312-02 features a two-pin, serial data interface that can be used to configure internal register settings that control particular device functions.

**Data Protocol**

The clock driver serial protocol supports byte/word write, byte/word read, block write and block read operations from the controller. For block write/read operation, the bytes must be

accessed in sequential order from lowest to highest byte with the ability to stop after any complete byte has been transferred. For byte/word write and byte read operations, system controller can access individual indexed byte. The offset of the indexed byte is encoded in the command code.

.The block write and block read protocol is outlined in *Table 1* while *Table 2* outlines the corresponding byte write and byte read protocol. The slave receiver address is 11010010 (D2h)

**Table 1. Command Code Definitions**

Bit	Descriptions
7	0 = Block read or block write operation 1 = Byte/Word read or byte/word write operation
6:0	Byte offset for byte/word read or write operation. For block read or write operations, these bits need to be set at '0000000'.

**Table 2. Block Read and Block Write Protocol**

Block Write Protocol		Block Read Protocol	
Bit	Description	Bit	Description
1	Start	1	Start
2:8	Slave address – 7 bits	2:8	Slave address – 7 bits
9	Write	9	Write
10	Acknowledge from slave	10	Acknowledge from slave
11:18	Command Code – 8 bits '00000000' stands for block operation	11:18	Command Code – 8 bits '00000000' stands for block operation
19	Acknowledge from slave	19	Acknowledge from slave
20:27	Byte Count – 8 bits	20	Repeat start
28	Acknowledge from slave	21:27	Slave address – 7 bits
29:36	Data byte 0 – 8 bits	28	Read
37	Acknowledge from slave	29	Acknowledge from slave
38:45	Data byte 1 – 8 bits	30:37	Byte count from slave – 8 bits
46	Acknowledge from slave	38	Acknowledge
...	Data Byte N/Slave Acknowledge...	39:46	Data byte from slave – 8 bits
...	Data Byte N – 8 bits	47	Acknowledge
...	Acknowledge from slave	48:55	Data byte from slave – 8 bits
...	Stop	56	Acknowledge
		...	Data bytes from slave/Acknowledge
		...	Data byte N from slave – 8 bits
		...	Not Acknowledge
		...	Stop

**Table 3. Word Read and Word Write Protocol**

Word Write Protocol		Word Read Protocol	
Bit	Description	Bit	Description
1	Start	1	Start
2:8	Slave address – 7 bits (D2)	2:8	Slave address – 7 bits (D3)
9	Write	9	Write
10	Acknowledge from slave	10	Acknowledge from slave
11:18	Command Code – 8 bits '1xxxxxxx' stands for byte or word operation bit[6:0] of the command code represents the offset of the byte to be accessed	11:18	Command Code – 8 bits '1xxxxxxx' stands for byte or word operation bit[6:0] of the command code represents the offset of the byte to be accessed
19	Acknowledge from slave	19	Acknowledge from slave
20:27	Data byte low – 8 bits	20	Repeat start
28	Acknowledge from slave	21:27	Slave address – 7 bits
29:36	Data byte high – 8 bits	28	Read
37	Acknowledge from slave	29	Acknowledge from slave
38	Stop	30:37	Data byte low from slave – 8 bits
		38	Acknowledge
		39:46	Data byte high from slave – 8 bits
		47	NOT acknowledge
		48	Stop

**Table 4. Byte Read and Byte Write Protocol**

Byte Write Protocol		Byte Read Protocol	
Bit	Description	Bit	Description
1	Start	1	Start
2:8	Slave address – 7 bits	2:8	Slave address – 7 bits
9	Write	9	Write
10	Acknowledge from slave	10	Acknowledge from slave
11:18	Command Code – 8 bits '1xxxxxxx' stands for byte operation bit[6:0] of the command code represents the offset of the byte to be accessed	11:18	Command Code – 8 bits '1xxxxxxx' stands for byte operation bit[6:0] of the command code represents the offset of the byte to be accessed
19	Acknowledge from slave	19	Acknowledge from slave
20:27	Data byte – 8 bits	20	Repeat start
28	Acknowledge from slave	21:27	Slave address – 7 bits
29	Stop	28	Read
		29	Acknowledge from slave
		30:37	Data byte from slave – 8 bits
		38	Not Acknowledge
		39	Stop

**W312-02 Serial Configuration Map**

1. The serial bits will be read by the clock driver in the following order:

Byte 0 - Bits 7, 6, 5, 4, 3, 2, 1, 0

Byte 1 - Bits 7, 6, 5, 4, 3, 2, 1, 0

Byte N - Bits 7, 6, 5, 4, 3, 2, 1, 0

2. All unused register bits (reserved and N/A) should be written to a "0" level.

3. All register bits labeled "Initialize to 0" must be written to zero during initialization.

**Byte 0: Control Register 0**

Bit	Pin#	Name	Default	Description
Bit 7	–	Spread Enable	0	0 = Disabled 1 = Enabled
Bit 6	–	Spread Select2	0	'000' = ±0.25% '001' = –0.5% '010' = ±0.5% '011' = ±0.38% '100' = Reserved '101' = Reserved '110' = Reserved '111' = Reserved
Bit 5	–	Spread Select1	0	
Bit 4	–	Spread Select0	0	
Bit 3	–	SEL3	0	
Bit 2	–	SEL2	0	SW Frequency selection bits. See <i>Table 5</i> .
Bit 1	–	SEL1	0	
Bit 0	–	SEL0	0	

