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AEC-BOX-5

INSTRUCTION MANUAL

ADRIENNE ELECTRONICS
CORPORATION

(LTC Translator/Regenerator with RS232/RS422 Interface)

Third Edition

May 2004

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INTRODUCTION

Longitudinal Time Code (LTC) is a specialized audio signal which contains digital time-of-day and frame count information relating to an accompanying video signal. As an audio signal, it can be recorded and played back by video and audio tape machines. LTC is used for audio/video editing, tape logging, and automation.

The logical question most people ask first is "Why do you need to translate LTC to LTC?". In an ideal world, there would indeed be no need for such a thing. However, in the real world, there exist three(3) different types of LTC, and there is often a need to translate back and forth between them. Also, in the real world, there is often a need to recover poor quality LTC signals, or to resynchronize them with the accompanying video signal.

The AEC-BOX-5 is a "play speed" LTC translator/regenerator with RS232 and RS422 interfaces. Depending on the operating mode, the LTC output is synchronized to either the LTC or Video Sync input, and will continue to work even if the LTC or Video Sync input disappears or is otherwise degraded. Through the serial interface, the LTC output can be monitored and controlled using a variety of personal computers and other devices. The AEC-BOX-5 works equally well with SMPTE (30fps) and EBU (25fps) time codes, and can also read (but not generate) FILM (24fps) time codes.

Related products include our PCI-LTC, PCI-VITC, and PCI-VLTC families of LTC and VITC readers and generators for IBM PC personal computers, USB-TC time code readers, along with other members of the AEC-BOX family of standalone VITC, LTC, video, RS232, and RS422 interface boxes. Contact us if you would like further information.

GETTING STARTED QUICKLY

If you want to use your AEC-BOX-5 right away, without reading the whole manual, just do the following:

- 1) Plug the AC power cord into a suitable voltage AC outlet.
- 2) Connect the LTC input signal to the "LTC IN" RCA jack.
- 3) Connect the "LTC OUT" RCA jack to wherever it is going.
- 4) Connect the Video Sync input signal to the "SYNC IN" BNC's.
- 5) (optional) Use a serial data cable to connect the 9-pin "D" connector (on the box) to your computer or other device.

The box should now be generating LTC, using EPROM default values or the LTC input data as a starting point. It will also be transmitting serial data every LTC frame, describing the present time, user, and embedded bits (see page 30). If any Video Sync or LTC input errors are detected, or if either one is missing, the power LED will blink off, then back on, once per second. If something doesn't work, you will have to carefully read the "INSTALLATION" section of this manual (see page 7).

AEC-BOX-5 SPECIFICATIONS

LTC READER INPUT:

Impedance	20kohms typical
Input Level	100mVpp to 20Vpp
DC on Input	+1V maximum
CMRR	>26dB @ 60Hz (optional - see page 7)
Bits Read	ALL time, user, and embedded bits.
Speed Range	Must be within 5% of "play" speed.
Time Code Standards	SMPTE and EBU (automatically selected).

VIDEO SYNC INPUT:

Impedance	6kohms typical (Hi-Z)
DC on Input	+1.0V maximum
Input Level	0.8Vpp to 2.2Vpp (1.0Vpp nominal)
Looping Response	+0.1db maximum, 0-5MHz
Video Frequency	Must be within 2% of nominal frequency.
Video Standards	NTSC and PAL (automatically selected).

LTC TRANSLATOR/REGENERATOR OUTPUT (2):

Impedance	100ohms typical
Level	1.8Vpp typical
DC on Output	+50mV maximum
Freerun Error (3)	+0.003% (3 frames/hour) maximum
Phasing Error	+20us maximum w.r.t. NTSC/PAL specs

MISCELLANEOUS:

Box Dimensions (4)	16cm wide x 5cm high x 21cm long
Box Weight	1.2kg
Power Consumption	7W
Temperature Range	0 to 50 degrees Centigrade
Relative Humidity	Up to 95%, noncondensing

Notes:

- (1) All specifications are subject to change without notice.
- (2) The LTC output frequency is always at "play" speed.
The time bits count may be STILL, or changing at other rates.
- (3) After continuous initial 5 minute learning period.
- (4) Allow at least 6cm in rear for cables and connectors.

