

# Procedure for DDR Clock Skew and Jitter Measurements

by Vasant Solanki

DDR-SDRAMs are widely being used in PCs and Servers. DDR is different than normal SDRAM. VCC is 2.5 Volts and the signals are differential, so you have CLK+ and CLK- for every Clock Signal. The differential nature of DDR has brought some confusion for how to measure the AC parameters. The purpose of this Application Note is to recommend how to do the measurement for Static Phase Error, Phase Shift, Half-Period Jitter; Cycle-to-Cycle Jitter and Period Jitter for DDR applications. The following measurements were made using the Pericom Semiconductor Corp. PI6C857 DDR zero delay clock buffer.

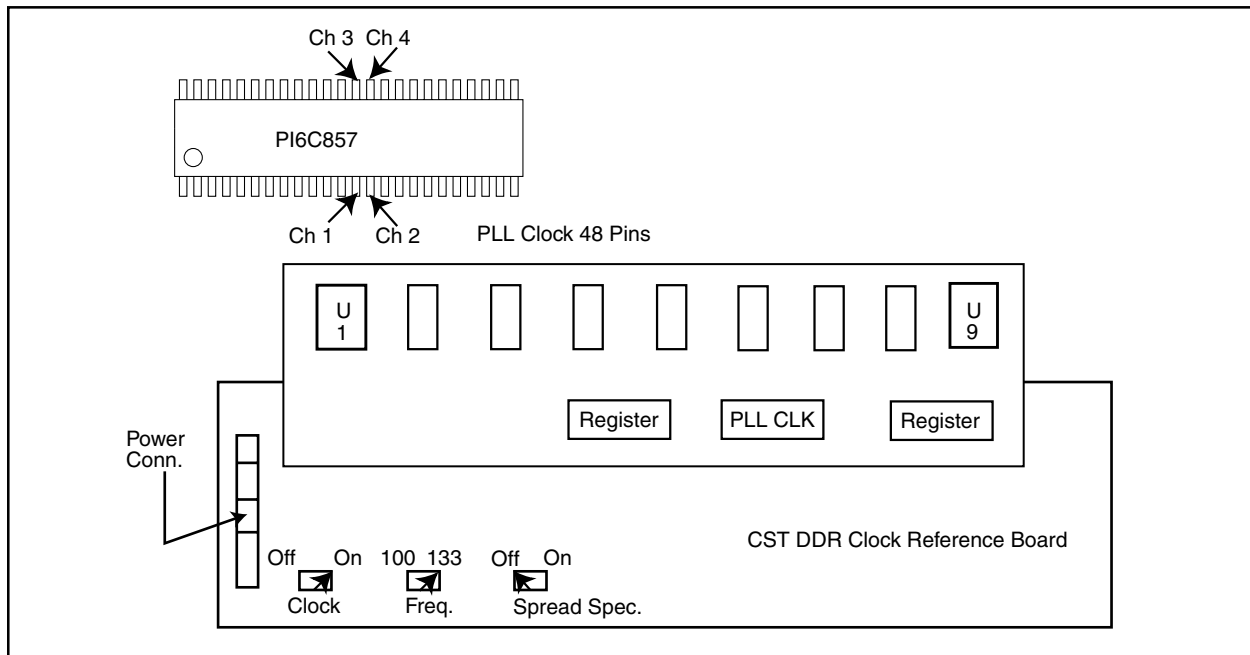
### Recommended Equipment:

- 1: Tektronix TDS 694C Four-channel digital real-time 3GHz oscilloscope.
- 2: HPE3630A triple o/p power supply.
- 3: Tektronix P6249 active probes of 4.0Ghz, 20kohm, 1.0pf.
- 4: M1 System. Time-interval Measurement System by Amherst Systems Associates, Inc.
- 5: CST DDR clock Reference Board.

### Oscilloscope Set Up:

1. Make sure that the oscilloscope is calibrated.
2. Set all the power supplies to the clock reference board at appropriate levels.