**Byte 1: Control Register 1**

Bit	Pin#	Name	Default	Description
Bit 7	42, 41	CPUT0, CPUC0	1	(Active/Inactive)
Bit 6	39, 38	CPUT_CS, CPUC_CS	1	(Active/Inactive)
Bit 5	6	48MHz	1	(Active/Inactive)
Bit 4	7	24_48MHz	1	(Active/Inactive)
Bit 3	–	Reserved	0	Reserved
Bit 2	28	AGP2	1	(Active/Inactive)
Bit 1	27	AGP1	1	(Active/Inactive)
Bit 0	26	AGP0	1	(Active/Inactive)

**Byte 2: Control Register 2**

Bit	Pin#	Name	Default	Description
Bit 7	20	PCI7	1	(Active/Inactive)
Bit 6	18	PCI6	1	(Active/Inactive)
Bit 5	17	PCI5	1	(Active/Inactive)
Bit 4	16	PCI4	1	(Active/Inactive)
Bit 3	14	PCI3	1	(Active/Inactive)
Bit 2	13	PCI2	1	(Active/Inactive)
Bit 1	11	PCI1	1	(Active/Inactive)
Bit 0	10	PCI0	1	(Active/Inactive)

**Byte 3: Control Register**

Bit	Pin#	Name	Default	Description
Bit 7	9	PCI_F	1	(Active/Inactive)
Bit 6	22	PCI9_E	1	(Active/Inactive)
Bit 5	–	Reserved	0	Reserved
Bit 4	21	PCI8	1	(Active/Inactive)
Bit 3	46	REF2	1	(Active/Inactive)
Bit 2	–	Reserved	0	Reserved
Bit 1	47	REF1	1	(Active/Inactive)
Bit 0	48	REF0	1	(Active/Inactive)

**Byte 4: Watchdog Timer Register**

Bit	Pin#	Name	Default	Description
Bit 7	–	Reserved	0	Reserved
Bit 6	–	FS_Override	0	0 = Select operating frequency by FS[4:0] input pins 1 = Select operating frequency by SEL[4:0] settings
Bit 5	–	WD_TIMER4	1	These bits store the time-out value of the Watchdog timer. The scale of the timer is determine by the prescaler. The timer can support a value of 150 ms to 4.8 sec when the prescaler is set to 150 ms. If the prescaler is set to 2.5 sec, it can support a value from 2.5 sec to 80 sec. When the Watchdog timer reaches “0”, it will set the WD_TO_STATUS bit.
Bit 4	–	WD_TIMER3	1	
Bit 3	–	WD_TIMER2	1	
Bit 2	–	WD_TIMER1	1	
Bit 1	–	WD_TIMER0	1	
Bit 0	–	WD_PRE_SCALER	0	0 = 150 ms 1 = 2.5 sec

**Byte 5: Control Register 5**

Bit	Pin#	Name	Default	Description
Bit 7	9	Latched FS4 input	X	Latched FS[4:0] inputs. These bits are read only.
Bit 6	7	Latched FS3 input	X	
Bit 5	6	Latched FS2 input	X	
Bit 4	47	Latched FS1 input	X	
Bit 3	48	Latched FS0 input	X	
Bit 2	–	Reserved	0	Reserved
Bit 1	–	Reserved	0	Reserved
Bit 0	–	SEL4	0	SW Frequency selection bits. See <i>Table 5</i> .

**Byte 6: Reserved Register**

Bit	Name	Default	Pin Description
Bit 7	Reserved	1	Reserved
Bit 6	Reserved	1	Reserved
Bit 5	Reserved	1	Reserved
Bit 4	Reserved	1	Reserved
Bit 3	Reserved	1	Reserved
Bit 2	Reserved	1	Reserved
Bit 1	Reserved	1	Reserved
Bit 0	Reserved	1	Reserved

**Byte 7: Reserved Register**

Bit	Name	Default	Pin Description
Bit 7	Reserved	1	Reserved
Bit 6	Reserved	1	Reserved
Bit 5	Reserved	1	Reserved
Bit 4	Reserved	1	Reserved
Bit 3	Reserved	1	Reserved
Bit 2	Reserved	1	Reserved
Bit 1	Reserved	1	Reserved
Bit 0	Reserved	1	Reserved

**Byte 8: Vendor ID and Revision ID Register (Read Only)**

Bit	Name	Default	Pin Description
Bit 7	Revision_ID3	0	Revision ID bit[3]
Bit 6	Revision_ID2	0	Revision ID bit[2]
Bit 5	Revision_ID1	0	Revision ID bit[1]
Bit 4	Revision_ID0	0	Revision ID bit[0]
Bit 3	Vendor_ID3	1	Bit[3] of Cypress Semiconductor's Vendor ID. This bit is read only.
Bit 2	Vendor_ID2	0	Bit[2] of Cypress Semiconductor's Vendor ID. This bit is read only.
Bit 1	Vendor_ID1	0	Bit[1] of Cypress Semiconductor's Vendor ID. This bit is read only.
Bit 0	Vendor_ID0	0	Bit[0] of Cypress Semiconductor's Vendor ID. This bit is read only.