AEC-BOX-5 HARDWARE DESCRIPTION

Throughout the following discussion you may want to refer to the AEC-BOX-5 schematics which are in the back of this manual. If your box has been customized in any way for your application, then the descriptions below may not be entirely accurate.

The power supply primary side comprises power transformer T1 and thermal "fuse" device F1. Of special note is the fact that this "fuse" does not burn out. If it trips, turn the power off for one minute to let it cool/reset, then turn the power back on. The power supply secondary side starts with full wave rectifiers DB1 and DB2, plus large filter capacitors C72, C73, C82, and C83. The resulting unregulated DC supplies are then passed through voltage regulators U70(+5V), U72(+12V), and U73(-12V).

The LTC input at RCA jack J1 first goes through a differential amplifier centered about U10B. Note that the outer conductor on the RCA jack is normally grounded, but may be converted to a true differential input by cutting jumper X3. See the INSTALLATION section for details. The output of the differential amplifier is AC coupled to eliminate DC offsets, then is fed into the window comparator made up of quad comparator U9 and surrounding components. This comparator automatically senses the incoming signal level and recovers the LTC transition data even from very poor quality input signals. The complementary outputs of the window comparator go directly to proprietary LTC reader chip U2.

The video sync input signal first passes through 3-pole low pass filter R17,C44,L1,C45, then is buffered by U8A. Transistor Q5 is turned on by each sync tip, and thus generates horizontal sync pulses which are fed to U4 pin 1. Low pass filter RN10B,C40 only exceeds the threshold of comparator U6B during vertical reset pulses. The vertical sync output of U6B then goes to U4 pin 2.

The LTC output pulses are created directly by microcomputer U4. OTA U11B switches current into and out of C21, with the amplitude limited by zener diodes D8 and D9. This circuit forms the proper LTC waveform, with flat tops and sloped edges, per SMPTE/EBU specifications. Buffer amplifier U10A drives RCA jack J2 through R18 and R19 to create the proper output level and impedance.

Microcomputer U4, together with address latch U20 and EPROM U1, form a completely self contained (but miniature) computer system. DIP switch SW1 is used to modify the contents of nonvolatile EEPROM U54, which in turn controls box operating modes, baud rates, and other features. "Watch dog" timer U5 resets the microcomputer chip, and thus the entire box, if the supply voltage drops too low or if the software crashes for some reason.

Serial data from UART U52 is translated to RS232 levels by U7, and is translated to RS422 levels by U14. U14 also translates received RS232 and RS422 data for use by UART U52. Nine pin "D" connector J3 contains the RS232 and RS422 data lines.

AEC-BOX-5 EXTERNAL CABLING INSTALLATION

LTC INPUT CONNECTION:

RCA jack J1 is the "LTC IN" high impedance (20kohm) LTC input connector. As shipped from the factory, the RCA jack's outer conductor is connected to frame ground (the box chassis) via shunt X3 (next to J1). You may remove X3 in order to get a true differential LTC input, provided that the common mode voltage (usually 50/60Hz hum) is less than 2Vrms. In this configuration, we suggest that you wrap insulating electrical tape around the outside of the RCA input plug, to prevent shorts to ground.

VIDEO SYNC INPUT CONNECTION:

The two "SYNC IN" BNC connectors are wired together, so you may loop your video reference signal through this box if desired. The high impedance input circuitry will load the video signal very little (see specifications). The nominal video input level is 1Vpp, but the input amplifiers will adjust themselves to other input levels, including the unterminated input condition.

LTC OUTPUT CONNECTION:

Simply connect the "LTC OUT" RCA jack (J2) to wherever you want it to go. Nominal signal level is 1.8Vpp.

