



CYPRESS

PRELIMINARY

W233

# Spread Spectrum FTG for VIA Mobile K7 Chipset

## Features

- Maximized EMI Suppression using Cypress's Spread Spectrum technology
- Single-chip system frequency synthesizer for VIA Mobile K7 chipset
- Two copies of CPU output
- Seven copies of PCI output
- One 48-MHz output for USB
- One 24-MHz or 48-MHz output for SIO
- Three buffered reference outputs
- Six SDRAM outputs provide support for three SODIMMs
- Supports frequencies up to 166 MHz
- SMBus interface for programming
- Power management control inputs
- Available in 48-pin SSOP

## Key Specifications

CPU to CPU Output Skew: ..... 175 ps

PCI to PCI Output Skew: ..... 500 ps

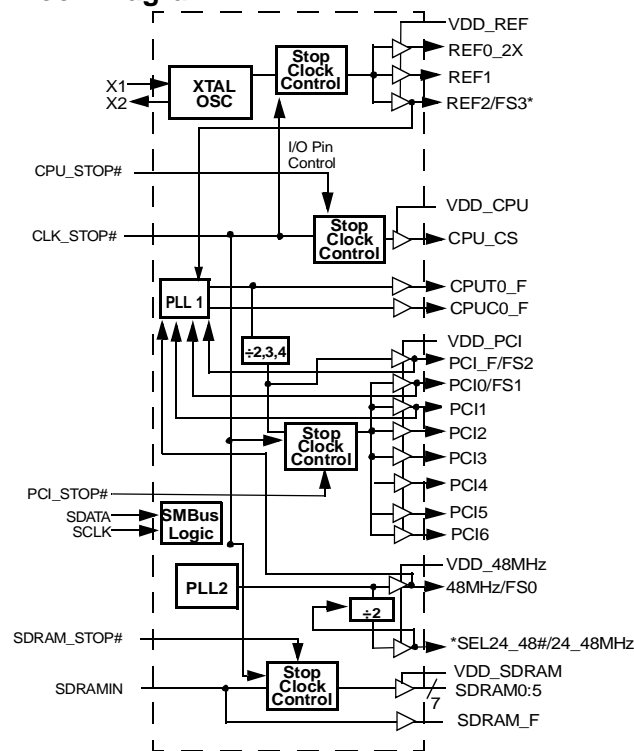
V<sub>DD</sub>: ..... 3.3V±5%

SDRAMIN to SDRAM0:5 Delay: ..... 2.0 ns typ.

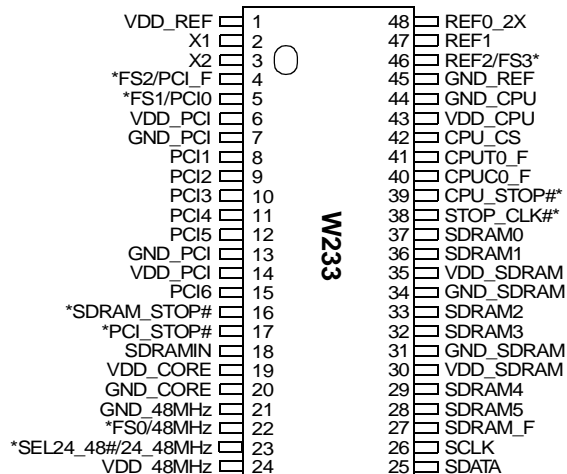
Table 1. Pin Selectable Frequency

Input Address				CPU (MHz)	PCI (MHz)	Spread Spectrum
FS3	FS2	FS1	FS0			
1	1	1	1	133.3	33.3	OFF
1	1	1	0	100.0	33.3	OFF
1	1	0	1	133.3	33.3	±0.5%
1	1	0	0	100.0	33.3	±0.5%
1	0	1	1	133.3	33.3	-0.5%
1	0	1	0	100.0	33.3	-0.5%
1	0	0	1	133.3	33.3	±0.25%
1	0	0	0	100.0	33.3	±0.25%
0	1	1	1	95.0	31.7	OFF
0	1	1	0	102.0	34.0	OFF
0	1	0	1	104.0	34.6	OFF
0	1	0	0	106.0	35.3	OFF
0	0	1	1	108.0	36.0	OFF
0	0	1	0	110.0	36.6	OFF
0	0	0	1	111.0	37.0	OFF
0	0	0	0	112.0	37.3	OFF