**Byte 9: System Reset and Watchdog Timer Register**

Bit	Name	Default	Pin Description
Bit 7	Reserved	0	Reserved
Bit 6	PCI_DRV	0	PCI clock output drive strength 0 = Normal 1 = High Drive
Bit 5	Reserved	0	Reserved
Bit 4	RST_EN_WD	0	This bit will enable the generation of a Reset pulse when a watchdog timer time-out occurs. 0 = Disabled 1 = Enabled
Bit 3	RST_EN_FC	0	This bit will enable the generation of a Reset pulse after a frequency change occurs. 0 = Disabled 1 = Enabled
Bit 2	WD_TO_STATUS	0	Watchdog Timer Time-out Status bit 0 = No time-out occurs (READ); Ignore (WRITE) 1 = time-out occurred (READ); Clear WD_TO_STATUS (WRITE)
Bit 1	WD_EN	0	0 = Stop and re-load Watchdog timer 1 = Enable Watchdog timer. It will start counting down after a frequency change occurs.
Bit 0	Reserved	0	Reserved

**Byte 10: Skew Control Register**

Bit	Name	Default	Description
Bit 7	CPU_Skew2	0	CPU skew control 000 = Normal 001 = -150 ps 010 = -300 ps 011 = -450 ps 100 = +150 ps 101 = +300 ps 110 = +450 ps 111 = +600 ps
Bit 6	CPU_Skew1	0	
Bit 5	CPU_Skew0	0	
Bit 4	Reserved	0	Reserved
Bit 3	PCI_Skew1	0	PCI skew control 00 = Normal 01 = -500 ps 10 = Reserved 11 = +500 ps
Bit 2	PCI_Skew0	0	
Bit 1	AGP_Skew1	0	AGP skew control 00 = Normal 01 = -150 ps 10 = +150 ps 11 = +300 ps
Bit 0	AGP_Skew0	0	

**Byte 11: Recovery Frequency N - Value Register**

Bit	Name	Default	Pin Description
Bit 7	ROCV_FREQ_N7	0	If ROCV_FREQ_SEL is set, W312-02 will use the values programmed in ROCV_FREQ_N[7:0] and ROCV_FREQ_M[6:0] to determine the recovery CPU output frequency when a Watchdog timer time-out occurs. The setting of FS_Override bit determines the frequency ratio for CPU, SDRAM, AGP and SDRAM. When it is cleared, W312-02 will use the same frequency ratio stated in the Latched FS[4:0] register. When it is set, W312-02 will use the frequency ratio stated in the SEL[4:0] register. W312-02 supports programmable CPU frequency ranging from 50 MHz to 248 MHz. W312-02 will change the output frequency whenever there is an update to either ROCV_FREQ_N[7:0] and ROCV_FREQ_M[6:0]. Therefore, it is recommended to use Word or Block write to update both registers within the same SMBus bus operation.
Bit 6	ROCV_FREQ_N6	0	
Bit 5	ROCV_FREQ_N5	0	
Bit 4	ROCV_FREQ_N4	0	
Bit 3	ROCV_FREQ_N3	0	
Bit 2	ROCV_FREQ_N2	0	
Bit 1	ROCV_FREQ_N1	0	
Bit 0	ROCV_FREQ_N0	0	

**Byte 12: Recovery Frequency M- Value Register**

Bit	Name	Default	Pin Description
Bit 7	ROCV_FREQ_SEL	0	ROCV_FREQ_SEL determines the source of the recover frequency when a Watchdog timer time-out occurs. The clock generator will automatically switch to the recovery CPU frequency based on the selection on ROCV_FREQ_SEL. 0 = From latched FS[4:0] 1 = From the settings of ROCV_FREQ_N[7:0] & ROCV_FREQ_M[6:0]
Bit 6	ROCV_FREQ_M6	0	If ROCV_FREQ_SEL is set, W312-02 will use the values programmed in ROCV_FREQ_N[7:0] and ROCV_FREQ_M[6:0] to determine the recovery CPU output frequency when a Watchdog timer time-out occurs. The setting of FS_Override bit determines the frequency ratio for CPU, SDRAM, AGP and SDRAM. When it is cleared, W312-02 will use the same frequency ratio stated in the Latched FS[4:0] register. When it is set, W312-02 will use the frequency ratio stated in the SEL[4:0] register. W312-02 supports programmable CPU frequency ranging from 50 MHz to 248 MHz. W312-02 will change the output frequency whenever there is an update to either ROCV_FREQ_N[7:0] and ROCV_FREQ_M[6:0]. Therefore, it is recommended to use Word or Block write to update both registers within the same SMBus bus operation.
Bit 5	ROCV_FREQ_M5	0	
Bit 4	ROCV_FREQ_M4	0	
Bit 3	ROCV_FREQ_M3	0	
Bit 2	ROCV_FREQ_M2	0	
Bit 1	ROCV_FREQ_M1	0	
Bit 0	ROCV_FREQ_M0	0	

**Byte 13: Programmable Frequency Select N-Value Register**

Bit	Name	Default	Pin Description
Bit 7	CPU_FSEL_N7	0	If Prog_Freq_EN is set, W300 will use the values programmed in CPU_FSEL_N[7:0] and CPU_FSEL_M[6:0] to determine the CPU output frequency. The new frequency will start to load whenever CPU_FSELM[6:0] is updated. The setting of FS_Override bit determines the frequency ratio for CPU, SDRAM, AGP and SDRAM. When it is cleared, W312 will use the same frequency ratio stated in the Latched FS[4:0] register. When it is set, W312-02 will use the frequency ratio stated in the SEL[4:0] register. W312-02 supports programmable CPU frequency ranging from 50 MHz to 248 MHz.
Bit 6	CPU_FSEL_N6	0	
Bit 5	CPU_FSEL_N5	0	
Bit 4	CPU_FSEL_N4	0	
Bit 3	CPU_FSEL_N3	0	
Bit 2	CPU_FSEL_N2	0	
Bit 1	CPU_FSEL_N1	0	
Bit 0	CPU_FSEL_N0	0	

