BIG BEN

192k Master Digital Clock

User's Guide
v1.0 - June 2003

APOGEE

SOUND AMAZING

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Warnings

FCC warning

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to take whatever measures necessary to correct the interference at his own expense.

Copyright Notice

Registration and Warranty Information

Be sure to register your BIG BEN, either by filling in the enclosed Registration Card or by completing the on-line registration form at our Web site: http://www.apogeedigital.com/register.html. If you do so, Apogee can contact you with any update information. As enhancements and upgrades are developed, you will be contacted at the registration address. Firmware updates are free for the first year of ownership unless otherwise stated. Please address any inquiries to your dealer or directly to Apogee at:

APOGEE ELECTRONICS CORPORATION,
3145 Donald Douglas Loop South, Santa Monica, CA 90405, USA.
TEL: (310) 915-1000, FAX: (310) 391-6262
email: support@apogeedigital.com. Web: http://www.apogeedigital.com/

APOGEE ELECTRONICS CORPORATION warrants this product to be free of defects in material and manufacture under normal use for a period of 12 months. The term of this warranty begins on the date of sale to the purchaser. Units returned for warranty repair to Apogee or an authorized Apogee warranty repair facility will be repaired or replaced at the manufacturer's option, free of charge. **ALL UNITS RETURNED TO APOGEE OR AN AUTHORIZED APOGEE REPAIR FACILITY MUST BE PREPAID, INSURED AND PROPERLY PACKAGED, PREFERABLY IN THEIR ORIGINAL BOX**. Apogee reserves the right to change or improve design at any time without prior notification. Design changes are not implemented retroactively, and the incorporation of design changes into future units does not imply the availability of an upgrade to existing units.

This warranty is void if Apogee determines, in its sole business judgment, the defect to be the result of abuse, neglect, alteration or attempted repair by unauthorized personnel.

The warranties set forth above are in lieu of all other warranties, expressed or implied, and Apogee specifically disclaims any and all implied warranty of merchantability or of fitness for a particular purpose. The buyer acknowledges and agrees that in no event shall the company be held liable for any special, indirect, incidental or consequential damages, or for injury, loss or damage sustained by any person or property, that may result from this product failing to operate correctly at any time.

USA: Some states do not allow for the exclusion or limitation of implied warranties or liability for incidental or consequential damage, so the above exclusion may not apply to you. This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

Service Information

The BIG BEN contains no user-serviceable components: refer to qualified service personnel for repair or upgrade. Your warranty will be voided if you tamper with the internal components. If you have any questions with regard to the above, please contact Apogee.

In the event your BIG BEN needs to be upgraded or repaired, it is necessary to contact Apogee prior to shipping, and a Return Materials Authorization (RMA) number will be assigned. This number will serve as a reference for you and helps facilitate and expedite the return process. Apogee requires that shipments be pre-paid and insured — unless otherwise authorized in advance.

IMPORTANT: ANY SHIPMENT THAT IS NOT PRE-PAID OR IS SENT WITHOUT AN RMA NUMBER WILL NOT BE ACCEPTED.

Declarations of Conformity

Declaration of Conformity—FCC

Apogee BIG BEN

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation. This equipment has been tested and found to comply with the limits of a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful inteference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

    1. Re-orient or relocate the receiving antenna.
    2. Increase the separation between the equipment and receiver.
    3. Connect the equipment into an outlet on a different circuit from that to which the receiver is connected.
    4. Consult the dealer or an experienced radio/TV technician for help.

NOTE: The use of non-shielded cable with this equipment is prohibited.
CAUTION: Changes or modifications not expressly approved by the manufacturer responsible for compliance could void the user's authority to operate the equipment.

Apogee Electronics Corporation, 3145 Donald Douglas Loop South, Santa Monica, CA 90405.
Betty Bennett, CEO.

Industry Canada Notice

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations. Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Declaration of Conformity – CE

Apogee Electronics Corporation hereby declares that the product, the BIG BEN, to which this declaration relates, is in material conformity with the following standards or other normative documents:

- EN50081-1/EN55022; 1995
- EN50082-1/IEC 801-2, 3, 4; 1992
  following the provisions of:
- 73/23/EEC – Low Voltage Directive
- 89/336/EEC – EMC Directive

Declaration of Conformity – Japan

Apogee Electronics Corporation hereby declares that the BIG BEN, to which this declaration relates, is in material conformity with the VCCI Class A standard.