SERIAL INPUT/OUTPUT AND RELAY CONNECTIONS:

If you ordered a serial data cable with your AEC-BOX-5, just plug it in to the 9-pin "D" connector (which has socket contacts) on the back of the unit. Otherwise, you may use the kit of mating connector parts to wire up to the box as follows:

Pin #	Function
1	
2	TX422-
3	RX422+
4	Relay GND
5	TX232
6	Relay Contact
7	TX422+
8	RX422- and RX232
9	Chassis GND

Notes:

- 1) Tiny pin numbers are molded into the connector face. Be careful not to be "off by one".
- 2) For RS422, note that the pinout is that of an ESBUS Tributary.
- 3) Limit RS232 cables to 30 meters maximum.
- 4) Limit RS422 cables to 1200 meters maximum.

AC INPUT VOLTAGE RANGE SELECTION

Normally all AEC-BOX's are shipped with the transformer primary wired for 100-130VAC. Your box will bear a special marking if it has been wired for 200-260VAC instead. For your own safety, PLEASE do not proceed unless the line cord has been unplugged! Just turning off a power switch somewhere is not sufficient!

*** WARNING ***

NEVER OPEN UP THE BOX unless the line cord has been unplugged from its AC power source! To do otherwise risks damage to your AEC-BOX, and could even KILL you! We cannot assume responsibility for such careless behavior.

Box Cover Removal:

First you must UNPLUG the AC power cord, remove all other cables, then remove the bottom cover as follows:

- 1) Use a small (#1) Phillips screwdriver to remove the two small black screws which are on each side of the box.
- 2) Slide off the front and back black plastic bezels.
- 3) Turn the box over, then lift off the BOTTOM cover.

Note that you are now exposing yourself to a severe (FATAL) shock hazard if the box is still plugged in to an AC power source!

Voltage Strap Modification for 200-260VAC:

In the area underneath power transformer T1, you will find four large holes in a row, with "115V" and "230V" markings adjacent. Using sharp nosed cutters, or some other appropriate tool, cut out at least 2mm of the narrow trace next to each of the "115V" markings. Then solder a short wire between the two holes closest to the "230V" marking, being careful not to poke the ends of the wire too far into the holes (could damage power transformer T1). Also make sure that the wire you added is flush with the bottom of the board, and will not even come close to touching to bottom of the box.

Voltage Strap Modification for 100-130VAC:

In the area underneath power transformer T1, you will find four large holes in a row, with "115V" and "230V" markings adjacent. Remove the wire between the two holes closest to the "230V" marking. Then solder a short wire between each pair of holes closest to the "115V" markings, being careful not to poke the ends of the wire too far into the holes (could damage power transformer T1). Also make sure that the two wires you added are flush with the bottom of the board, and will not even come close to touching to bottom of the box.

AC POWER INPUT VOLTAGE RANGE SELECTION (continued)

Box Cover Replacement:

Basically, just follow the earlier instructions in reverse order (power to the box must be OFF):

- 1) Put the bottom cover back in place.
- 2) Slide a black plastic bezel onto each end of the unit. The box looks better if the two small molding marks are facing towards the bottom of the unit.
- 3) Reattach the bezels to the chassis with the four small black screws you removed earlier. Be careful not to strip the threads in the aluminum side extrusions!

Label The Line Cord:

Attach a small label to the plug end of the line cord, so that the next person to use this AEC-BOX will know what AC power input voltage range it expects to see.

Test Your Work:

BEFORE connecting any cables to the box, plug it in to the appropriate AC power source and make sure it works (no smoke).

INSTALLING YOUR OWN AC POWER LINE PLUG

If the plug on the end of the AC line cord is not suitable, you can cut it off and put on your own. Where possible, please wire the new plug as follows:

- 1) Green = Ground (Chassis)
- 2) Blue = Neutral
- 3) Brown = Hot

In no case should the green wire be connected to anything but ground! Use a continuity tester to verify that the ground lug on your new power cord is connected directly to the AEC-BOX chassis.

AEC-BOX-5 EPROM MODIFICATIONS

Most AEC-BOX-5 operating parameters can be controlled via DIP switch (EEPROM) programming, or via the serial port. However, in a standalone or transmit-only environment, some box operations can be tailored to your specific application only by modifying the EPROM chip inside the box. Whatever is stored in the EPROM becomes the new power-up default. Most box operations can still be modified via serial commands, as described elsewhere.