**Byte 14: Programmable Frequency Select N-Value Register**

Bit	Name	Default	Description
Bit 7	Pro_Freq_EN	0	Programmable output frequencies enabled 0 = disabled 1 = enabled
Bit 6	CPU_FSEL_M6	0	If Prog_Freq_EN is set, W300 will use the values programmed in CPU_FSEL_N[7:0] and CPU_FSEL_M[6:0] to determine the CPU output frequency. The new frequency will start to load whenever CPU_FSELM[6:0] is updated. The setting of FS_Override bit determines the frequency ratio for CPU, SDRAM, AGP and SDRAM. When it is cleared, W312-02 will use the same frequency ratio stated in the Latched FS[4:0] register. When it is set, W312-02 will use the frequency ratio stated in the SEL[4:0] register. W312-02 supports programmable CPU frequency ranging from 50 MHz to 248 MHz.
Bit 5	CPU_FSEL_M5	0	
Bit 4	CPU_FSEL_M4	0	
Bit 3	CPU_FSEL_M3	0	
Bit 2	CPU_FSEL_M2	0	
Bit 1	CPU_FSEL_M1	0	
Bit 0	CPU_FSEL_M0	0	

**Byte 15: Reserved Register**

Bit	Pin#	Name	Default	Description
Bit 7	–	Reserved	0	Reserved
Bit 6	–	Reserved	0	Reserved
Bit 5	–	Reserved	0	Reserved
Bit 4	–	Reserved	0	Reserved
Bit 3	–	Reserved	0	Reserved
Bit 2	–	Reserved	0	Reserved
Bit 1	–	Reserved	1	Reserved. Write with '1'
Bit 0	–	Reserved	1	Reserved. Write with '1'

**Byte 16: Reserved Register**

Bit	Pin#	Name	Default	Description
Bit 7	–	Reserved	0	Reserved
Bit 6	–	Reserved	0	Reserved
Bit 5	–	Reserved	0	Reserved
Bit 4	–	Reserved	0	Reserved
Bit 3	–	Reserved	0	Reserved
Bit 2	–	Reserved	0	Reserved
Bit 1	–	Reserved	0	Reserved

**Byte 17: Reserved Register**

Bit	Pin#	Name	Default	Description
Bit 7	–	Reserved	0	Reserved
Bit 6	–	Reserved	0	Reserved
Bit 5	–	Reserved	0	Reserved
Bit 4	–	Reserved	0	Reserved
Bit 3	–	Reserved	0	Reserved
Bit 2	–	Reserved	0	Reserved
Bit 1	–	Reserved	0	Reserved

**Table 5. Additional Frequency Selections through Serial Data Interface Data Bytes**

Input Conditions					Output Frequency			PLL Gear Constants (G)
FS4 SEL4	FS3 SEL3	FS2 SEL2	FS1 SEL1	FS0 SEL0	CPU	3V66	PCI	
0	0	0	0	0	156.0	78.0	39.0	48.00741
0	0	0	0	1	154.0	77.0	38.5	48.00741
0	0	0	1	0	152.0	76.0	38.0	48.00741
0	0	0	1	1	147.0	73.5	36.8	48.00741
0	0	1	0	0	144.0	72.0	36.0	48.00741
0	0	1	0	1	142.0	71.0	35.5	48.00741
0	0	1	1	0	138.0	69.0	34.5	48.00741
0	0	1	1	1	136.0	68.0	34.0	48.00741
0	1	0	0	0	124.0	62.0	31.0	48.00741
0	1	0	0	1	122.0	61.0	30.5	48.00741
0	1	0	1	0	117.0	78.0	39.0	48.00741
0	1	0	1	1	115.0	76.7	38.3	48.00741
0	1	1	0	0	113.0	75.3	37.7	48.00741
0	1	1	0	1	108.0	72.0	36.0	48.00741
0	1	1	1	0	105.0	70.0	35.0	48.00741
0	1	1	1	1	102.0	68.0	34.0	48.00741
1	0	0	0	0	Reserved	Reserved	Reserved	Reserved
1	0	0	0	1	Reserved	Reserved	Reserved	Reserved
1	0	0	1	0	Reserved	Reserved	Reserved	Reserved
1	0	0	1	1	200.0	66.6	33.3	48.00741
1	0	1	0	0	190.0	76.0	38.0	48.00741
1	0	1	0	1	180.0	72.0	36.0	48.00741
1	0	1	1	0	170.0	68.0	34.0	48.00741
1	0	1	1	1	150.0	75.0	37.5	48.00741
1	1	0	0	0	140.0	70.0	35.0	48.00741
1	1	0	0	1	120.0	60.0	30.0	48.00741
1	1	0	1	0	110.0	73.3	33.3	48.00741
1	1	0	1	1	66.6	66.6	33.3	48.00741
1	1	1	0	0	200.0	66.6	33.3	48.00741
1	1	1	0	1	166.6	66.6	33.3	48.00741
1	1	1	1	0	100.0	66.6	33.3	48.00741
1	1	1	1	1	133.3	66.6	33.3	48.00741

**Programmable Output Frequency, Watchdog Timer and Recovery Output Frequency Functional Description**

The Programmable Output Frequency feature allows users to generate any CPU output frequency from the range of 50 MHz to 248 MHz. Cypress offers the most dynamic and the simplest programming interface for system developers to utilize this feature in their platforms.