Declaration of Conformity – Australia

Apogee Electronics Corporation hereby declares that the BIG BEN is in material conformity with AN/NZS standard requirements.

OWNER'S RECORD

The serial number is located on the rear panel of the unit. We suggest you record the serial number in the space provided below. Refer to it whenever you call an authorized Apogee Electronics repair facility or the manufacturer. Please be sure to return your completed warranty card immediately!

BIG BEN Serial No.

Purchase Date

Factory Firmware Revision

Dealer

Phone

Address

User's Installation Notes:

CAUTION:
Any changes or modifications not expressly approved by APOGEE ELECTRONICS
CORPORATION could void your authority to operate this equipment under the FCC rules.

BIG BEN
User's Guide

Table of Contents

Introduction

Apogee Electronics' Big Ben Master Digital Clock provides a complete clock synchronization solution for the digital production studio. Each feature of Big Ben has been carefully designed to ensure the highest quality, stability and simplicity when synchronizing your studio.

- At the heart of Big Ben, Apogee's C777 Clock Technology uses Direct Digital Synthesis to generate ultra-stable clock frequencies whose jitter is virtually un-measurable regardless of the clock source. Big Ben operates at frequencies up to 192 kHz, including common pull up/ pull down frequencies and VSO (varispeed) functionality.

- Adaptive Loop Filtering (ALF) optimizes clock performance and attenuates jitter, so that even poor reference clock sources won't degrade Big Ben's performance.

- A wide range of input and output connections simplifies studio configuration; included are AES, S/PDIF and Optical I/O, plus 6 Word Clock outputs and 1 Word Clock/Video input. An Option Card slot, for "emerging" digital formats such as FireWire, offers the ability to update Big Ben's functionality. Format conversion is available between AES, S/PDIF, Optical and Option formats.

- Sure Lock ensures a fail safe lock to external sources, thereby stabilizing the entire clock configuration. Word Clock termination sensing verifies that all Word Clock connections are properly terminated, thus avoiding transmission mis-matches which lead to hard-to-find clocking errors.

Please register this unit by filling in the included registration card, or registering online at
http://www.apogeedigital.com/register.html
Please read this manual – if you call for technical support, we'll assume that you have. There will be a quiz.

Getting Started Quickly

CONNECTING POWER

Big Ben performs best when connected to AC power, and will accept an AC input of 100 to 240 VAC at a frequency of 50 to 60 Hz. In other words, Big Ben may be connected to virtually any AC power outlet found worldwide without concern for voltage settings or fuse ratings.

RESET

To reset the Big Ben, power up the unit while pressing the DOWN key. This provides a quick method to return to factory default settings when exploring the unit's functionality and capabilities.

QUICKSTART

Follow these simple steps to get clocking quickly:

1) Reset Big Ben by powering up the unit while pressing the DOWN key. This will configure the unit as shown at the top of this page.

2) Configure Big Ben to the desired settings by following these steps:

- Enable Setup mode by pressing any of the 4 SETUP buttons. The SET UP LED will illuminate and the active parameter will blink for a few seconds.
- Choose the parameter to be modified by pressing either the PREV or NEXT button. Scroll through the 7 parameter choices a few times to get a "feel" for choosing the desired parameter.
- Modify the selected parameter to the desired value by pressing either the UP or DOWN button. Again, scroll through the available values.
- If no buttons are pushed for 2 seconds, Setup mode is automatically disabled.

USING THIS MANUAL

While the regularly scheduled manual runs in the adjacent text, in-depth explanations, operational warnings and other digressions will be presented in these columns.

In this manual, "parameters" are defined as the characteristics of operation, such as **CLOCK SOURCE** or **AES** format, and are capitalized in this manner : **CLOCK SOURCE**.

"Values" are defined as the choices available for each parameter – for example, the parameter **CLOCK SOURCE** has the values *INTernal, AES1, AES2,OPTICAL,OPTION,WC* and *VIDEO*. Values are italicized in this manner: *S/PDIF*.

"Settings" are defined as the entire set of parameters and values.

When physical controls such as buttons or switches are referred to in the text, they are highlighted in this manner: DOWN.

SYMBOLS:

The exclamation mark alerts the user to potential pitfalls of operation.
The musical note indicates in-depth explanations.