## Block Diagram



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



### Note:

1. Internal pull-up resistors should not be relied upon for setting I/O pins HIGH.

## Pin Definitions

Pin Name	Pin No.	Pin Type	Pin Description
CPUC0_F, CPUT0_F,	40, 41	O (open-drain)	<b>CPU Clock Output 0:</b> CPUT0_F and CPUC0_F are the differential CPU clock outputs for the K7 processor.
CPU_CS	42	O	<b>CPU Clock Output for Chipset:</b> CPU_CS is the push-pull clock output for the chipset. It has the same phase relationship as CPUT0_F.
PCI1:6	8, 9, 10, 11, 12, 15	O	<b>PCI Clock Outputs 1 through 6:</b> These six PCI clock outputs are controlled by the PCI_STP# control pin. Frequency is set by FS0:3 inputs or through serial input interface, see <i>Tables 1</i> and <i>5</i> for details. Output voltage swing is controlled by voltage applied to VDDQ3.
FS1/PCI0	5	I/O	<b>Fixed PCI Clock Output/Frequency Select 1:</b> As an output, frequency is set by FS0:3 inputs or through serial input interface. This pin also serves as a PCI_STP# strap option to determine device operating frequency as described in <i>Table 1</i> .
FS2/PCI_F	4	I/O	<b>Fixed PCI Clock Output/Frequency Select 2:</b> As an output, frequency is set by the FS0:3 inputs or through serial input interface, see <i>Tables 1</i> and <i>5</i> . This output is controlled by the STOP_CLK# input. This pin also serves as a power-on strap option to determine device operating frequency as described in <i>Table 2</i> .
STOP_CLK#	38	I	<b>STOP_CLK# Input:</b> LVTTTL-compatible input that places the device in stop-clock mode when held LOW. In stop-clock mode, CPUT0_F and CPUC0_F will be active and all the other output clocks will be driven LOW. STOP_CLK# is an asynchronous input. W233 will not complete the current clock cycle when STOP_CLK# is being driven LOW.
48MHz/FS0	22	I/O	<b>48-MHz Output/Frequency Select 0:</b> 48 MHz is provided in normal operation. In standard PC systems, this output can be used as the reference for the Universal Serial Bus host controller. This pin also serves as a power on strap option to determine device operating frequency as described in <i>Table 1</i> .
SEL24_48#/24_48MHz	23	I/O	<b>24_48-MHz Output/Frequency Select 24 or 48 MHz:</b> In standard PC systems, this output can be used as the clock input for a Super I/O chip. The output frequency is controlled by Configuration Byte 3 bit[6] or SEL 24_48 MHz stop option. The default output frequency is 24 MHz. This pin also serves as a power-on strap option to determine device operating frequency.
REF1	47	I/O	<b>Reference Clock Output 1:</b> 3.3V 14.318-MHz output clock.
REF2/FS3	46	I/O	<b>Reference Clock Output 2/Frequency Select 3:</b> 3.3V 14.318-MHz output clock. This pin also serves as a power-on strap option to determine device operating frequency.
REF0_2X	48	O	<b>Reference Clock Output 0:</b> 3.3V 14.318-MHz output clock with double drive strength.
SDRAMIN	18	I	<b>Buffered Input Pin:</b> The signal provided to this input pin is buffered to seven outputs (SDRAM0:5 & SDRAM_F).
SDRAM0:5, SDRAM_F	37, 36, 33, 32, 29, 28, 27	O	<b>Buffered Outputs:</b> These seven dedicated outputs provide copies of the signal provided at the SDRAMIN input. The swing is set by VDD, and they are deactivated when SDRAM_STOP# input is set LOW, except SDRAM_F.
SCLK	26	I	Clock pin for SMBus circuitry.
SDATA	25	I/O	Data pin for SMBus circuitry.
X1	2	I	<b>Crystal Connection or External Reference Frequency 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	3	O	<b>Crystal Connection:</b> An input connection for an external 14.318-MHz crystal. If using an external reference, this pin must be left unconnected.
SDRAM_STOP#	16	I	<b>SDRAM Stop Input:</b> LVTTTL compatible input that disables the SDRAM output clocks, except SDRAM_F.

**Pin Definitions** (continued)

Pin Name	Pin No.	Pin Type	Pin Description
PCI_STOP#	17	I	<b>PCI Stop Input:</b> LVTTTL compatible input that disables the PCI output clocks, except PCI_F.
CPU_STOP#	39	I	<b>CPU Stop Input:</b> LVTTTL compatible input that disables the CPU output clocks, except CPUT0_F and CPUC0_F.
VDD_REF, VDD_PCI, VDD_CORE, VDD_48MHz, VDD_SDRAM, VDD_CPU	1, 6, 14, 19, 24, 30, 35, 43	P	<b>Power Connection:</b> Power supply for core logic, PLL circuitry, SDRAM outputs, PCI outputs, reference outputs, 48-MHz output, and 24_48-MHz output. Connect to 3.3V supply
GND_PCI, GND_CORE, GND_48MHz, GND_SDRAM, GND_CPU, GND_REF	7, 13, 20, 21, 31, 34, 44, 45	G	<b>Ground Connections:</b> Connect all ground pins to the common system ground plane.

## Overview

The W233 was developed as a single-chip device to meet the clocking needs of VIA K7 core logic chip sets. In addition to the typical outputs provided by a standard FTG, the W233 adds a seventh output buffer, supporting SDRAM DIMM modules in conjunction with the chipset.

Cypress's proprietary spread spectrum frequency synthesis technique is a feature of the CPU and PCI outputs. When enabled, this feature reduces the peak EMI measurements of not only the output signals and their harmonics, but also of any other clock signals that are properly synchronized to them.

## Functional Description

### I/O Pin Operation

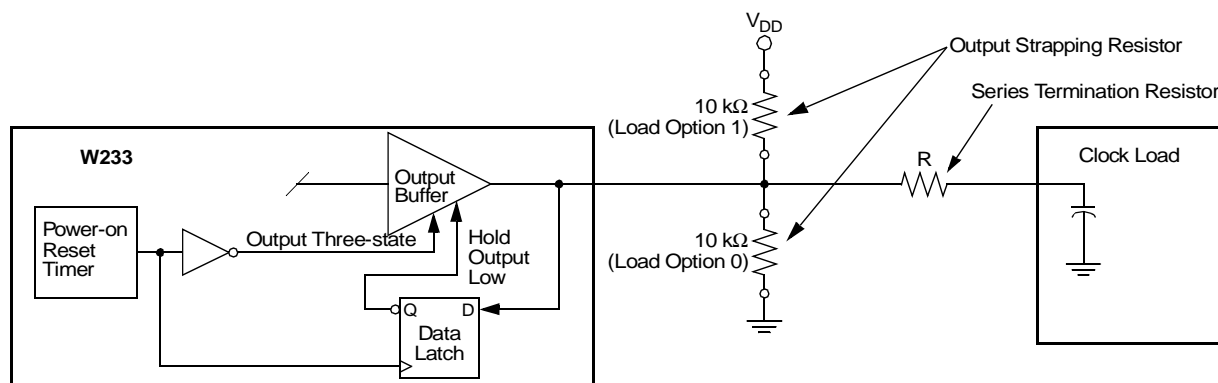
Pins 4, 5, 22, 23, and 46 are dual-purpose I/O pins. Upon power-up these pins act as logic inputs, allowing the determination of assigned device functions. A short time after power-up, the logic state of each pin is latched and the pins become clock outputs. This feature reduces device pin count by combining clock outputs with input select pins.