The Watchdog Timer and Recovery Output Frequency features allow users to implement a recovery mechanism when the system hangs or getting unstable. System BIOS or other control software can enable the Watchdog timer before they attempt to make a frequency change. If the system hangs and a Watchdog timer time-out occurs, a system reset will be generated and a recovery frequency will be activated.

All of the related registers are summarized in *Table 7*.

**Table 6. Register Summary**

Name	Description
Pro_Freq_EN	<p>Programmable output frequencies enabled            0 = Disabled (default)            1 = Enabled</p> <p>When it is disabled, the operating output frequency will be determined by either the latched value of FS[4:0] inputs or the programmed value of SEL[4:0]. If FS_Override bit is clear, latched FS[4:0] inputs will be used. If FS_Override bit is set, programmed value of SEL[4:0] will be used.</p> <p>When it is enabled, the CPU output frequency will be determined by the programmed value of CPUFSEL_N, CPUFSEL_M and the PLL Gear Constant. The program value of FS_Override, SEL[4:0] or the latched value of FS[4:0] will determine the PLL Gear Constant and the frequency ratio between CPU and other frequency outputs</p>
FS_Override	<p>When Pro_Freq_EN is cleared or disabled,            0 = Select operating frequency by FS input pins (default)            1 = Select operating frequency by SEL bits in SMBus control bytes</p> <p>When Pro_Freq_EN is set or enabled,            0 = Frequency output ratio between CPU and other frequency groups and the PLL Gear Constant are based on the latched value of FS input pins (default)            1 = Frequency output ratio between CPU and other frequency groups and the PLL Gear Constant are based on the programmed value of SEL bits in SMBus control bytes</p>
CPU_FSEL_N, CPU_FSEL_M	<p>When Prog_Freq_EN is set or enabled, the values programmed in CPU_FSEL_N[7:0] and CPU_FSEL_M[6:0] determines the CPU output frequency. The new frequency will start to load whenever there is an update to either CPU_FSEL_N[7:0] or CPU_FSEL_M[6:0]. Therefore, it is recommended to use Word or Block write to update both registers within the same SMBus bus operation.</p> <p>The setting of FS_Override bit determines the frequency ratio for CPU, AGP and PIC. When FS_Override is cleared or disabled, the frequency ratio follows the latched value of the FS input pins. When FS_Override is set or enabled, the frequency ratio follows the programmed value of SEL bits in SMBus control bytes.</p>
ROCV_FREQ_SEL	<p>ROCV_FREQ_SEL determines the source of the recover frequency when a Watchdog timer time-out occurs. The clock generator will automatically switch to the recovery CPU frequency based on the selection on ROCV_FREQ_SEL.</p> <p>0 = From latched FS[4:0]            1 = From the settings of ROCV_FREQ_N[7:0] &amp; ROCV_FREQ_M[6:0]</p>
ROCV_FREQ_N[7:0], ROCV_FREQ_M[6:0]	<p>When ROCV_FREQ_SEL is set, the values programmed in ROCV_FREQ_N[7:0] and ROCV_FREQ_M[6:0] will be used to determine the recovery CPU output frequency when a Watchdog timer time-out occurs</p> <p>The setting of FS_Override bit determines the frequency ratio for CPU, AGP and PIC. When it is cleared, the same frequency ratio stated in the Latched FS[4:0] register will be used. When it is set, the frequency ratio stated in the SEL[4:0] register will be used.</p> <p>The new frequency will start to load whenever there is an update to either ROCV_FREQ_N[7:0] and ROCV_FREQ_M[6:0]. Therefore, it is recommended to use Word or Block write to update both registers within the same SMBus bus operation.</p>
WD_EN	<p>0 = Stop and reload Watchdog timer            1 = Enable Watchdog timer. It will start counting down after a frequency change occurs.</p>
WD_TO_STATUS	<p>Watchdog Timer Time-out Status bit            0 = No time-out occurs (READ); Ignore (WRITE)            1 = time-out occurred (READ); Clear WD_TO_STATUS (WRITE)</p>
WD_TIMER[4:0]	<p>These bits store the time-out value of the Watchdog timer. The scale of the timer is determine by the prescaler.            The timer can support a value of 150 ms to 4.8 sec when the pre-scaler is set to 150 ms. If the pre-scaler is set to 2.5 sec, it can support a value from 2.5 sec to 80 sec.            When the Watchdog timer reaches "0", it will set the WD_TO_STATUS bit.</p>
WD_PRE_SCALER	<p>0 = 150 ms            1 = 2.5 sec</p>

**Table 6. Register Summary** (continued)

Name	Description
RST_EN_WD	This bit will enable the generation of a Reset pulse when a Watchdog timer time-out occurs. 0 = Disabled 1 = Enabled
RST_EN_FC	This bit will enable the generation of a Reset pulse after a frequency change occurs. 0 = Disabled 1 = Enabled

**How to Program CPU Output Frequency**

When the programmable output frequency feature is enabled (Pro\_Freq\_EN bit is set), the CPU output frequency is determined by the following equation:

$$F_{cpu} = G * (N+3)/(M+3)$$

“N” and “M” are the values programmed in Programmable Frequency Select N-Value Register and M-Value Register, respectively.

“G” stands for the PLL Gear Constant, which is determined by the programmed value of FS[4:0] or SEL[4:0]. The value is listed in *Table 5*. The ratio of (N+3) and (M+3) need to be greater than “1” [(N+3)/(M+3) > 1].