Please note that if you make any EPROM modifications, you are largely on your own. We cannot analyze your EPROM's for wrong data, wrong addresses, wrong checksum, creating weird combinations of features, and things of that sort.

The proper procedure for making EPROM modifications is:

- 1) In the charts which follow, indicate the changes to be made. This is necessary for debugging and technical support reasons.
- 2) Obtain a blank 27256 type EPROM (note programming voltage!).
- 3) Copy the entire AEC-BOX-5 EPROM into your EPROM programmer. Save the original EPROM in case your application changes, or in case your EPROM modifications don't work.
- 4) Using the EPROM programmer, make changes as desired. Make sure the data in the byte you are changing matches the default values shown in the table below.
- 5) Be sure to calculate and save the new checksum byte(!).
- 6) Program your new AEC-BOX-5 EPROM.
- 7) Install the new EPROM, then turn on the box. If the LED fails to come on, you probably have a checksum error. You may also have modified something you shouldn't have.

*** IMPORTANT ***

You are authorized to copy and make changes to the firmware (EPROM) for this product only for the memory locations described below. Any other copies or changes constitute an infringement of our copyright (and probably won't work either).

Address	Description	Default Value	New Value
0064h	Time Code Mode Control Byte #1	00h	_____
0065h	Time Code Mode Control Byte #2	00h	_____

(see page 37)

AEC-BOX-5 EPROM MODIFICATIONS
(continued)

Address	Description	Default Value	New Value
0067h	LTC Generator Embedded Bits	00h	_____
0068h	LTC Generator Time Bit Frames	00h	_____
0069h	LTC Generator Time Bit Seconds	00h	_____
006Ah	LTC Generator Time Bit Minutes	00h	_____
006Bh	LTC Generator Time Bit Hours	00h	_____
0070h	Comparator Frames Data	00h	_____
0071h	Comparator Seconds Data	00h	_____
0072h	Comparator Minutes Data	00h	_____
0073h	Comparator Hours Data	00h	_____
0074h	Comparator Frames Mask	3Fh	_____
0075h	Comparator Seconds Mask	7Fh	_____
0076h	Comparator Minutes Mask	7Fh	_____
0077h	Comparator Hours Mask	3Fh	_____
0078h	Comparator Operating Mode (see page 27)	01h	_____
0080h	ASCII Mode Upper Address Byte	30h["0"]	_____
0081h	ASCII Mode Lower Address Byte	30h["0"]	_____
0082h	Binary Mode Upper Address Byte	A0h	_____
0083h	Binary Mode Lower Address Byte	C0h	_____
7FFFh	Checksum Byte (3)	??h	_____

Notes:

- (1) Time and user bit data and mask bytes are all packed BCD.
- (2) Unless noted otherwise, the format for these bytes is the same as that described in their respective sections in this manual.
- (3) The checksum is chosen so that the single byte sum of ALL of the bytes in the EPROM is 00h.

DIP SWITCH (EEPROM) PROGRAMMING

Many aspects of AEC-BOX-5 operations can be easily modified in the field via DIP switch (EEPROM) programming. The EEPROM gets its default information from the EPROM whenever a new EPROM is installed. Thereafter, the AEC-BOX-5 uses EEPROM data to control its behavior. By modifying EEPROM data using special DIP switch patterns, as described elsewhere in this manual, the box can be easily customized to your liking.

Whenever power is first applied to the box, it checks the DIP switch settings, and alters the appropriate EEPROM data if required. This EEPROM programming sequence also takes place if you change DIP switch settings while power is applied to the box, in which case you will probably start entering spurious data. Thus, NEVER CHANGE DIP SWITCH SETTINGS WHILE THE POWER IS ON!

In general, to perform DIP switch (EEPROM) programming, you will be instructed to:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover (see below).
- 3) Set DIP switches SW1-SW8 to a particular pattern (TBD).
- 4) Reassemble the box (see next page).
- 5) Plug it in and check for proper operation.

Box Cover Removal:

First you must UNPLUG the AC power cord, remove all other cables, then remove the top cover as follows:

- 1) Use a small (#1) Phillips screwdriver to remove the two small black screws which are on each side of the box.
- 2) Slide off the front and back black plastic bezels.
- 3) Lift off the top cover.