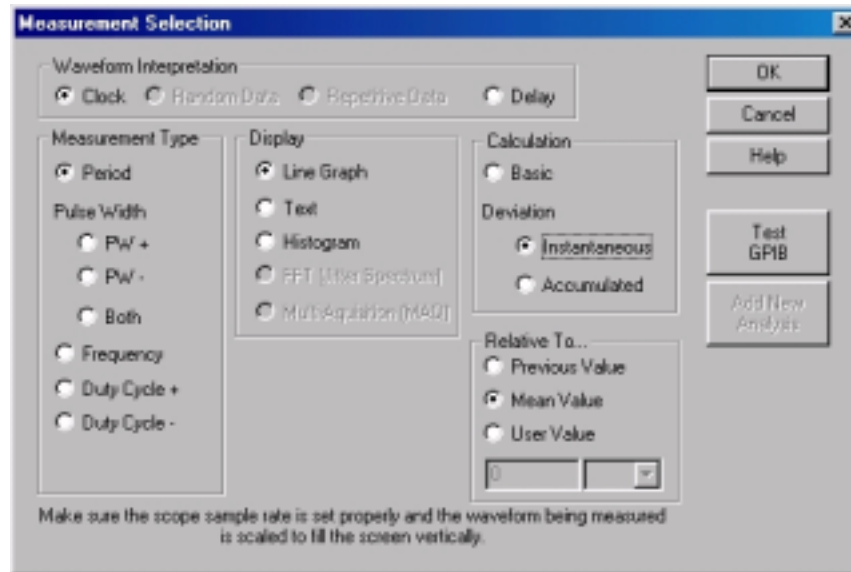
3. Set all the switches on the clock reference board to appropriate locations. (Measurements done at 133 MHz)
4. De-skew all the 4 probes. Use the reference clock positive(RefClk+) on clock reference board for de-skewing.
5. All attached wires to facilitate probing need to be matched in length and kept as short as possible (less than 0.5 inch). GND wires should be placed at device GND pin near signals to be probed.
6. CH 1 and CH 2 are connected at CLK+ and CLK- respectively. (I.e., to pin# 13 and #14 of the clock)
7. CH 3 and CH 4 are connected at FBIN+ and FBIN- respectively. (I.e., to pin#36 and #35)
8. On Oscilloscope for horizontal menu, select Horizontal record length to 15000 pts. In 300 div. (to get proper waveform at M1 system.)
9. Since the DDR clocks have differential inputs and differential outputs, it becomes very important to measure the phase error on differential signals. The phase error is measured from the crosspoint of the input reference signals to the crosspoint of the output signals. For example, in the Pericom PI6C857 clock driver, the phase error is measured from CLK(Pin#13) and CLK-(CLK bar Pin#14) input pins to FBIN(pin#36) and FBIN bar (pin#35). Therefore, all 4 probes of typical oscilloscope are used.



## DDR Measurement Steps Using M1 System:

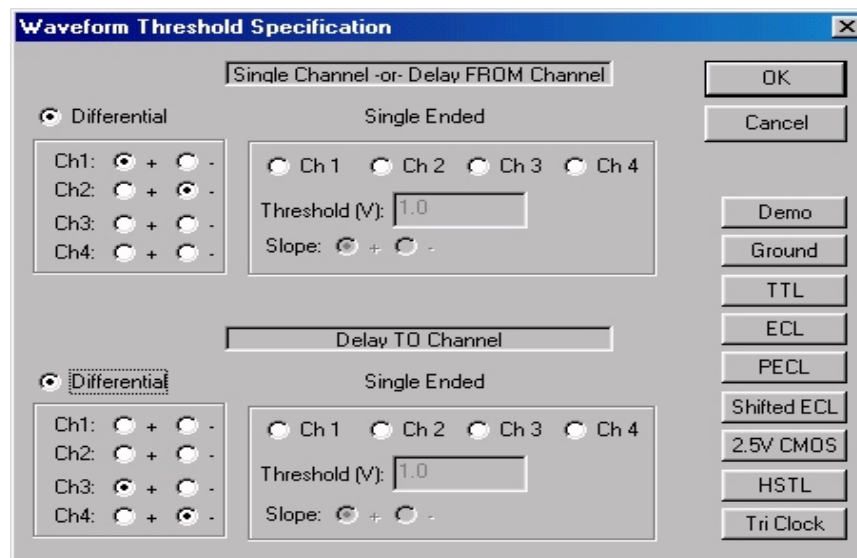
### To Measure Static Phase Offset OR Static Phase Error

- The connections for the oscilloscope channels should be as above for all 4 channels.
- On M1 System computer click on M1 system and then M1 new.
- From M1 System tool bar menu click on new measurement III. You will see the following screen for M1 system.