Navigating the Front Panel

It's Got a Mind of Its Own!
As Big Ben's settings are modified, certain parameters and values become unavailable for selection, while others seem to change all by themselves! In fact, Big Ben intelligently modifies many settings according to the configuration of the unit. For example, when an external **CLOCK SOURCE** is selected, **SAMPLE RATE** can't be modified, as its value is determined from the selected **CLOCK SOURCE.** As another example, the **VSO** value may be selected only when **CLOCK SOURCE** is set to *INTernal.*

Keep in mind that before modification of any Big Ben setting, SETUP mode must be enabled.

1) Power Switch – Every aspect of Big Ben has been carefully thought out – even the Power Switch! Three configurations, set with internal jumpers, are available:

1) Big Ben is powered on in the expected manner, by pushing the Power Switch;

2) Big Ben powers on automatically when AC input is applied, but the Power Switch is still functional;

3) the Power Switch is completely disabled.

Please see the section on "Internal Adjustments" for instructions on changing the Power Switch mode.

Note that the Power Switch LED indicates that Big Ben is receiving a proper AC input, and is in Standby mode. The LED goes out when Big Ben is powered on.

2) Set-Up buttons and LED – These buttons are used to modify all settings on Big Ben. In general, setting modification requires 4 steps: enabling Setup mode, choosing the parameter to be modified; choosing the desired value and disabling Setup mode.

1) Enable Setup mode by simply pressing any of the SETUP buttons. The SETUP LED will illuminate and the value selected the previous time SETUP mode was enabled will blink.

2) Press either the PREV or NEXT buttons until the current value of the parameter to be modified is blinking.

3) Press either the UP or DOWN buttons until the desired value is blinking.

4) If no buttons are pushed for 2 seconds, Setup mode is disabled automatically, and the value which was blinking will now illuminate solidly. All settings (except some VSO settings) are saved in non-volatile memory, and will be recalled the next time Big Ben is powered up.

Navigating the Front Panel - *continued*

3) CLOCK /Digital Audio SOURCE – At it's simplest, Big Ben derives a reference clock frequency from an internal or external source and generates several ultra low jitter clock outputs based on this reference. The CLOCK SOURCE parameter selects the source of the reference clock frequency. When a Clock Source is selected which contains a digital audio signal, that signal is routed to all outputs capable of transmitting digital audio. The following sources are available:

- *INT* – Big Ben's clock outputs are derived from an internal clock frequency generator. CLOCK SOURCE must be set to *INTernal* to set the PULL UP/DOWN parameter to *VSO*,

- *AES1* – clock and digital audio outputs are derived from the AES1 input. If AES is set to *DOUBLE*, both *AES1* and *AES2* will light.

- *AES 2* – clock and digital audio outputs are derived from the AES2 input.

- *S/P COAX* – clock and digital audio outputs are derived from the S/PDIF coaxial input.

- *OPTICAL* - clock and digital audio outputs are derived from the Optical input.

- *OPTION* - clock and digital audio outputs are derived from the Option Card input. This selection is only available when an Option Card is installed.

- *WC* - clock outputs are derived from the Video/Word Clock input when a valid word clock signal has been connected.

- *VIDEO* - clock outputs are derived from the Video/Word Clock input when a valid video signal has been connected. The video format (PAL,NTSC or B&W) will be automatically detected.

⚠ When video has been selected as the clock source, allow Big Ben approximately 30 seconds to achieve the best lock.

Navigating the Front Panel - *continued*

The better the input reference signal, the smaller the phase differences between that input and Big Ben's ultra-stable output . If these phase differences are less than 1 degree (as depicted in FIGURE 1), the NARROW and WIDE LEDs light. If, on the other hand, these phase differences increase to a point where a loss of lock may occur (as depicted in FIGURE 2), the Narrow LED will extinguish, leaving only the WIDE LED lit. Though Big Ben's output will remain remarkably stable, loss of NARROW lock indicates a stability problem with the input reference signal, caused by excessive jitter or electrical failure.
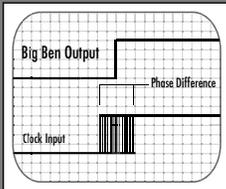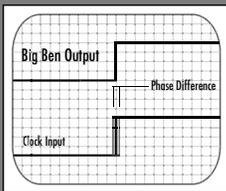

FIGURE 1

FIGURE 2

Note that Apogee's use of Wide and Narrow terminology differs from that of other manufacturers, who use "narrow" to designate a clock reference running precisely at standard rates, and "wide" to designate a clock reference running at any varispeed rate.