*Table 7* lists set of N and M values for different frequency output ranges. This example use a fixed value for the M-Value Register and select the CPU output frequency by changing the value of the N-Value Register.

**Table 7. Examples of N and M Value for Different CPU Frequency Range**

Frequency Ranges	Gear Constants	Fixed Value for M-Value Register	Range of N-Value Register for Different CPU Frequency
50 MHz–129 MHz	48.00741	93	97–255
130 MHz–248 MHz	48.00741	48	127–245

**Absolute Maximum Ratings<sup>[2]</sup>**

Stresses greater than those listed in this table may cause permanent damage to the device. These represent a stress rating only. Operation of the device at these or any other condi-

tions above those specified in the operating sections of this specification is not implied. Maximum conditions for extended periods may affect reliability.

Parameter	Description	Rating	Unit
V <sub>DD</sub> , V <sub>IN</sub>	Voltage on any pin with respect to GND	-0.5 to +7.0	V
T <sub>STG</sub>	Storage Temperature	-65 to +150	°C
T <sub>B</sub>	Ambient Temperature under Bias	-55 to +125	°C
T <sub>A</sub>	Operating Temperature	0 to +70	°C
ESD <sub>PROT</sub>	Input ESD Protection	2 (min.)	kV

**DC Electrical Characteristics: T<sub>A</sub> = 0°C to +70°C, V<sub>DD</sub> = 3.3V±5% and 2.5V±5%**

Parameter	Description	Test Condition	Min.	Typ.	Max.	Unit	
<b>Supply Current</b>							
I <sub>DD</sub>	3.3V Supply Current	CPU = 100 MHz Outputs Loaded <sup>[3]</sup>		260		mA	
I <sub>DD</sub>	2.5V Supply Current	CPUCS = 100 MHz Outputs Loaded <sup>[3]</sup>		25		mA	
<b>Logic Inputs</b>							
V <sub>IL</sub>	Input Low Voltage		GND - 0.3		0.8	V	
V <sub>IH</sub>	Input High Voltage		2.0		V <sub>DD</sub> + 0.3	V	
I <sub>IL</sub>	Input Low Current <sup>[4]</sup>				-25	µA	
I <sub>IH</sub>	Input High Current <sup>[4]</sup>				10	µA	
<b>Clock Outputs</b>							
V <sub>OL</sub>	Output Low Voltage	I <sub>OL</sub> = 1 mA			50	mV	
V <sub>OH</sub>	Output High Voltage	I <sub>OH</sub> = -1 mA	3.1			V	
V <sub>OL</sub>	Output Low Voltage	CPUT_CS, CPUC_CS, CPUT0, CPUC0 Termination to V pull-up (external)	0		0.3	V	
V <sub>OH</sub>	Output High Voltage	CPUT_CS, CPUC_CS, CPUT0, CPUC0 Termination to V pull-up (external)	1.0		1.2	V	
I <sub>OL</sub>	Output Low Current	PCI, AGP	V <sub>OL</sub> = 1.5V	70	110	135	mA
		REF	V <sub>OL</sub> = 1.5V	50	70	100	mA
		48 MHz	V <sub>OL</sub> = 1.5V	50	70	100	mA
		24_48 MHz	V <sub>OL</sub> = 1.5V	50	70	100	mA
I <sub>OH</sub>	Output High Current	PCI, AGP	V <sub>OH</sub> = 1.5V	70	110	135	mA
		REF	V <sub>OH</sub> = 1.5V	50	70	100	mA
		48 MHz	V <sub>OH</sub> = 1.5V	50	70	100	mA
		24_48 MHz	V <sub>OH</sub> = 1.5V	50	70	100	mA

**Notes:**

- Multiple Supplies: The voltage on any input or I/O pin cannot exceed the power pin during power-up. Power supply sequencing is NOT required.
- All clock outputs loaded with 6" 60Ω transmission lines with 20-pF capacitors.
- X1 input threshold voltage (typical) is V<sub>DD</sub>/2.

**DC Electrical Characteristics:**  $T_A = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{DD} = 3.3\text{V}\pm 5\%$  and  $2.5\text{V}\pm 5\%$  (continued)

Parameter	Description	Test Condition	Min.	Typ.	Max.	Unit
<b>Crystal Oscillator</b>						
$V_{TH}$	X1 Input Threshold Voltage <sup>[4]</sup>	$V_{DD} = 3.3\text{V}$		1.65		V
$C_{LOAD}$	Load Capacitance, Imposed on External Crystal <sup>[5]</sup>			18		pF
$C_{IN,X1}$	X1 Input Capacitance <sup>[6]</sup>	Pin X2 unconnected		TBD		pF
<b>Pin Capacitance/Inductance</b>						
$C_{IN}$	Input Pin Capacitance	Except X1 and X2			5	pF
$C_{OUT}$	Output Pin Capacitance				6	pF
$L_{IN}$	Input Pin Inductance				7	nH

**AC Electrical Characteristics**
 $T_A = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{DDQ3} = 3.3\text{V}\pm 5\%$ ,  $f_{XTL} = 14.31818\text{ MHz}$ 

AC clock parameters are tested and guaranteed over stated operating conditions using the stated lump capacitive load at the clock output; Spread Spectrum is disabled.