An external 10-k $\Omega$  "strapping" resistor is connected between the I/O pin and ground or  $V_{DD}$ . Connection to ground sets a latch to "0," connection to  $V_{DD}$  sets a latch to "1." *Figure 1* and *Figure 2* show two suggested methods for strapping resistor connections.

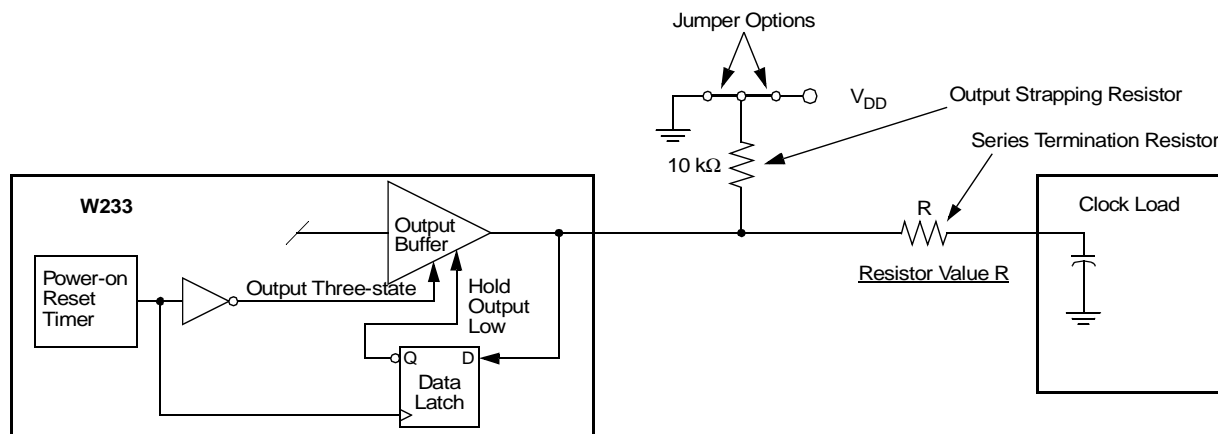
Upon W233 power-up, the first 2 ms of operation is used for input logic selection. During this period, the five I/O pins (4, 5, 22, 23, 46) are three-stated, allowing the output strapping resistor on the I/O pins to pull the pins and their associated capacitive clock load to either a logic HIGH or LOW state. At the end of the 2-ms period, the established logic "0" or "1" condition of the I/O pin is latched. Next the output buffer is enabled converting the I/O pins into operating clock outputs. The 2-ms timer starts when  $V_{DD}$  reaches 2.0V. The input bits can only be reset by turning  $V_{DD}$  off and then back on again.

It should be noted that the strapping resistors have no significant effect on clock output signal integrity. The drive impedance of clock outputs is <40 $\Omega$  (nominal), which is minimally affected by the 10-k $\Omega$  strap to ground or  $V_{DD}$ . As with the series termination resistor, the output strapping resistor should be placed as close to the I/O pin as possible in order to keep the interconnecting trace short. The trace from the resistor to ground or  $V_{DD}$  should be kept less than two inches in length to prevent system noise coupling during input logic sampling.

When the clock outputs are enabled following the 2-ms input period, the specified output frequency is delivered on the pin, assuming that  $V_{DD}$  has stabilized. If  $V_{DD}$  has not yet reached full value, output frequency initially may be below target but will increase to target once  $V_{DD}$  voltage has stabilized. In either case, a short output clock cycle may be produced from the CPU clock outputs when the outputs are enabled.



**Figure 1. Input Logic Selection Through Resistor Load Option**



**Figure 2. Input Logic Selection Through Jumper Option**

## Spread Spectrum Frequency Timing Generator

The device generates a clock that is frequency modulated in order to increase the bandwidth that it occupies. By increasing the bandwidth of the fundamental and its harmonics, the amplitudes of the radiated electromagnetic emissions are reduced. This effect is depicted in *Figure 3*.

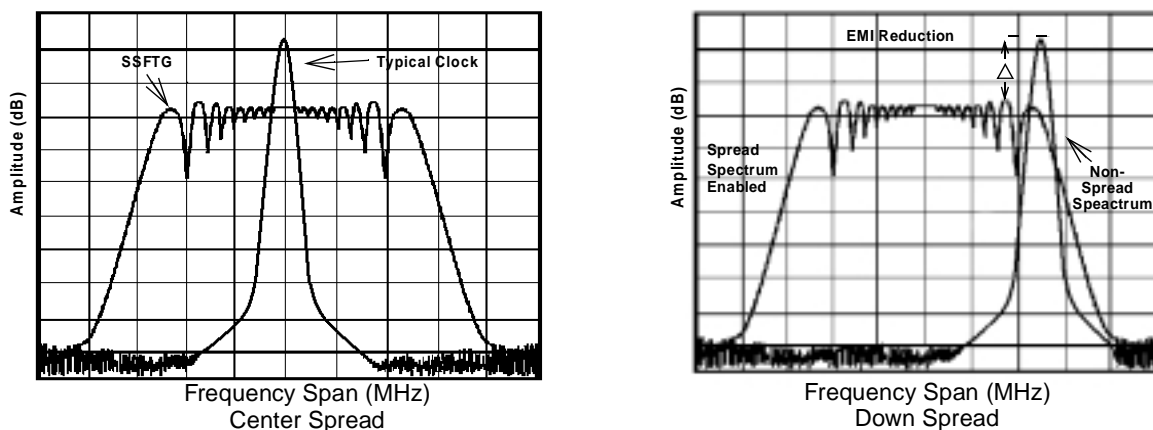
As shown in *Figure 3*, a harmonic of a modulated clock has a much lower amplitude than that of an unmodulated signal. The reduction in amplitude is dependent on the harmonic number and the frequency deviation or spread. The equation for the reduction is:

$$dB = 6.5 + 9 \log_{10}(P) + 9 \log_{10}(F)$$

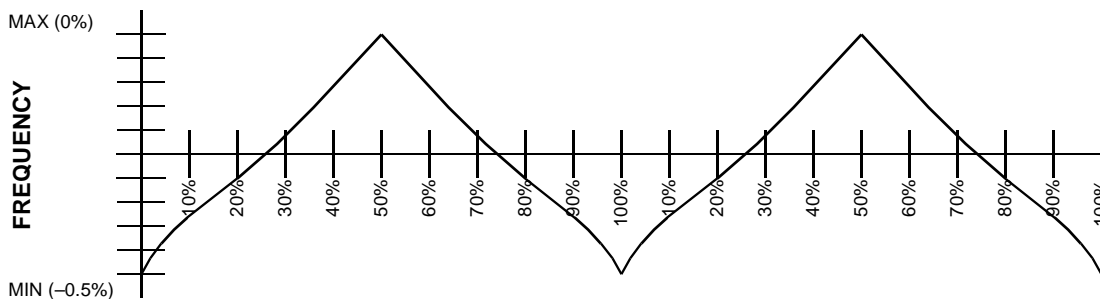
Where  $P$  is the percentage of deviation and  $F$  is the frequency in MHz where the reduction is measured.

The output clock is modulated with a waveform depicted in *Figure 4*. This waveform, as discussed in "Spread Spectrum Clock Generation for the Reduction of Radiated Emissions" by Bush, Fessler, and Hardin produces the maximum reduction in the amplitude of radiated electromagnetic emissions. The deviation selected for this chip is specified in *Table 5*. *Figure 4* details the Cypress spreading pattern. Cypress does offer options with more spread and greater EMI reduction. Contact your local Sales representative for details on these devices.

Spread Spectrum clocking is activated or deactivated by selecting the appropriate data bytes of the SMBus data stream. Refer to *Table 5* for more details.



**Figure 3. Clock Harmonic with and without SSCG Modulation Frequency Domain Representation**



**Figure 4. Typical Modulation Profile**

## Serial Data Interface

The W233 features a two-pin, serial data interface that can be used to configure internal register settings that control particular device functions. Upon power-up, the W233 initializes with default register settings, therefore the use of this serial data interface is optional. The serial interface is write-only (to the clock chip) and is the dedicated function of device pins SDATA and SCLOCK. In motherboard applications, SDATA and SCLOCK are typically driven by two logic outputs of the

chipset. Clock device register changes are normally made upon system initialization, if any are required. The interface can also be used during system operation for power management functions. *Table 2* summarizes the control functions of the serial data interface.

### Operation

Data is written to the W233 in eleven bytes of eight bits each. Bytes are written in the order shown in *Table 3*.

**Table 2. Serial Data Interface Control Functions Summary**

Control Function	Description	Common Application
Clock Output Disable	Any individual clock output(s) can be disabled. Disabled outputs are actively held LOW.	Unused outputs are disabled to reduce EMI and system power. Examples are clock outputs to unused PCI slots.
CPU Clock Frequency Selection	Provides CPU/PCI frequency selections through software. Frequency is changed in a smooth and controlled fashion.	For alternate microprocessors and power management options. Smooth frequency transition allows CPU frequency change under normal system operation.
Spread Spectrum Enabling	Enables or disables spread spectrum clocking.	For EMI reduction.
Output Three-state	Puts clock output into a high impedance state.	Production PCB testing.
(Reserved)	Reserved function for future device revision or production device testing.	No user application. Register bit must be written as 0.

**Table 3. Byte Writing Sequence**

Byte Sequence	Byte Name	Bit Sequence	Byte Description
1	Slave Address	11010010	Commands the W233 to accept the bits in Data Bytes 0–6 for internal register configuration. Since other devices may exist on the same common serial data bus, it is necessary to have a specific slave address for each potential receiver. The slave receiver address for the W233 is 11010010. Register setting will not be made if the Slave Address is not correct (or is for an alternate slave receiver).
2	Command Code	Don't Care	Unused by the W233, therefore bit values are ignored ("Don't Care"). This byte must be included in the data write sequence to maintain proper byte allocation. The Command Code Byte is part of the standard serial communication protocol and may be used when writing to another addressed slave receiver on the serial data bus.
3	Byte Count	Don't Care	Unused by the W233, therefore bit values are ignored ("Don't Care"). This byte must be included in the data write sequence to maintain proper byte allocation. The Byte Count Byte is part of the standard serial communication protocol and may be used when writing to another addressed slave receiver on the serial data bus.
4	Data Byte 0	Refer to <i>Table 4</i>	The data bits in Data Bytes 0–7 set internal W233 registers that control device operation. The data bits are only accepted when the Address Byte bit sequence is 11010010, as noted above. For description of bit control functions, refer to <i>Table 4</i> , Data Byte Serial Configuration Map.
5	Data Byte 1		
6	Data Byte 2		
7	Data Byte 3		
8	Data Byte 4		
9	Data Byte 5		
10	Data Byte 6		
11	Data Byte 7		

### Writing Data Bytes

Each bit in the data bytes controls a particular device function except for the “reserved” bits, which must be written as a logic 0. Bits are written MSB (Most Significant Bit) first, which is bit

7. Table 4 gives the bit formats for registers located in Data Bytes 0–7.

Table 5 details additional frequency selections that are available through the serial data interface.