4) SAMPLE RATE – When CLOCK SOURCE is set to *INTernal* or *VIDEO*, SAMPLE RATE displays the frequency of the internally generated clock, and may be set to a frequency of 44.1 -192 kHz. When CLOCK SOURCE is set to any other value (*AES1, AES2, S/P COAX, OPTICAL, OPTION* or *WC*), SAMPLE RATE displays the frequency detected at the selected input.

5) Lock Indication LEDs – Big Ben's lock status to the selected CLOCK SOURCE is indicated with a group of 5 LEDs; the following states are indicated:

- Blinking Green Arrow – Big Ben is not locked to the selected CLOCK SOURCE.
- Solid Green Arrow + "WIDE LOCK" displayed – Big Ben is locked to the selected CLOCK SOURCE, but the quality of the input signal is questionable.
- Solid Green Arrow + Blue Dot + "NARROW LOCK" displayed – Big Ben has achieved the most precise lock possible.
- Blinking Green Arrow + Blue LED solidly lit – Big Ben is no longer locked to the selected CLOCK SOURCE (indicated by the Blinking Green Arrow) but has entered Surelock mode and is transmitting a stable clock nevertheless (indicated by the solidly lit Blue LED.

Navigating the Front Panel - *continued*

6) OPTICAL – This parameter determines the format of the Optical Input/Output connectors.

7) AES - This parameter determines the format of the AES Input/Output connectors.

Valid settings of the OPTICAL and AES parameters are determined by the SAMPLE RATE as depicted in FIGURE 3 below;

	192/176.4	96/88.2	48/44.1
S/PDIF	valid	valid	valid
ADAT	x	x	valid
S/MUX 2	x	valid	x
S/MUX 4	valid	x	x
AES Single	valid	valid	valid
AES Double	valid	valid	x

FIGURE 3

Please see the section of this manual entitled "About Digital Audio Formats and Format Conversion" for a more detailed explanation of Big Ben's digital functionality.

Navigating the Front Panel - *continued*
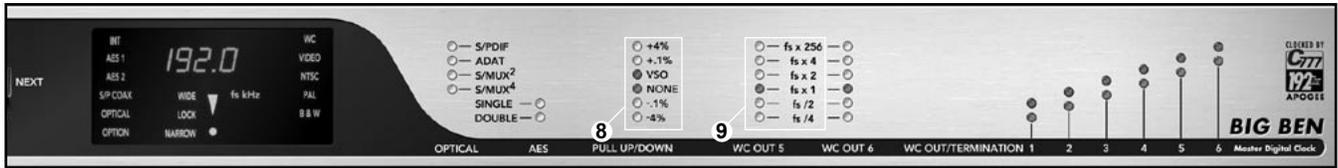
In VSO mode:
due to the limitations of a 4 digit display, only one of the three units of measurement can be displayed accurately; display values for the remaining two units are approximated. Whichever unit of measurement is displayed when modifying **SAMPLE RATE** accurately represents the output; if a second unit of measurement is selected and **SAMPLE RATE** is modified, that second unit of measurement becomes the accurately displayed unit. For this reason it's recommended to choose the unit of measurement desired before setting the SAMPLE RATE value.

When in VSO mode, please note that the SAMPLE RATE value is not retained in Non-Volatile memory, and will be lost when Big Ben is power cycled. All other settings are memorized.

To clock most digital systems, a word clock of the same frequency as the audio sample rate is required. For those systems where the required word clock is a multiple of the sample rate, WC Out 5 & 6 may be set accordingly.

8) PULL UP/DOWN – The Pull Up/Down parameter is active only when SAMPLE RATE is set to *INTernal* or *VIDEO*. The frequency of the SAMPLE RATE may be modified by 4 defined percentages to accommodate specific situations encountered during video production and post. The +- 4% values are usually employed when transferring between PAL video and film, while the +- 0.1 values are employed when transferring between NTSC video and film.

VSO (Variable Speed Override) is the term historically used to denote the variable speed control on a tape machine. Variable Speed is accomplished in the digital audio domain by modifying the sample rate. Big Ben allows this modification of the SAMPLE RATE over a wide range of values when CLOCK SOURCE is set to *INTernal* and the PULL UP/DOWN parameter is set to *VSO*, Moreover, the SAMPLE RATE may be displayed in three units of measurement : 1) absolute frequency in Hz 2) amount of change in percentage, and 3) amount of change in cents (i.e. subdivisions of a semitone).