**CPU Clock Outputs (CPUT0, CPUC0, CPU\_CS)<sup>[7]</sup>**

Parameter	Description	Test Condition/Comments	CPU = 100 MHz			CPU = 133 MHz			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
$t_R$	Output Rise Edge Rate	CPU_CS	1.0		4.0	1.0		4.0	V/ns
$t_F$	Output Fall Edge Rate	CPU_CS	1.0		4.0	1.0		4.0	V/ns
$t_D$	Duty Cycle	Measured at 50% point	45		55	45		55	%
$t_{JC}$	Jitter, Cycle to Cycle				250			250	ps
$f_{ST}$	Frequency Stabilization from Power-up (cold start)	Assumes full supply voltage reached within 1 ms from power-up. Short cycles exist prior to frequency stabilization.		3			3		ms
$Z_o$	AC Output Impedance	$V_O = V_X$		50			50		$\Omega$

**Notes:**

5. The W312-02 contains an internal crystal load capacitor between pin X1 and ground and another between pin X2 and ground. Total load placed on crystal is 18 pF; this includes typical stray capacitance of short PCB traces to crystal.
6. X1 input capacitance is applicable when driving X1 with an external clock source (X2 is left unconnected).
7. Refer to *Figure 1* for K7 operation clock driver test circuit.



**PCI Clock Outputs (Lump Capacitance Test Load = 30 pF)**

Parameter	Description	Test Condition/Comments	Min.	Typ.	Max.	Unit
t <sub>P</sub>	Period	Measured on rising edge at 1.5V	30			ns
t <sub>H</sub>	High Time	Duration of clock cycle above 2.4V	12			ns
t <sub>L</sub>	Low Time	Duration of clock cycle below 0.4V	12			ns
t <sub>R</sub>	Output Rise Edge Rate	Measured from 0.4V to 2.4V	1		4	V/ns
t <sub>F</sub>	Output Fall Edge Rate	Measured from 2.4V to 0.4V	1		4	V/ns
t <sub>D</sub>	Duty Cycle	Measured on rising and falling edge at 1.5V	45		55	%
t <sub>JC</sub>	Jitter, Cycle-to-Cycle	Measured on rising edge at 1.5V. Maximum difference of cycle time between two adjacent cycles.			250	ps
t <sub>SK</sub>	Output Skew	Measured on rising edge at 1.5V			500	ps
t <sub>O</sub>	CPU to PCI Clock Skew	Covers all CPU/PCI outputs. Measured on rising edge at 1.5V. CPU leads PCI output.	1.5		4	ns
f <sub>ST</sub>	Frequency Stabilization from Power-up (cold start)	Assumes full supply voltage reached within 1 ms from power-up. Short cycles exist prior to frequency stabilization.			3	ms
Z <sub>O</sub>	AC Output Impedance	Average value during switching transition. Used for determining series termination value.		30		Ω

**REF Clock Outputs (Lump Capacitance Test Load = 20 pF)**

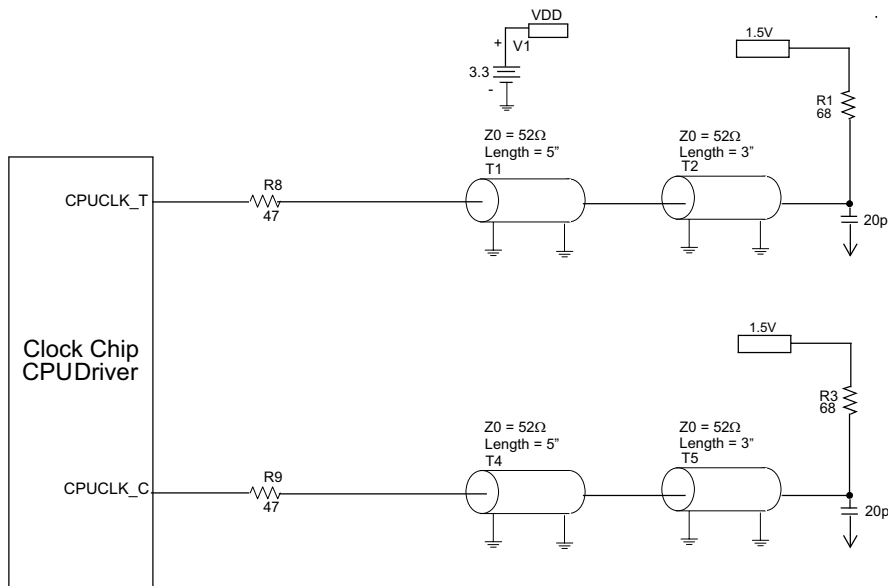
Parameter	Description	Test Condition/Comments	Min.	Typ.	Max.	Unit
f	Frequency, Actual	Frequency generated by crystal oscillator	14.318			MHz
t <sub>R</sub>	Output Rise Edge Rate	Measured from 0.4V to 2.4V	0.5		2	V/ns
t <sub>F</sub>	Output Fall Edge Rate	Measured from 2.4V to 0.4V	0.5		2	V/ns
t <sub>D</sub>	Duty Cycle	Measured on rising and falling edge at 1.5V	45		55	%
f <sub>ST</sub>	Frequency Stabilization from Power-up (cold start)	Assumes full supply voltage reached within 1 ms from power-up. Short cycles exist prior to frequency stabilization.			3	ms
Z <sub>O</sub>	AC Output Impedance	Average value during switching transition. Used for determining series termination value.		40		Ω