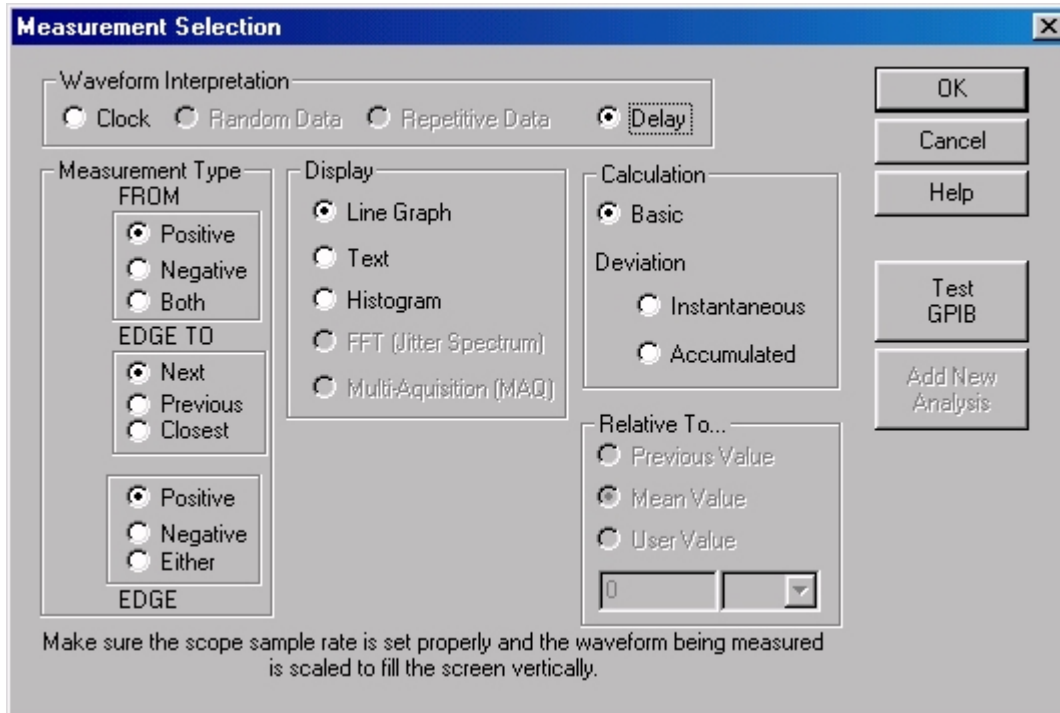
**Figure 1.** (Ignore the selected choices from above screen, follow the procedure below)

- Select “Delay” from waveform Interpretation and click “OK”.
- Now from the M1 system tool bar menu click on f? (setup i/p). You will see following screen.



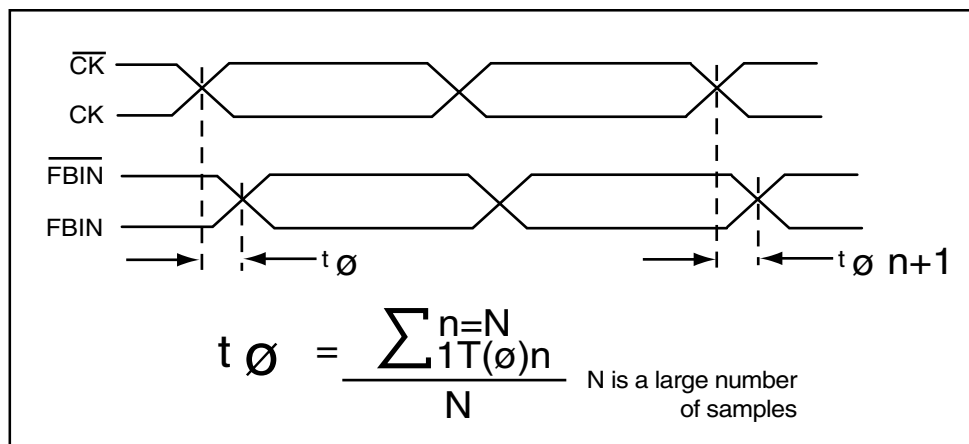
**Figure 2. Waveform Threshold Specification**