For VSO operation,
  1) Ensure that CLOCK SOURCE is set to *INTernal*, and that the desired base SAMPLE RATE has been selected.
  2) Set PULL UP/DOWN to *VSO*
  3) Select the SAMPLE RATE parameter, and set the desired amount of varispeed with the UP or DOWN buttons (Pressing and holding the UP or DOWN key causes values to scroll more rapidly) The SAMPLE RATE value will now vary in increments of 1 hz,, 0.1% (1% when the amount of change is greater than 10 %) or 1 cent, depending on the unit of measurement displayed.

To change the units of measurement displayed, select the SAMPLE RATE parameter and press and hold either the PREV or NEXT button.

To reset the SAMPLE RATE to an unchanged state, select the SAMPLE RATE parameter and press and hold both the UP and DOWN buttons. Alternatively, it's possible to toggle the PULL UP/DOWN parameter between *NONE* and *VSO*.

9) WC OUT 5 – This parameter allows the frequency of Word Clock Output 5 to be set to a multiple of the SAMPLE RATE.

Navigating the Front Panel - *continued*

10) WC OUT 6 – Similar to the WC OUT 5 parameter, the frequency of Word Clock Output 6 may be set to a multiple of the SAMPLE RATE.

Valid settings are determined by the SAMPLE RATE as depicted in FIGURE 4 below

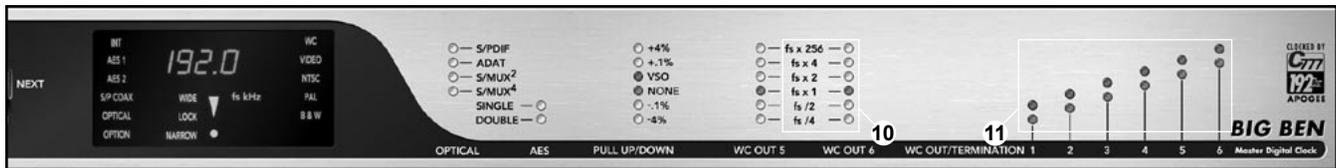| WC OUT 5&6 value	Big Ben SAMPLE RATE		
	192/176.4	**96/88.2**	**48/44.1**
fs x 256	x	x	valid
fs x 4	x	x	valid
fs x2	x	valid	valid
fs x1	valid	valid	valid
fs/2	valid	valid	x
fs/4	valid	x	x

FIGURE 4

If the UP button is pressed while powering up the unit, WC outputs 5 & 6 transmit clock signals suitable for DSD devices, as depicted in FIGURE 5 below. WC OUT 5 & 6 default to *fsx1* and may not be modified

	192/96/48 kHz	**176.4/88.2/44.1kHz**
WC OUT 5 (Fs x64 at 44.1/48kHz)	**3.072 MHz**	**2.8224 MHz**
WC OUT 6 (Fs x128 at 44.1/48kHz)	**6.144 MHz**	**5.6448 MHz**

FIGURE 5

11) WC OUT/TERMINATION – Correct termination of word clock inputs is crucial to a stable clock configuration. The 6 WC OUT/TERMINATION LEDs indicate whether each of Big Ben's six Word Clock outputs have been properly terminated at the inputs to which they are connected. Three states of termination are indicated for each word clock output:

- Red LED on – Input is OVER terminated
- Green LED on – Input is correctly terminated
- No LED on – Input is un-terminated or output is not connected

Termination sensing can also be used to verify the integrity of word clock cables by following these steps (Big Ben must be locked to perform this test):

1) Connect one end of the cable being tested to one of Big Ben's word clock outputs, and leave the other end unconnected - the corresponding Termination Sensing LEDs should remain unlit; if the red LED lights, then the cable's shield is shorted to it's center conductor.

2) Now connect a 75 ohm termination plug to the unconnected end of the cable - the corresponding green Termination Sensing LED should light; if no LEDs light, then either the shield or center conductor has become open. If the red LED lights again, then either the connector has shorted or a 50 ohm termination plug is connected.

Connections on the Rear Panel

1) AES IN 1 & 2 – These XLR connections accept AES/EBU input in the format selected by the front panel AES parameter. When AES is set to *SINGLE*, each connection accepts a discrete stereo input; when AES is set to *DOUBLE*, both connections used in conjunction accept one stereo input.

2) AES OUT 1 & 2 - These XLR connections provide AES/EBU output in the format selected by the front panel AES parameter. When AES is set to *SINGLE*, stereo output is duplicated on each connection; when AES is set to *DOUBLE*, both connections used in conjunction provide one stereo output.