**Table 4. Data Bytes 0–7 Serial Configuration Map**

Bit(s)	Affected Pin		Control Function	Bit Control		Default
	Pin No.	Pin Name		0	1	
Data Byte 0						
7	--	--	(Reserved)	--	--	0
6	--	--	SEL_2	See Table 5		0
5	--	--	SEL_1	See Table 5		0
4	--	--	SEL_0	See Table 5		0
3	--	--	Hardware/Software Frequency Select	Hardware	Software	0
2	--	--	SEL_4	See Table 5		1
1	--	--	SEL_3	See Table 5		0
0	--	--		Normal	Three-stated	0
Data Byte 1						
7	--	--	(Reserved)	--	--	0
6	--	--	(Reserved)	--	--	0
5	--	--	(Reserved)	--	--	0
4	--	--	(Reserved)	--	--	0
3	--	--	(Reserved)	--	--	0
2	42	CPU_CS	Clock Output Disable	Low	Active	1
1	40	CPUC0_F	Clock Output Disable	High	Active	1
0	41	CPUT0_F	Clock Output Disable	Low	Active	1
Data Byte 2						
7	15	PCI6	Clock Output Disable	Low	Active	1
6	12	PCI5	Clock Output Disable	Low	Active	1
5	11	PCI4	Clock Output Disable	Low	Active	1
4	10	PCI3	Clock Output Disable	Low	Active	1
3	9	PCI2	Clock Output Disable	Low	Active	1
2	8	PCI1	Clock Output Disable	Low	Active	1
1	5	PCI0	Clock Output Disable	Low	Active	1
0	4	PCI_F	Clock Output Disable	Low	Active	1
Data Byte 3						
7	--	--	(Reserved)	--	--	0
6	--	SEL_24MHz	SEL 24MHz as the output frequency for 24_48MHz	24-MHz	48-MHz	0
5	22	48MHz	Clock Output Disable	Low	Active	1
4	23	24_48MHz	Clock Output Disable	Low	Active	1
3	27	SDRAM_F	Clock Output Disable	Low	Active	1
2	29, 28	SDRAM4:5	Clock Output Disable	Low	Active	1
1	33, 32	SDRAM2:3	Clock Output Disable	Low	Active	1

**Table 4. Data Bytes 0–7 Serial Configuration Map** (continued)

Bit(s)	Affected Pin		Control Function	Bit Control		Default
	Pin No.	Pin Name		0	1	
0	37, 36	SDRAM0:1	Clock Output Disable	Low	Active	1
<b>Data Byte 4</b>						
7	--	--	(Reserved)	--	--	0
6	--	--	(Reserved)	--	--	0
5	--	--	(Reserved)	--	--	0
4	--	--	(Reserved)	--	--	0
3	--	--	(Reserved)	--	--	0
2	--	--	(Reserved)	--	--	0
1	--	--	(Reserved)	--	--	0
0	--	--	(Reserved)	--	--	0
<b>Data Byte 5</b>						
7	--	--	(Reserved)	--	--	0
6	--	--	(Reserved)	--	--	0
5	--	--	(Reserved)	--	--	0
4	--	--	(Reserved)	--	--	0
3	--	--	(Reserved)	--	--	0
2	46	REF2	Clock Output Disable	Low	Active	1
1	47	REF1	Clock Output Disable	Low	Active	1
0	48	REF0_2X	Clock Output Disable	Low	Active	1
<b>Data Byte 6</b>						
7	--	--	(Reserved)	--	--	0
6	--	--	(Reserved)	--	--	0
5	--	--	(Reserved)	--	--	0
4	--	--	(Reserved)	--	--	0
3	--	--	(Reserved)	--	--	0
2	--	--	(Reserved)	--	--	0
1	--	--	(Reserved)	--	--	0
0	--	--	(Reserved)	--	--	0
<b>Data Byte 7</b>						
7	--	--	(Reserved)	--	--	0
6	--	--	(Reserved)	--	--	0
5	--	--	(Reserved)	--	--	0
4	--	--	(Reserved)	--	--	0
3	--	--	(Reserved)	--	--	0
2	--	--	(Reserved)	--	--	0
1	--	--	(Reserved)	--	--	0
0	--	--	(Reserved)	--	--	0



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

Input Conditions					Output Frequency		
Data Byte 0, Bit 3 = 1					CPU	PCI	Spread Spectrum
Bit 2 SEL_4	Bit 1 SEL_3	Bit 6 SEL_2	Bit 5 SEL_1	Bit 4 SEL_0			
1	1	1	1	1	133.3	33.3	OFF
1	1	1	1	0	100.0	33.3	OFF
1	1	1	0	1	133.3	33.3	±0.5%
1	1	1	0	0	100.0	33.3	±0.5%
1	1	0	1	1	133.3	33.3	−0.5%
1	1	0	1	0	100.0	33.3	−0.5%
1	1	0	0	1	133.3	33.3	±0.25%
1	1	0	0	0	100.0	33.3	±0.25%
1	0	1	1	1	95.0	31.7	OFF
1	0	1	1	0	102.0	34.0	OFF
1	0	1	0	1	104.0	34.6	OFF
1	0	1	0	0	106.0	35.3	OFF
1	0	0	1	1	108.0	36.0	OFF
1	0	0	1	0	110.0	36.6	OFF
1	0	0	0	1	111.0	37.0	OFF
1	0	0	0	0	112.0	37.3	OFF
0	1	1	1	1	113.0	37.6	OFF
0	1	1	1	0	114.0	38.0	OFF
0	1	1	0	1	115.0	38.3	OFF
0	1	1	0	0	116.0	38.6	OFF
0	1	0	1	1	118.0	39.3	OFF
0	1	0	1	0	120.0	40.0	OFF
0	1	0	0	1	124.0	31.0	OFF
0	1	0	0	0	127.0	31.7	OFF
0	0	1	1	1	130.0	32.5	OFF
0	0	1	1	0	136.0	34.0	OFF
0	0	1	0	1	140.0	35.0	OFF
0	0	1	0	0	145.0	36.2	OFF
0	0	0	1	1	150.0	37.5	OFF
0	0	0	1	0	155.0	38.7	OFF
0	0	0	0	1	160.0	40.0	OFF
0	0	0	0	0	166.0	41.6	OFF

## Absolute Maximum Ratings

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 conditions

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
$V_{DD}, V_{IN}$	Voltage on any pin with respect to GND	-0.5 to +7.0	V
$T_{STG}$	Storage Temperature	-65 to +150	°C
$T_B$	Ambient Temperature under Bias	-55 to +125	°C
$T_A$	Operating Temperature	0 to +70	°C
$ESD_{PROT}$	Input ESD Protection	2 (min.)	kV