Note that the bottom cover will fall off easily at this point, exposing you to a severe (FATAL) shock hazard if the box is still plugged in to an AC power source!

*** WARNING ***

NEVER OPEN UP THE BOX unless the line cord has been unplugged from its AC power source! To do otherwise risks damage to your AEC-BOX, and could even KILL you! We cannot assume responsibility for such careless behavior.

Changing DIP Switch (SW1) Settings:

Note that the switches are numbered 1 through 8. Also note the small "1" and "0" numbers down on the PCB next to both ends of SW1. To set a switch to be a "1", simply press down on the "1" (OPEN) end of that switch. Conversely, to set a switch to be a "0", simply press down on the "0" end of that switch. All done!

DIP SWITCH (EEPROM) PROGRAMMING (continued)

Box Cover Replacement:

Basically, just follow the earlier instructions in reverse order (power to the box must be OFF):

- 1) Put the top cover back in place.
- 2) Slide a black plastic bezel onto each end of the unit. The box looks better if the two small molding marks are facing towards the bottom of the unit.
- 3) Reattach the bezels to the chassis with the four small black screws you removed earlier. Be careful not to strip the threads in the aluminum side extrusions!

Resetting the EEPROM:

In case the box is behaving strangely, perhaps because you accidentally changed something in the EEPROM that you shouldn't have, you may want to reload the EEPROM with all of its default settings (from the EPROM). You will then have to redo all the DIP switch (EEPROM) programming steps that you performed previously (operating mode, relay mode, baud rate, etc.), and the box will automatically learn your exact video reference frequency again. To completely reset the EEPROM, proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover (see previous page).
- 3) Write down the existing switch settings for later.
- 4) Set DIP switches SW1-SW8 to 11111111 (all 1's).
- 5) Temporarily replace the top cover.
- 6) Turn on power, wait 3 seconds, turn off power.
- 7) Set DIP switches SW1-SW8 back they way they were in step #3.
- 8) Fully reassemble the box (see top of this page).
- 9) Plug it in and check for proper operation.

Note that the box will not operate properly if you leave the DIP switches all set to "1", hence the need for steps 3, 5, 6, and 7.

Factory Default Translator/Regenerator Setting:

Unless you requested otherwise, the factory default setting is "Auto LTC Regenerator with Sync to Video", so SW1 will normally be 0000001 for switches 1-8.

DIP Switch Terminology:

You may have noticed that we use "SW1-SW8" to refer to the eight(8) DIP switches individually, and we use "SW1" to refer to the entire DIP switch assembly on the printed circuit board. If we had thought about it more carefully ahead of time, we probably could have done better. In this manual, the term "SW1" should be unambiguous, depending on how it is used (the context).

LTC READER COMMON OPERATIONS

The LTC reader uses a proprietary chip to read the LTC input signal present at the "LTC IN" RCA jack. The reader will properly read both SMPTE and EBU LTC signals, with LTC input signal levels ranging from 100mVpp to 20Vpp. In this product, it is always assumed that the LTC input is at play speed.

If the LTC input signal is severely distorted, which usually happens only when tape machines are played back at speeds below 1/2x, the reader may not be able to decode the LTC signal without errors. The LTC signal quality is highly dependent on the tape and tape machine that you are using. Even a single bit error out of the 80 in each frame is enough to invalidate the entire frame.

If you are using the serial port to monitor the LTC reader data, and if the AEC-BOX detects any LTC read errors, it will always "hold on" to the last valid data read. Thus if the LTC signal is of poor quality, the LTC reader data will appear to momentarily "freeze", then will skip (jump) several frames. Also, if the LTC input signal disappears altogether, the last valid count will be held indefinitely.

While in the LTC regenerator operating modes, the AEC-BOX-5 automatically detects whether SMPTE or EBU type LTC is present. Switching between SMPTE and EBU can take up to three seconds with a play speed LTC input.