3) S/PDIF IN/OUT – These RCA (Cinch) connections provide S/PDIF Coaxial Input/ Output

4) OPTICAL IN/OUT – These Toslink connections provide Optical input/output in the format selected by the front panel OPTICAL parameter. Please see the section entitled "About Digital Audio Formats and Format Conversion" for detailed information on the formats provided.

5) OPTION CARD – This slot is reserved for Option cards which provide additional input/ output formats, such as FireWire.

6) VIDEO/WORD CLOCK IN – This BNC connection accepts both TTL Logic and video black burst signals, according to the front panel CLOCK SOURCE parameter. When CLOCK SOURCE is set to *Video*, the video format (*PAL, NTSC* or *B&W*) is automatically detected. The Video/Word Clock input is internally TERMINATED – no external termination should be used.

7) WC OUT 1-6 – These BNC connections provide TTL logic level word clock outputs. Outputs 1-4 transmit clocks whose frequency equals the SAMPLE RATE, while Outputs 5 & 6 may be set to transmit a clock whose frequency is a multiple of the SAMPLE RATE.

8) AC IN – This IES connection accepts an AC input of 100 to 240 VAC at a frequency of 50 to 60 Hz.

About Digital Audio Formats and Format Conversion

Name(s)	Connector used	Valid Sample Rates	Channels per connector	Digital Data Rate
AES Single Wire or Double Fast or Single Wide	XLR	44.1-192kHz	2	Fs x 1
AES Double Wire or Double Wide	XLR	88.2-192 kHz	1	Fs /2
S/PDIF Coaxial	RCA (coaxial)	44.1-192kHz	2	Fs x 1
S/PDIF Optical	Toslink (optical)	44.1-96kHz	2	Fs x 1
ADAT	Toslink (optical)	44.1-48kHz	8	Fs x 1
S/MUX 2	Toslink (optical)	88.2-96kHz	4	Fs /2
S/MUX 4	Toslink (optical)	176.4-192kHz	2	Fs /4

FIGURE 6

As sample rates and bit resolutions have increased, digital audio formats have been modified to handle the increased flow of data, to the point where the proliferation of format variations has led to some confusion. For example, 5 variations of the AES/EBU format have been developed to handle sample rates between 44.1kHz and 192kHz.

FIGURE 6 depicts the characteristics of the digital audio formats available on Big Ben, including the names by which the format is known, the connector used, valid sample rates, the number of digital audio channels per connection, and the rate of transmission. For example, AES Double Wire format can carry only 1 channel of audio per connection, uses XLR connectors, is used only with sample rates between 88.2 and 192 kHz, and transmits data at half the sample rate – i.e., bits travel at 48kHz when transmitting a 96kHz digital audio signal.

To convert a digital audio signal from one format to any other format, the source format must be selected as the **CLOCK SOURCE**. Digital audio data present at the selected input will be routed to all outputs capable of transmitting digital audio data.
When format converting, Big Ben will transmit as many channels as possible based on the input format selected and the capability of each output format. For example, if *S/MUX 2* input (capable of accepting 4 channels) is selected as the **CLOCK SOURCE** and **AES** is set to *SINGLE* (thus allowing transmission of 2 channels on each connector), S/MUX input channels 1 & 2 will be routed to AES Output 1, while S/MUX input channels 3 & 4 will be routed to AES Output 2; on the other hand, only S/MUX channels 1 & 2 will be routed to the S/PDIF Coaxial output (capable of transmitting 2 channels on the sole S/PDIF connector).

About SureLock

Thanks to SureLock, Apogee's intelligent clock continuity algorithm, even the loss of the input reference will not degrade the stability of Big Ben's outputs. When the selected CLOCK SOURCE is no longer applied to Big Ben, the unit will continue to generate clock outputs at the last known valid frequency; the "Wide" arrow will blink to indicate the loss of the input reference while the blue "Narrow LED will light solidly to indicate stable output. When an input reference is re-connected, Big Ben will attempt to regain lock as seamlessly as possible; nonetheless, it's recommended to re-connect the input reference at a moment when a brief interruption of Big Ben's output won't pose a problem.

Internal Adjustments

We've gone to great lengths to avoid DIP switches and other inaccessible controls on Big Ben, but there are a few internal jumpers used to configure infrequently modified parameters. See the photo below for an indication of each jumper's location.

Power On Mode –Jumper P8
1) Jumper P8 set to *MANUAL* – when AC power is applied to the input, Big Ben does not power up immediately; to power on the unit, the POWER button must be pressed. This is the default setting.