## DC Electrical Characteristics: $T_A = 0^\circ\text{C}$ to $+70^\circ\text{C}$ , $V_{DD} = 3.3\text{V} \pm 5\%$

Parameter	Description	Test Condition	Min.	Typ.	Max.	Unit
<b>Supply Current</b>						
$I_{DD}$	3.3V Supply Current	CPU0_F, CPUC0_F, CPU_CS = 100 MHz Outputs Loaded <sup>[2]</sup>		260		mA
$I_{DD}$	2.5V Supply Current	CPU0_F, CPUC0_F, CPU_CS = 100 MHz Outputs Loaded <sup>[2]</sup>		25		mA
<b>Logic Inputs</b>						
$V_{IL}$	Input Low Voltage		GND - 0.3		0.8	V
$V_{IH}$	Input High Voltage		2.0		$V_{DD} + 0.3$	V
$I_{IL}$	Input Low Current <sup>[3]</sup>				-25	μA
$I_{IH}$	Input High Current <sup>[3]</sup>				10	μA
<b>Clock Outputs</b>						
$V_{OL}$	Output Low Voltage	$I_{OL} = 1\text{ mA}$			50	mV
$V_{OH}$	Output High Voltage	$I_{OH} = -1\text{ mA}$	3.1			V
$V_{OL}$	Output Low Voltage	CPU_CS, CPU0_F, CPUC0_F Termination to V pull-up (external)	0		0.3	V
$V_{OH}$	Output High Voltage	CPU_CS, CPU0_F, CPUC0_F Termination to V pull-up (external)	1.0		1.2	V
$I_{OL}$	Output Low Current	PCI0:6, PCI_F $V_{OL} = 1.5\text{V}$	70	110	135	mA
		REF0:2 $V_{OL} = 1.5\text{V}$	50	70	100	mA
		48 MHz $V_{OL} = 1.5\text{V}$	50	70	100	mA
		24 MHz $V_{OL} = 1.5\text{V}$	50	70	100	mA
		SDRAM0:5, SDRAM_F $V_{OL} = 1.5\text{V}$	70	110	135	mA
$I_{OH}$	Output High Current	PCI0:6, PCI_F $V_{OH} = 1.5\text{V}$	70	110	135	mA
		REF0:2 $V_{OH} = 1.5\text{V}$	50	70	100	mA
		48 MHz $V_{OH} = 1.5\text{V}$	50	70	100	mA
		24 MHz $V_{OH} = 1.5\text{V}$	50	70	100	mA
		SDRAM0:5, SDRAM_F $V_{OH} = 1.5\text{V}$	70	110	135	mA

### Notes:

- All clock outputs loaded with 6" 60Ω transmission lines with 20-pF capacitors.
- W233 logic inputs (except FS3) have internal pull-up devices (pull-ups not full CMOS level). Logic input FS3 has an internal pull-down device.

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

Parameter	Description	Test Condition	Min.	Typ.	Max.	Unit
<b>Crystal Oscillator</b>						
$V_{TH}$	X1 Input Threshold Voltage <sup>[4]</sup>	$V_{DDQ3} = 3.3\text{V}$		1.65		V
$C_{LOAD}$	Load Capacitance, Imposed on External Crystal <sup>[5]</sup>			14		pF
$C_{IN,X1}$	X1 Input Capacitance <sup>[6]</sup>	Pin X2 unconnected		28		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  $+70^{\circ}\text{C}$ ,  $V_{DD} = 3.3\text{V} \pm 5\%$ ,  $f_{XTL} = 14.31818\text{ MHz}$ 

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 (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			1.0			1.0		V/ns
$t_F$	Output Fall Edge Rate			1.0			1.0		V/ns
$t_D$	Duty Cycle	Measured at 50% point		50			50		%
$t_{JC}$	Jitter, Cycle to Cycle			200			200		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:**

- X1 input threshold voltage (typical) is  $V_{DD}/2$ .
- The W233 contains an internal crystal load capacitor between pin X1 and ground and another between pin X2 and ground. Total load placed on crystal is 14 pF; this includes typical stray capacitance of short PCB traces to crystal.
- X1 input capacitance is applicable when driving X1 with an external clock source (X2 is left unconnected).
- Refer to Figure 5 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
$t_P$	Period	Measured on rising edge at 1.5V	30			ns
$t_H$	High Time	Duration of clock cycle above 2.4V	12			ns
$t_L$	Low Time	Duration of clock cycle below 0.4V	12			ns
$t_R$	Output Rise Edge Rate	Measured from 0.4V to 2.4V	1		4	V/ns
$t_F$	Output Fall Edge Rate	Measured from 2.4V to 0.4V	1		4	V/ns
$t_D$	Duty Cycle	Measured on rising and falling edge at 1.5V	45		55	%
$t_{JC}$	Jitter, Cycle-to-Cycle	Measured on rising edge at 1.5V. Maximum difference of cycle time between two adjacent cycles.			250	ps
$t_{SK}$	Output Skew	Measured on rising edge at 1.5V			500	ps
$t_O$	CPU to PCI Clock Skew	Covers all CPU/PCI outputs. Measured on rising edge at 1.5V. CPU leads PCI output.	1.0	1.7	4	ns
$f_{ST}$	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	ms
$Z_O$	AC Output Impedance	Average value during switching transition. Used for determining series termination value.		30		$\Omega$