LTC GENERATOR COMMON OPERATIONS

The LTC output is generated directly by microcomputer chip U4. The box must be in a SMPTE/NTSC output mode in order to sync to an NTSC Video Sync input and generate SMPTE (30fps) LTC, and must be in a EBU/PAL output mode in order to sync to a PAL Video Sync input and generate EBU (25fps) LTC. In some operating modes the box automatically detects whether an NTSC/SMPTE or PAL/EBU type Video Sync input is present, and adjusts itself accordingly.

The starting time, user, and embedded bits are taken from the EPROM (see page 11). You may change the generator time, user, and/or embedded bits, every frame if needed, by sending the appropriate serial commands (see pages 34-36). Since the generator data is updated shortly after the midpoint of field 2, you must load your new data into the generator before this time if you want it to appear in the very next LTC frame. Otherwise it will first appear in the following frame. Changing the generator data during the last half of field 2 will not hurt anything, but you won't know exactly when the new data will first be used.

If the Video Sync input disappears, or if any errors are detected, the LTC generator will "coast" as long as necessary, automatically incrementing the time count every frame. When (and if) the video input reappears, the LTC generator will smoothly realign itself with the video input within 1 second. When (and if) the VITC data reappears, the LTC generator will once again jam the VITC data into the LTC output data (if enabled) as usual.

Time code mode byte #2 can be altered to control the LTC output in three ways. The LTC generator's time count will "freeze" (not change) if you set bit 1 to a "1", although the LTC output will still be enabled. The LTC output can be disabled at any time by setting bit 2 to a "1" (allow 200ms for the output amplifier to respond). When altering this time code mode byte, make sure you don't accidentally change any other bits.

The AEC-BOX-5 does not have the ability to detect color subcarrier phase, so the LTC generator cannot properly color frame or color lock the LTC output. Of course, if the LTC input is properly color framed while the box is in a LTC regenerator mode, the LTC output will be also.

LTC REGENERATOR WITH VIDEO SYNC (MODE 1)

This AEC-BOX-5 operating mode is used to provide a clean, stable LTC output from a crummy LTC input, or to synchronize an LTC signal to a video reference signal, or to provide a fixed time offset between the LTC input and the LTC output, or to modify the LTC user bits in some way, or some combination of all the above. In this operating mode, the box automatically adapts to PAL/EBU, NTSC/SMPTE(NDF), and NTSC/SMPTE(DF) input signals. In all cases, the box attempts to produce an exact (mirror image) copy of the LTC input signal, whatever its format.

In order to select this AEC-BOX-5 operating mode, which can only be done via the DIP switches inside the box, first review the important cautions and detailed instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Set DIP switches SW1-SW8 to 00000001 (SW8 = 1; others = 0).
- 4) Reassemble the box.
- 5) Plug it in and begin operations.

In this operating mode it is assumed that:

- 1) The LTC input is at (or very close to) play speed.
- 2) The Video Sync input (if present) is stable and very near its nominal frequency.
- 3) The LTC and Video Sync inputs use the same standards set.
Must have SMPTE LTC with NTSC video, or EBU LTC with PAL video.

If the LTC input and Video Sync are incompatible, the LTC input will be ignored, the LED will blink, and the relay may also open or close (see page 25), to indicate that a problem exists.

The LTC output will be properly synchronized (phased) to the Video Sync reference input (if one is present). After an initial 5 minute learning period, during which time the box calibrates itself to your video reference frequency, the box will continue to generate LTC with a maximum error of 3 frames per hour should the video reference input signal become disconnected.

See page 24 for information on how to insert a fixed time offset between the incoming and outgoing LTC signals. Also, see page 22 for information on how to modify the user bits if so desired.

The Status Relay (see page 25) may be used to indicate whether or not everything is working properly. For example, a television station might want to set off a visible or audible alarm if the Video Sync input to the AEC-BOX-5 becomes disconnected. With the AEC-BOX-5's accurate freerun frequency, this would give the station's operators plenty of time to correct the problem before timing errors became noticeable in the station's output.

SMPTE NDF TO DF TRANSLATOR (MODE 4)

This AEC-BOX-5 operating mode is used to translate a SMPTE Non Drop Frame (NDF) LTC signal, such as one used as a real time clock reference, into a corresponding SMPTE Drop Frame (DF) LTC signal, such as those associated with NTSC color video signals.