2) Jumper P8 set to *AUTO* – when AC power is applied to the input, Big Ben powers on immediately; nevertheless, the POWER switch is functional. This setting may be preferred when a Master switch controls several devices including Big Ben.

Power Switch Disabled – Jumper P27
When a jumper is removed from P8 and installed across P27, the power switch is disabled, and has no function. As is the case with all electronics, keeping Big Ben powered on at all times ensures the most stable operation. Power Switch Disabled ensures that the unit is not accidentally powered off.

SureLock Defeat –Jumper 17
When a jumper is installed across P17 and Big Ben is power cycled, SureLock functionality is defeated. For those who get nervous when machines silently take over.

Defeat FC (Format Conversion) – Jumper 18
When a jumper is installed across P18 and Big Ben is power cycled, Format Conversion functionality is defeated and Digital "Black" is sent to all digital audio outputs.
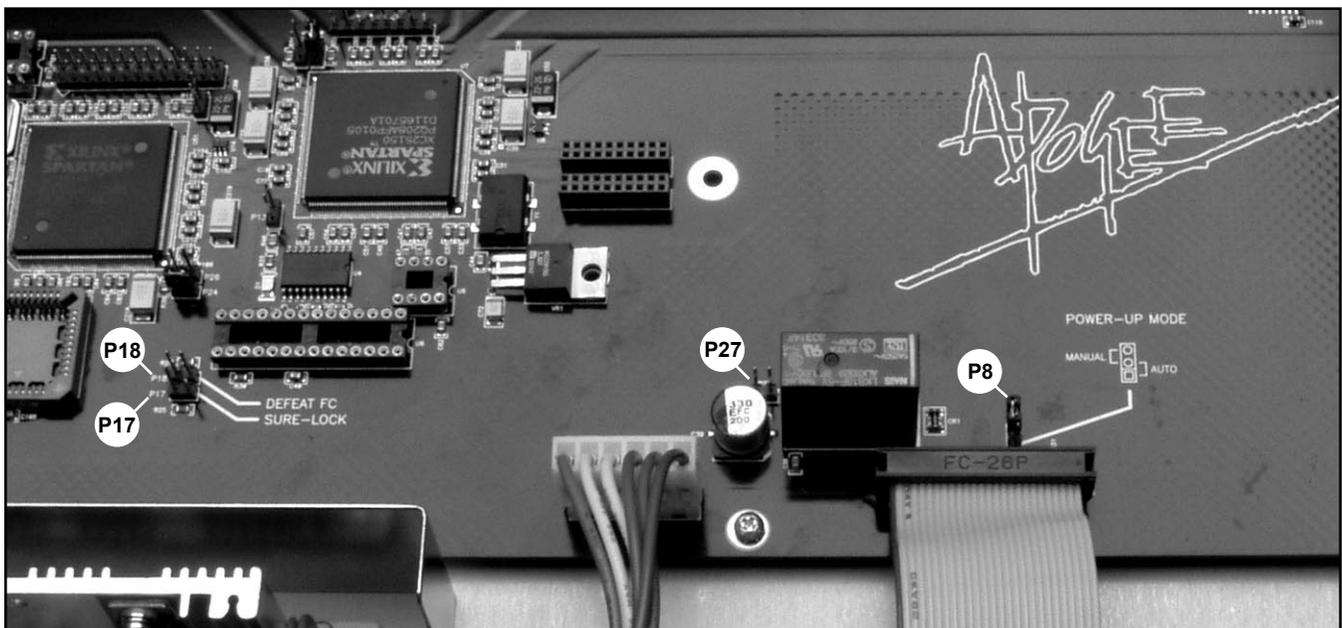

FIGURE 7

Clock Distribution Theory and Practice

Master Clock and Conversion
To understand the importance of the clock signal during the A-to-D and D-to-A conversion, it's useful to examine the similarities between film and digital audio, two media which capture reality by recording and reproducing small slices of that reality.

Much in the same way that a film captures fluid motion with discrete, regularly timed still pictures, digital audio technology captures audio waveforms with regularly timed snapshots called samples. In each case, the timing regularity of the slices is paramount to successfully reproducing the original event.

For example, just as a hand-cranked projector will cause a perfectly normal film to appear jerky and unnatural, timing inconsistencies (known as jitter) in a digital-to-analog converter add inaccuracies to an otherwise good digital audio signal. Worse, if a hand-cranked film camera were used to capture a performance, even the most stable projector couldn't remove the instability of the movement recorded on film. Likewise, jitter anomalies encoded during the analog-to-digital stage can never be removed further down the digital audio chain. The overall quality of a digital system is determined by the quality of the A-to-D and D-to-A converters; the most stable clock possible ensures the most consistent timing, and therefore the highest quality, for these stages.