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

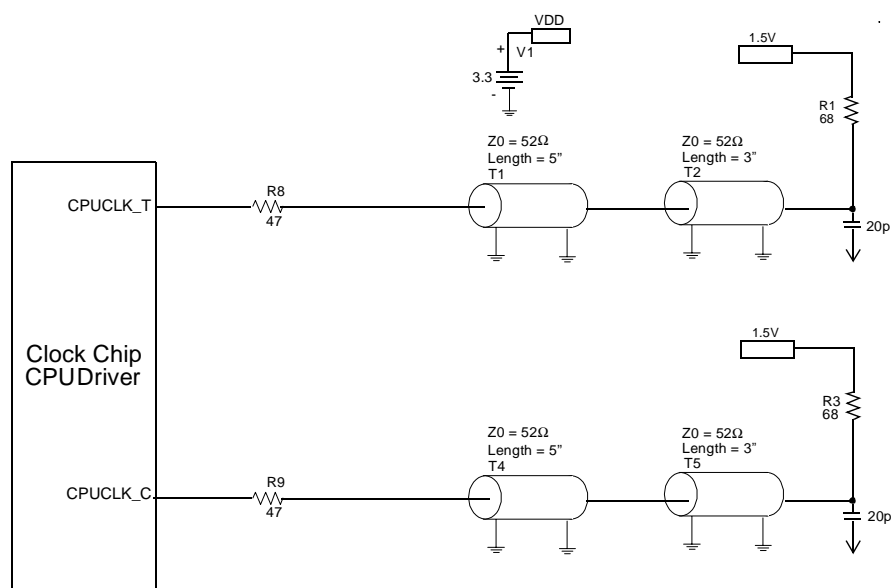
Parameter	Description	Test Condition/Comments	Min.	Typ.	Max.	Unit
$f$	Frequency, Actual	Frequency generated by crystal oscillator	14.318			MHz
$t_R$	Output Rise Edge Rate	Measured from 0.4V to 2.4V	0.5		2	V/ns
$t_F$	Output Fall Edge Rate	Measured from 2.4V to 0.4V	0.5		2	V/ns
$t_D$	Duty Cycle	Measured on rising and falling edge at 1.5V	45		55	%
$f_{ST}$	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	ms
$Z_O$	AC Output Impedance	Average value during switching transition. Used for determining series termination value.		40		$\Omega$

**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
$f_D$	Deviation from 48 MHz	$(48.008 - 48)/48$	+167			ppm
m/n	PLL Ratio	$(14.31818 \text{ MHz} \times 57/17 = 48.008 \text{ MHz})$	57/17			
$t_R$	Output Rise Edge Rate	Measured from 0.4V to 2.4V	0.5		2	V/ns
$t_F$	Output Fall Edge Rate	Measured from 2.4V to 0.4V	0.5		2	V/ns
$t_D$	Duty Cycle	Measured on rising and falling edge at 1.5V	45		55	%
$f_{ST}$	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	ms
$Z_O$	AC Output Impedance	Average value during switching transition. Used for determining series termination value.		40		$\Omega$

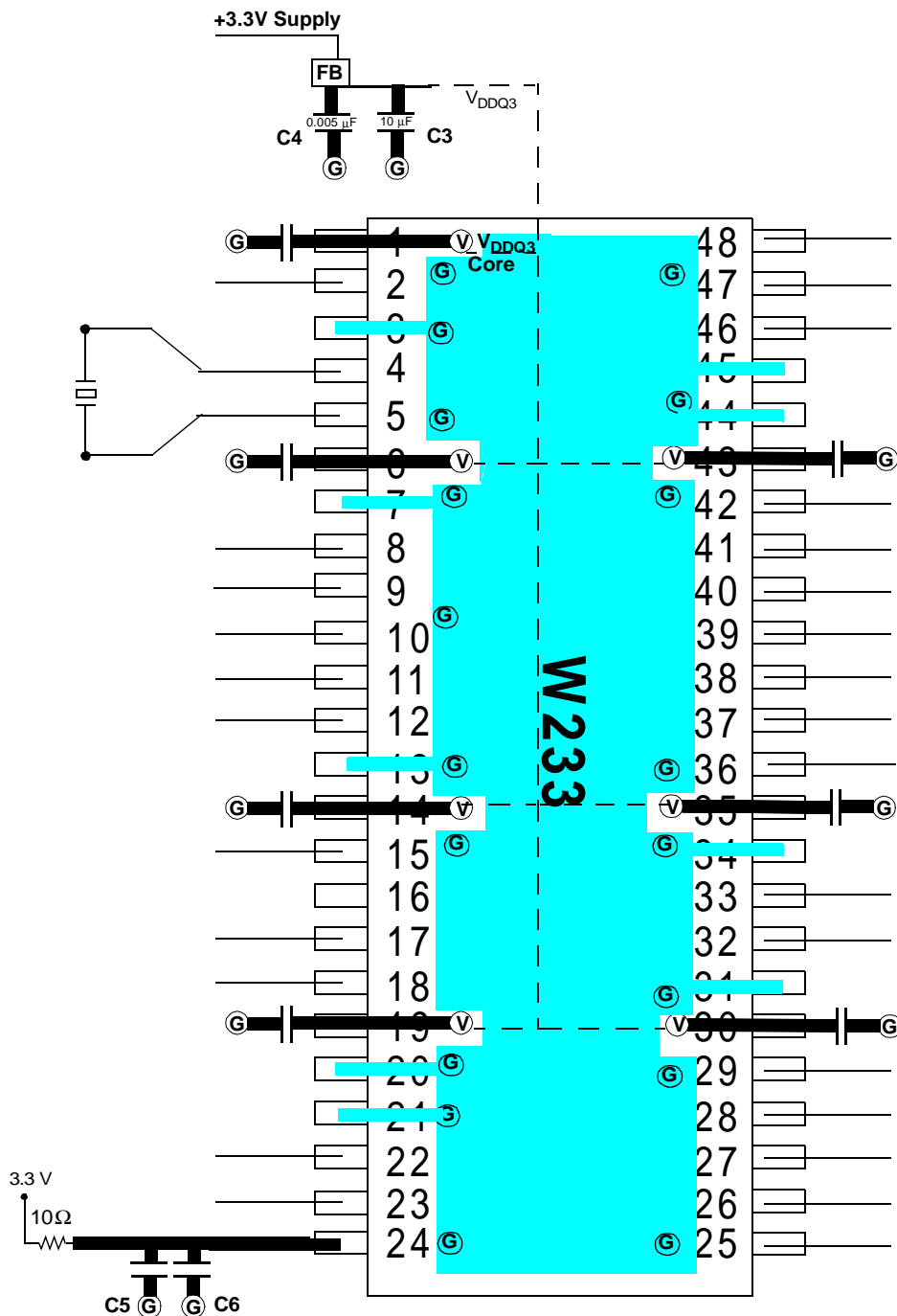
**24-MHz Clock Output (Lump Capacitance Test Load = 20 pF)**

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 5. K7 Open Drain Clock Driver Test Circuit**
**Ordering Information**

