

▶ **PRODUCT:** Big Ben

▶ **TOPIC:** Termination : How and Why

## Termination Sensing LEDs

With Big Ben's simple but powerful Termination Sensing function, you may discover that you've got configuration problems you didn't even know you had! In this AppNote, you'll find the following information: 1) how to connect Big Ben to the five commonly encountered word clock input configurations; 2) how to correct over and under-terminated clock lines; 3) known compatibility issues with specific hardware devices; 4) an in-depth explanation of termination theory.

## Commonly Encountered Word Clock Input Configurations

As no standard exists concerning the implementation of word clock input termination, the manner in which you connect Big Ben word clock outputs depends on the receiving device's input configuration. Listed below are the five most commonly encountered configurations; if you don't know the configuration of the device connected, assume that it's un-terminated, connect the input and observe the corresponding Termination LED on the Big Ben. If termination is still incorrect, follow the steps found further in this document. Keep in mind that termination should only be applied to the END of a clock line.

Word Clock Connections	Connection
Un-terminated input	Connect the Big Ben output to the word clock input using a BNC "T" connector and Termination Plug as shown in FIGs 1 & 2.
Un-terminated input (with Word Clock Thru & Word Clock Out)	Connect the Big Ben output to the word clock input, and connect a Termination Plug to the word clock thru.
Un-terminated input (Word Clock Out only)	Connect the Big Ben output to the word clock input using a BNC "T" connector and Termination Plug as shown in FIGs 1 & 2. Don't connect the termination plug to the Word Clock Output; this will not properly terminate the Word Clock Input.
Internally Terminated input	Connect the Big Ben output to the word clock input; as input is internally terminated, no additional termination should be employed.
Switchable Termination	Connect the Big Ben output to the word clock input, and set the termination switch to 75 ohm.



FIG 1: BNC "T" and 75 Ohm TERMINATION PLUG



FIG 2: "T" and PLUG Connected to a Rosetta 800 WC In

# Apogee AppNotes *(continued)*

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## Under-Termination

When none of the TERMINATION LED's light, the word clock line is *under-terminated*. Under-termination may be caused by the following reasons:

Cause	Solution
The word clock input to which Big Ben is connected is un-terminated	Terminate the input by: 1) connecting a BNC "T" connector and termination plug (see FIGs 1&2); 2) if the receiving device has a 75 ohm termination switch available on it's word clock input, engage it.
The cable is bad	Disconnect the device word clock input and place a BNC "T" connector and termination plug directly on the cable end. If no TERMINATION LEDs light, the cable is an open circuit and should be replaced.
Big Ben is connected to a hardware device with a known issue	Please see the list of known issues further in this document.

## Over-Termination

When the red TERMINATION LED lights, the word clock line is *over-terminated*. This may be caused by the following reasons:

Cause	Solution
Big Ben's Word Clock output is connected to two terminated inputs	If Big Ben's word clock output is connected to a terminated word clock input, and the clock signal is split to a second terminated input with a BCN "T", the line will be over-terminated. Use another output for the second device.
A BNC "T" and Termination plug are used on an internally terminated input.	Remove the BNC "T" and Termination Plug
The cable is bad	Disconnect the device word clock input and place a BNC "T" connector and termination plug directly on the cable end. If the red TERMINATION LED lights, the cable is shorted and should be replaced.
A 50 ohm Termination Plug is employed	Be aware that not all Termination Plugs are 75 ohm; 50 ohm Termination Plugs are commonly found in Ethernet installations, and should not be used.

# Apogee AppNotes *(continued)*

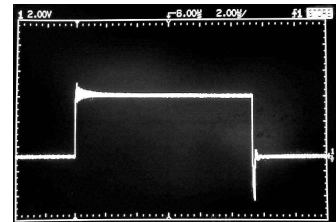
## Known Compatibility Issues With Specific Hardware Devices

When connecting certain hardware devices to Big Ben's word clock outputs, the Termination LEDs will not display correct termination due to the non-standard implementation of these devices' word clock inputs. In most cases, clock performance is not affected.

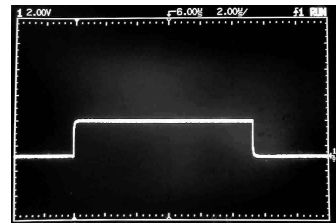
Device	Incompatibility
Mark of the Unicorn Hardware	When a MOTU interface is connected without termination, Big Ben's Termination LEDs light correctly when the MOTU interface is powered off, but indicate under termination when the interface is powered on. When a MOTU input is terminated with a 75 ohm load, Big Ben's red (over-terminated) LED lights. Thus, do not terminate MOTU inputs; this does not affect clock performance.
Digidesign Superclock (x256) Inputs Only	SuperClock inputs on Digidesign interfaces behave in a similar manner to that noted above for MOTU interfaces; do not terminate SuperClock inputs. This does not affect clock performance.
Waves L2 Hardware	Due to a non-standard implementation of the L2's word clock input, it will not lock to Big Ben's output. Please contact Waves for more information.
Tascam DA-88	The Tascam DA-88's Word Clock Input MUST be terminated with a BNC "T" connector and Termination Plug to operate correctly. When the DA-88 is off, Big Ben's Termination LEDs indicate over-termination; when the DA-88 is on, the Termination LEDs indicate proper termination.

## In-Depth

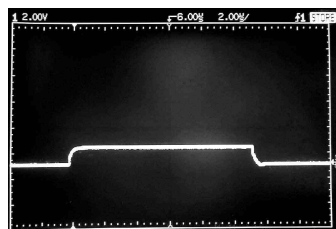
Now that all Big Ben's word clock outputs are properly terminated, let's examine a few of the technical aspects behind proper termination. A high speed clock signal propagating down a relatively long cable behaves like a wave, and can be compared to the behavior of waves through water. When the clock signal meets an un-terminated input, it reacts to this input much as a wave striking a hard wall: the "backwash" creates peaks and troughs that compromise the integrity of the signal. These perturbations, known as reflections, can be observed on an oscilloscope as over- and undershoot, and can lead to increased jitter and other clock errors.



When the clock signal meets a terminated input, it reacts much as a wave meeting a pliable gate – the wave remains unperturbed but simply attenuated in strength. This attenuation is observable on a 'scope as the normal attenuation of the 5 volt (p-p) word clock output to around 2.5 volts (p-p) (technicians take note!!).



Finally, when the clock signal meets an over-terminated input, it reacts much as a wave meeting a pliable but heavy gate – the wave remains unperturbed but is attenuated too much. This over-attenuation, easily observable on a 'scope, leads to mis-clocking and subsequent clicks and pops.



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