**48-MHz Clock Output (Lump Capacitance Test Load = 20 pF)**

Parameter	Description	Test Condition/Comments	Min.	Typ.	Max.	Unit
f	Frequency, Actual	Determined by PLL divider ratio (see m/n below)	48.008			MHz
f <sub>D</sub>	Deviation from 48 MHz	(48.008 – 48)/48	+167			ppm
m/n	PLL Ratio	(14.31818 MHz x 57/17 = 48.008 MHz)	57/17			
t <sub>R</sub>	Output Rise Edge Rate	Measured from 0.4V to 2.4V	0.5		2	V/ns
t <sub>F</sub>	Output Fall Edge Rate	Measured from 2.4V to 0.4V	0.5		2	V/ns
t <sub>D</sub>	Duty Cycle	Measured on rising and falling edge at 1.5V	45		55	%
f <sub>ST</sub>	Frequency Stabilization from Power-up (cold start)	Assumes full supply voltage reached within 1 ms from power-up. Short cycles exist prior to frequency stabilization.			3	ms
Z <sub>O</sub>	AC Output Impedance	Average value during switching transition. Used for determining series termination value.		40		Ω

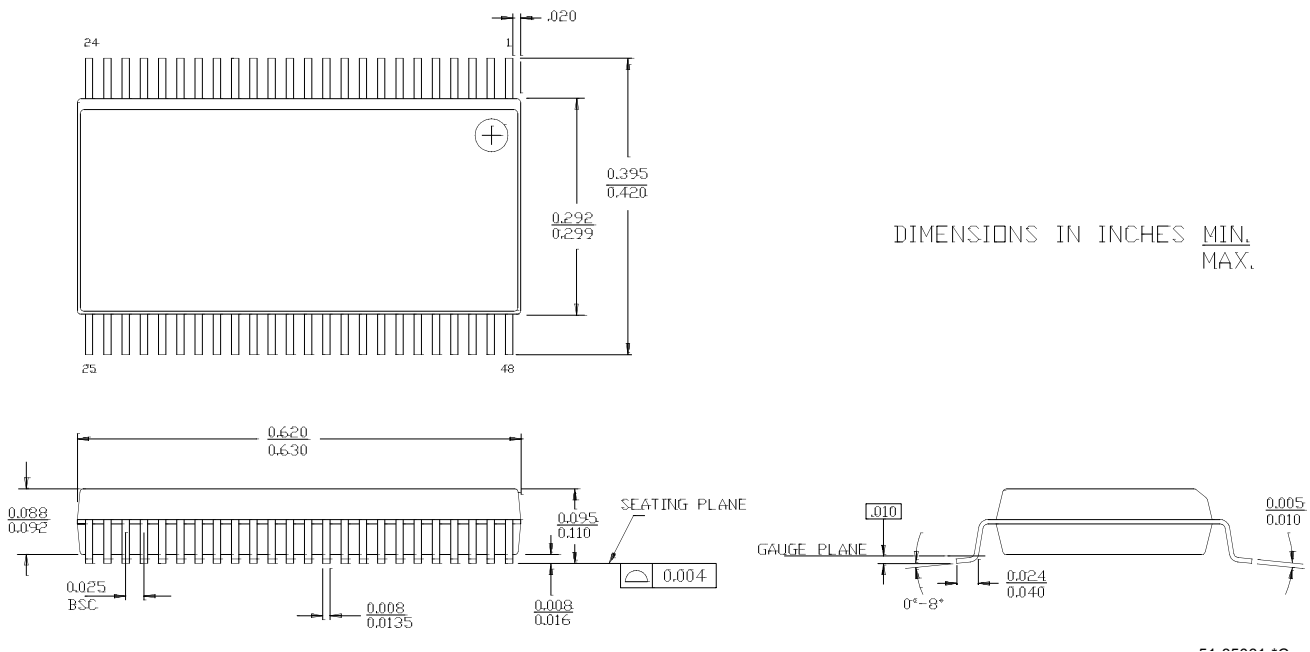
**24-MHz Clock Output (Lump Capacitance Test Load = 20 pF)**

Parameter	Description	Test Condition/Comments	Min.	Typ.	Max.	Unit
f	Frequency, Actual	Determined by PLL divider ratio (see m/n below)	24.004			MHz
f <sub>D</sub>	Deviation from 24 MHz	(24.004 – 24)/24	+167			ppm
m/n	PLL Ratio	(14.31818 MHz x 57/34 = 24.004 MHz)	57/34			
t <sub>R</sub>	Output Rise Edge Rate	Measured from 0.4V to 2.4V	0.5		2	V/ns
t <sub>F</sub>	Output Fall Edge Rate	Measured from 2.4V to 0.4V	0.5		2	V/ns
t <sub>D</sub>	Duty Cycle	Measured on rising and falling edge at 1.5V	45		55	%
f <sub>ST</sub>	Frequency Stabilization from Power-up (cold start)	Assumes full supply voltage reached within 1 ms from power-up. Short cycles exist prior to frequency stabilization.			3	ms
Z <sub>o</sub>	AC Output Impedance	Average value during switching transition. Used for determining series termination value.		40		Ω


**Figure 1. K7 Open Drain Clock Driver Test Circuit**

**Ordering Information**

Ordering Code	Package Type	Product Flow
W312-02H	48-pin SSOP	Commercial, 0°C to 70°C
W312-02HT	48-pin SSOP - Tape and Reel	Commercial, 0°C to 70°C
<b>Lead-free</b>		
CYW312OXC	48-pin SSOP	Commercial, 0°C to 70°C
CYW312OXCT	48-pin SSOP - Tape and Reel	Commercial, 0°C to 70°C

**Package Drawing and Dimension**
**48-Lead Shrunken Small Outline Package O48**


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