In order to select this AEC-BOX-5 operating mode, which can only be done via the DIP switches inside the box, first review the important cautions and detailed instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Set DIP switches SW1-SW8 to 00000100 (SW6 = 1; others = 0).
- 4) Reassemble the box.
- 5) Plug it in and begin operations.

In this operating mode it is assumed that:

- 1) The LTC input is Non Drop Frame (NDF) SMPTE LTC format.
- 2) The Video Sync input is NTSC format.
- 3) Both inputs are stable and very near their nominal frequencies.

Other LTC or Video Sync input signal formats will be ignored, and will blink the LED, and may also open or close the relay (see page 25), to indicate that a problem exists.

The Drop Frame LTC output will be properly synchronized (phased) to the Video Sync reference input (if one is present). After an initial 5 minute learning period, during which time the box calibrates itself to your video reference frequency, the box will continue to generate LTC with a maximum error of 3 frames per hour should the video reference input signal become disconnected.

Even under ideal conditions, the NDF and DF counts will drift apart from each other at a very slow rate. At the end of each 24 hour period, there will be a 2.4 frame (nominal) offset which must be corrected. By default, at 3:10am each day, the AEC-BOX-5 slowly begins skipping or repeating frame counts until the NDF and DF counts are once again properly aligned. The time of day at which this happens, and the algorithm used to do this are both somewhat programmable via DIP switch (EEPROM) programming. Contact the factory if the default algorithm is giving you any trouble.

The Status Relay (see page 25) may be used to indicate whether or not everything is working properly. For example, a television station might want to set off a visible or audible alarm if the Video Sync input to the AEC-BOX-5 becomes disconnected. With the AEC-BOX-5's accurate freerun frequency, this would give the station's operators plenty of time to correct the problem before timing errors became noticeable in the station's output.

EBU TO SMPTE-DF TRANSLATOR (MODE 8)

This AEC-BOX-5 operating mode is used to translate a 25fps EBU LTC signal into a corresponding 30fps SMPTE Drop Frame (DF) LTC signal.

In order to select this AEC-BOX-5 operating mode, which can only be done via the DIP switches inside the box, first review the important cautions and detailed instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Set DIP switches SW1-SW8 to 00001000 (SW5 = 1; others = 0).
- 4) Reassemble the box.
- 5) Plug it in and begin operations.

In this operating mode it is assumed that:

- 1) The LTC input is 25fps EBU LTC format.
- 2) The Video Sync input is 30fps NTSC video format.
- 3) Both inputs are stable and very near their nominal frequencies.

Other LTC or Video Sync input signal formats will be ignored, and will blink the LED, and may also open or close the relay (see page 25), to indicate that a problem exists.

The Drop Frame LTC output will be properly synchronized (phased) to the Video Sync reference input (if one is present). After an initial 5 minute learning period, during which time the box calibrates itself to your video reference frequency, the box will continue to generate LTC with a maximum error of 3 frames per hour should the video reference input signal become disconnected.

The LTC output time will jump to match the LTC input time (after performing a 25fps to 30fps frame number interpolation) whenever there is a +4 frame or larger difference between the generator output time and the reader input time. If a persistent +3 frame offset is noted, one frame count will be added or dropped from the LTC output as needed to bring the generator back within the acceptable +2 frame difference window. Drop frame (DF) time code inherently slowly "drifts around" +2 frames with respect to "real time", so under this operating mode, such time offset differences are deemed to be acceptable/normal and will not be corrected.

If there is a video signal associated with this 25fps to 30fps LTC conversion, it may be delayed several frames during the video conversion process. To compensate for the delay in the video path, a fixed time offset can be added to the incoming time code. For example, an offset of 23:59:59:20 would effectively "delay" the output time code by 10 frames with respect to the input time code. See page 24 for time offset programming details.

The Status Relay (see page 25) may be used to indicate whether or not everything is working properly.