- You will get Waveform Threshold Specification menu Figure 2.
- Select “Differential for Ch1 O+ (rising edge) and Ch 2 O-(falling edge).
- Select “differential for Ch 3 O+ (rising edge) and for Ch4 O-(falling edge). And then “OK”.
- Again from M1 System tool bar menu select “New Measurement” you will see following screen



**Figure 3. Measurement Selection** (Ignore the choices from above screen, follow the procedure below)

- Waveform Interpretation, Select “Delay” . Display as “Multi-Acquisition”(MAQ).
- Measurement Type FROM Positive EDGE TO Closest Positive and press OK.
- Now from M1 System tool bar click on “CONTINUOUS RUN”, if you select “Multi-Aquisition (MAQ)” you will get the data results in the form of a table.
- Now open Paint shop screen capture .
- Go click on “Capture” and select window, and click the right mouse button the image will be captured which can be saved as \*.pif files.
- Check Figure 4 (M1 system Line graph), the value “Mean” is the mean Value for Static Phase Offset which is show in Figure 4.
- Interpret the M1 System line graph table for the other measurement such as “Phase Shift”, “Half period Jitter”, “Cycle to Cycle Jitter” and “Period Jitter”.



**Static phase Offset**

**Phase Shift Measurement:**

- Connect Channel 1 and Channel 2 at the back of memory module i.e. at the input of memory chip.
- It could also be connected at the termination resistor of 120 ohm.
- Connect Channel 3 and 4 at 120-ohm resistors at registered Reference Nets of Clock Ref. Board.
- At M1 System the procedure for Phase Shift measurements is the same as Static Phase Offset measurement described as above. You will get the measurement graph as shown below on M1

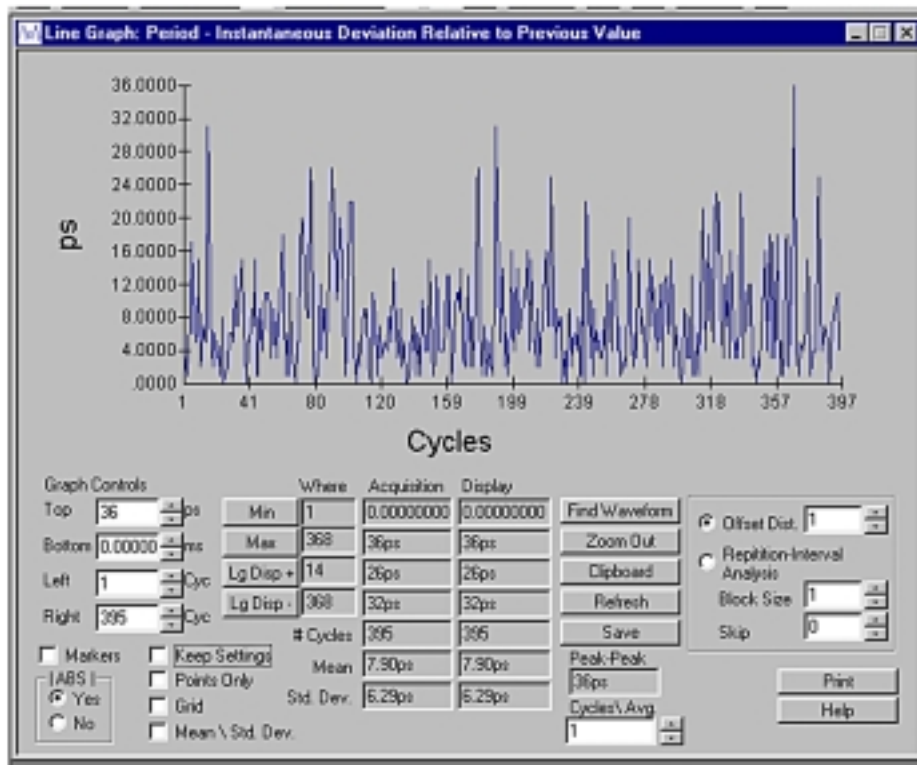
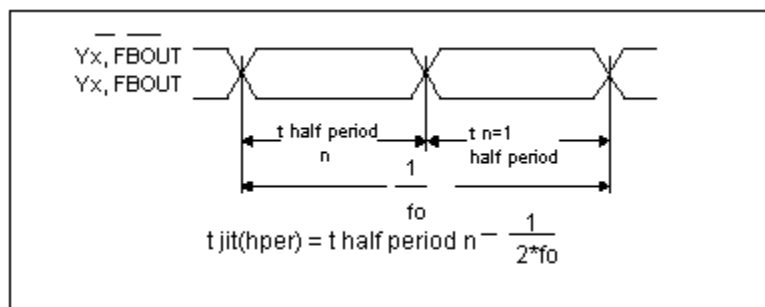