Ordering Code	Package Name	Package Type
W233	H	48-pin SSOP (300 mils)

Document #: 38-01037-\*A

**Layout Diagram**


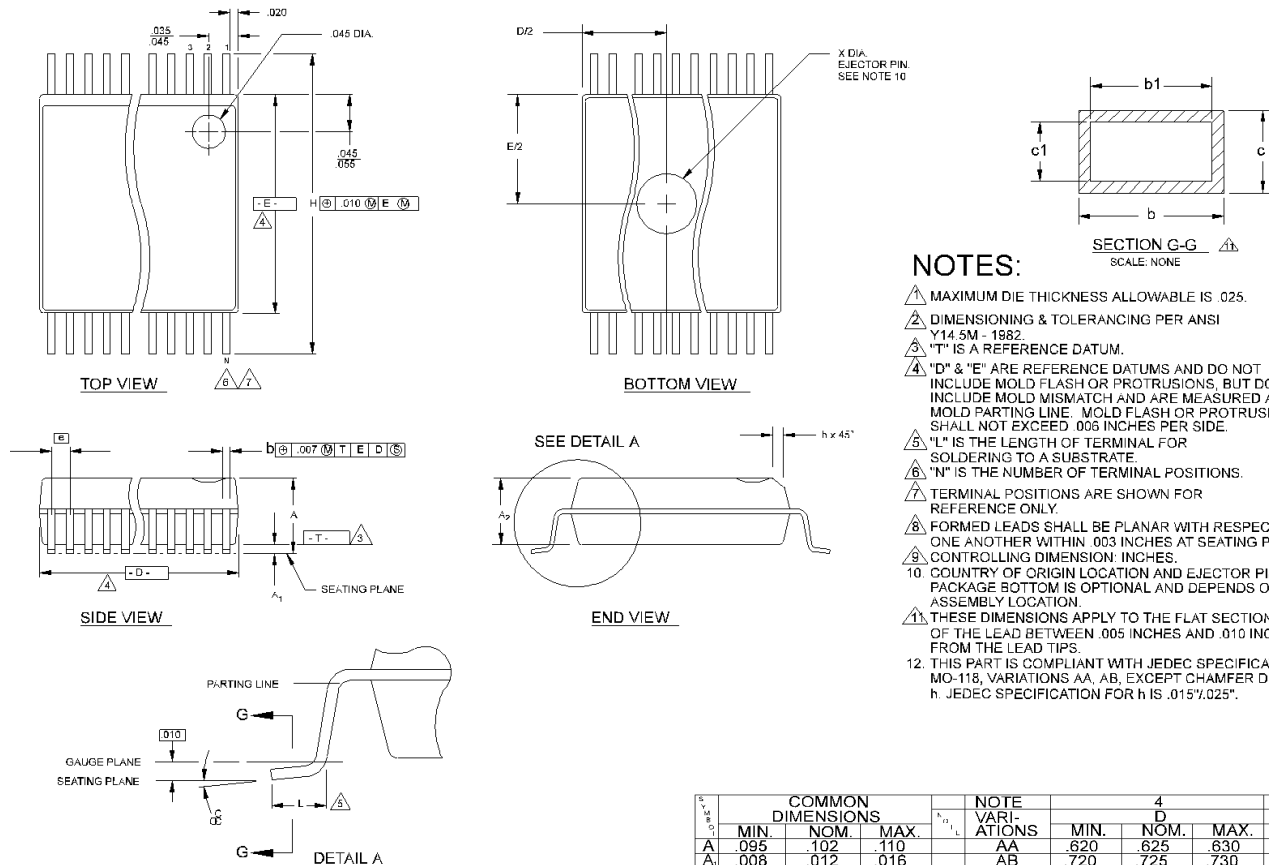
**FB** = Dale ILB1206 - 300 (300Ω @ 100 MHz) or TDK ACB2012L-120

**Ceramic Caps** C3 & C5 = 10–22 μF C4 = 0.005 μF C6 = 0.1 μF

(G) = VIA to GND plane layer (V) = VIA to respective supply plane layer

Note: Each supply plane or strip should have a ferrite bead and capacitors.

All  $V_{DD}$  by passes = 0.1 μF

**Package Diagram**
**48-Pin Small Shrink Outline Package (SSOP, 300 mils)**

**Summary of nominal dimensions in inches:**

**Body Width: 0.296**  
**Lead Pitch: 0.025**  
**Body Length: 0.625**  
**Body Height: 0.102**

SYMBOL	COMMON DIMENSIONS			NOTE	4			6
	MIN.	NOM.	MAX.		MIN.	NOM.	MAX.	
A	.095	.102	.110	AA	.620	.625	.630	48
A	.008	.012	.016	AB	.720	.725	.730	56
b	.008	.010	.0135					
b	.008	.010	.012					
c	.005	-	.010					
c	.005	.006	.0085					
D	SEE VARIATIONS			4				
E	.292	.296	.299					
e	.025 BSC							
H	.400	.406	.410					
h	.010	.013	.016					
L	.024	.032	.040					
N	SEE VARIATIONS			6				
X	.085	.093	.100	10				
α	0°	5°	8°					

THIS TABLE IN INCHES

SYMBOL	COMMON DIMENSIONS			NOTE	4			6
	MIN.	NOM.	MAX.		MIN.	NOM.	MAX.	
A	2.41	2.59	2.79	AA	15.75	15.88	16.00	48
A	0.20	0.31	0.41	AB	18.29	18.42	18.54	56
A	2.24	2.29	2.34					
b	0.203	0.254	0.343					
b	0.203	0.254	0.305					
c	0.127	-	0.254					
c	0.127	0.152	0.216					
D	SEE VARIATIONS			4				
E	7.42	7.52	7.59					
e	0.635 BSC							
H	10.16	10.31	10.41					
h	0.25	0.33	0.41					
L	0.61	0.81	1.02					
N	SEE VARIATIONS			6				
X	2.16	2.36	2.54	10				
α	0°	5°	8°					

THIS TABLE IN MILLIMETERS