Master Clock and Device Synchronization
A Master Clock also ensures the synchronization of all devices in a studio, allowing any possible digital connection to be made seamlessly without clicks, pops or digital hash. To understand the requirements of a clock signal, consider the analogy between the digital studio and a musical ensemble.

In order for a musical ensemble to play together successfully, each member must perform his part at a common tempo. Likewise, each device in a digital studio must transmit and receive digital bits as dictated by a common clock signal. The larger the ensemble, the more difficult it is to play together without a conductor - imagine the resulting cacophony if each player in an orchestra followed the tempo of his neighbor. A similar situation arises in the digital studio when each device receives a clock signal from its neighbor - timing differences between devices can cause digital bits to be dropped when the studio must "play together", for example while transferring or mixing digitally.

On the other hand, when each member of the orchestra follows the tempo set by a conductor, even a large group of musicians can play precisely in unison. Likewise, when each device receives a robust and precise clock signal directly from Big Ben, even a large digital studio can operate in perfect synchronization.

Word Clock Termination
As the frequency of a word clock signal increases, termination requirements become more critical to precise transmission. In order to ensure the integrity of the clock waveform, each connection should be terminated by a 75 ohm load impedance. Over-termination (a load impedance lower than 75 ohms) will attenuate the signal excessively, while under-termination ((a load impedance greater than 75 ohms) introduces overshoot and other waveform distortions. Both conditions compromise clock accuracy, and are indicated by Big Ben's termination sensing LEDs.

Connecting Clock Signals

From the preceding information , these four Rules of Clock can be established:

1) Ensure that all A-to-D and D-to-A converters are clocked by the most precise source possible, to ensure the highest quality for the entire digital audio system.
2) Each digital device should be connected directly to the Master Clock Source with the shortest possible cable, in a "star" configuration.
3) Each Word Clock line should be terminated with a 75 ohm load, as indicated by Big Ben's Termination sensing LEDs. When the word clock input of connected devices is un-terminated, it's acceptable to chain a few devices with a BNC "T" connector on the word clock input.
4) Don't delay the clock signal to any device by chaining a signal through input/output clock circuitry. Every device should receive the digital "downbeat" simultaneously.

Features and Specifications

- Direct Digital Synthesis (DDS) using Apogee's C777 Clock Technology up to 192kHz
- AES, S/PDIF, Optical I/O - Word Clock/Video In - 6 Word Clock Outs
- Optional FireWire connection to facilitate clocking and format conversion with other Firewire devices
- Realtime format conversion between all digital formats
- Adaptive Loop Filtering (ALF) to optimize clock performance and minimize jitter
- Fail safe lock to external sources (Sure Lock)
- Word Clock termination sensing

Inputs:
- 2 x AES-EBU on XLR 44.1k-192k single-wide and 88.2-192k double-wide.
- S/PDIF optical on TOS-LINK 44.1-48k
- S/PDIF coaxial on RCA 44.1-192k
- ADAT 44.1-48k
- ADAT/SMUX II for 88.2-96k
- ADAT/SMUX IV for 176.4-192k
- Word Clock BNC 44.1-192k
- Video
- Optional Firewire

Outputs:
- 2 x AES-EBU on XLR single or double wide 44.1-192k
- S/PDIF coaxial 44.1-192k
- S/PDIF optical on TOS-LINK 44.1-48k
- 6 x BNC Word Clock 44.1-192k (of which 2 can output x256fs, x4, x2, 1/2, 1/4 at apropriate sample rates)
- ADAT
- SMUX II
- SMUX IV
- Optional FireWire

Specs:
- Sample rates: 44.1/48-88.2/96-176/192 . All +/- 10%
- Video: PAL/NTSC/60Hz
- "SuperClock" (256fs)
- Pull up/down 0.1% and 4% from any sample rate
- Apogee's new Ultra Low Jitter C777 clock
- Three stage termination indicator (under/correct/over) on each Word Clock output
- "SureLock" technology for drop out prevention
- Varispeed in absolute frequency or relative musical values (i.e. semitones to allow pitch changes)
- 4 digit numeric true sample rate indication
- Universal power: 15 W 90-250 VAC 50-60 HZ

Due to on-going development Apogee reserves the right to change all information and specifications without notice.

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SOUND AMAZING