Figure 4. Half period Jitter

**Half Period Jitter:**

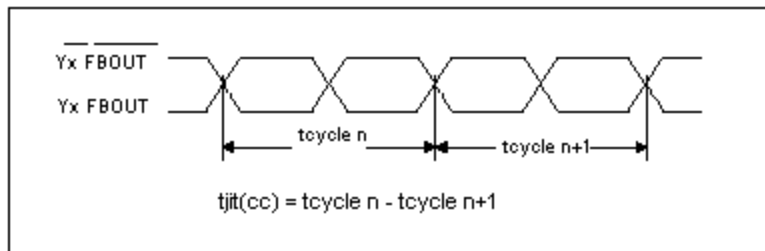
- The probe connection for Half Period Jitter is the same as Phase Shift Measurement mentioned above.
- Half Period Jitter measure is done using 2 channels only. In this case we will use channel 3 and channel 4.
- At M1 system waveform interpretation select "Clock". Measurement type "Both".
- For calculation select "Instantaneous" relative to "Mean value" and click "OK".
- From M1 system tool bar menu click on "f?" you will get the waveform threshold specification screen as shown in Figure2. previously.
- Select "Differential for Channel 3 and #4. And click "OK".
- Click on "One shot Only" on M1 system tool bar menu.



Half Period Jitter

**Cycle to Cycle Jitter:**

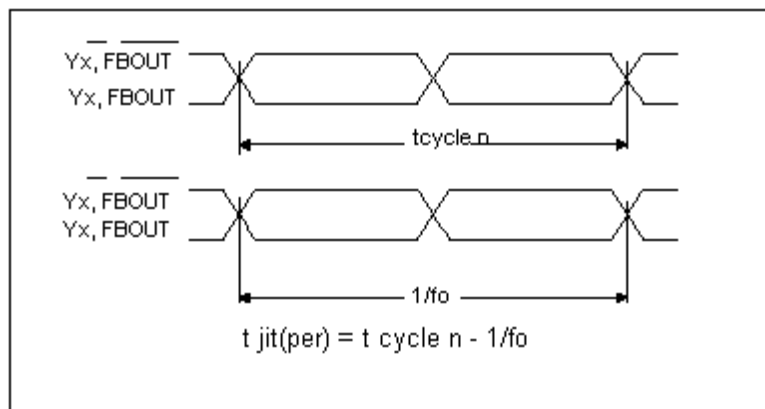
- The probe connection is the same as above.
- This measurement is done using Channel 3 and 4 only too.
- At M1 system when you see Figure 1. Select waveform interpretation as “Clock”.
- Select measurement type as “Period”. Calculation Deviation “Instantaneous”.
- Select Relative to “Previous value” and then select “OK”.
- Click “f?” from tool bar menu and you will get screen as in Figure 2. previously.
- Select “Differential” for channel 3 and channel 4. (Select Ch3 rising edge and Ch4 falling edge)
- Run “One Shot” only.



**Cycle-To-Cycle Jitter**

**Period Jitter:**

- The channel connections are same.
- Period Jitter measurement is done by using channel 3 and 4.
- At M1 system for measurement type select “Period”.
- Select calculation as “instantaneous” relative to “mean value”.
- Run just “One Shot” only.



**Period Jitter**

**Conclusion:**

DDR SDRAM skew and jitter measurements are complex if you do not have the proper Tools. This application note listed how to make the measurements easy using the M1 System.