EBU TO SMPTE-NDF TRANSLATOR (MODE 9)

This AEC-BOX-5 operating mode is used to translate a 25fps EBU LTC signal into a corresponding 30fps SMPTE Non Drop Frame (NDF) LTC signal.

In order to select this AEC-BOX-5 operating mode, which can only be done via the DIP switches inside the box, first review the important cautions and detailed instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Set DIP switches SW1-SW8 to 00001001 (SW5,SW8 = 1; others = 0).
- 4) Reassemble the box.
- 5) Plug it in and begin operations.

In this operating mode it is assumed that:

- 1) The LTC input is 25fps EBU LTC format.
- 2) The Video Sync input is 30fps NTSC video format.
- 3) Both inputs are stable and very near their nominal frequencies.
- 4) Best results are obtained when both inputs are frequency locked to each other.

Other LTC or Video Sync input signal formats will be ignored, and will blink the LED, and may also open or close the relay (see page 25), to indicate that a problem exists.

The NDF LTC output will be properly synchronized (phased) to the Video Sync reference input (if one is present). After an initial 5 minute learning period, during which time the box calibrates itself to your video reference frequency, the box will continue to generate LTC with a maximum error of 3 frames per hour should the video reference input signal become disconnected.

The LTC output time will immediately jump to match the LTC input time (after performing a 25fps to 30fps frame number interpolation) whenever there is a +2 frame or larger difference between the generator output time and the reader input time. If a persistent +1 frame offset is noted, one frame count will be added or dropped from the LTC output as needed to bring the generator time back into agreement with the (interpolated) reader time.

If there is a video signal associated with this 25fps to 30fps LTC conversion, it may be delayed several frames during the video conversion process. To compensate for the delay in the video path, a fixed time offset can be added to the incoming time code. For example, an offset of 23:59:59:20 would effectively "delay" the output time code by 10 frames with respect to the input time code. See page 24 for time offset programming details.

The Status Relay (see page 25) may be used to indicate whether or not everything is working properly.

FILM TO SMPTE-DF TRANSLATOR (MODE C)

This AEC-BOX-5 operating mode is used to translate a 24fps FILM LTC signal into a corresponding 30fps SMPTE Drop Frame (DF) LTC signal.

In order to select this AEC-BOX-5 operating mode, which can only be done via the DIP switches inside the box, first review the important cautions and detailed instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Set DIP switches SW1-SW8 to 00001100 (SW5,SW6 = 1; others = 0).
- 4) Reassemble the box.
- 5) Plug it in and begin operations.

In this operating mode it is assumed that:

- 1) The LTC input is 24fps FILM LTC format.
- 2) The Video Sync input is 30fps NTSC video format.
- 3) Both inputs are stable and very near their nominal frequencies.

Other LTC or Video Sync input signal formats will be ignored, and will blink the LED, and may also open or close the relay (see page 25), to indicate that a problem exists.

The Drop Frame LTC output will be properly synchronized (phased) to the Video Sync reference input (if one is present). After an initial 5 minute learning period, during which time the box calibrates itself to your video reference frequency, the box will continue to generate LTC with a maximum error of 3 frames per hour should the video reference input signal become disconnected.

The LTC output time will jump to match the LTC input time (after performing a 24fps to 30fps frame number interpolation) whenever there is a +4 frame or larger difference between the generator output time and the reader input time. If a persistent +3 frame offset is noted, one frame count will be added or dropped from the LTC output as needed to bring the generator back within the acceptable +2 frame difference window. Drop frame (DF) time code inherently slowly "drifts around" +2 frames with respect to "real time", so under this operating mode, such time offset differences are deemed to be acceptable/normal and will not be corrected.

If there is a video signal associated with this 24fps to 30fps LTC conversion, it may be delayed several frames during the video conversion process. To compensate for the delay in the video path, a fixed time offset can be added to the incoming time code. For example, an offset of 23:59:59:20 would effectively "delay" the output time code by 10 frames with respect to the input time code. See page 24 for time offset programming details.

The Status Relay (see page 25) may be used to indicate whether or not everything is working properly.

FILM TO SMPTE-NDF TRANSLATOR (MODE D)

This AEC-BOX-5 operating mode is used to translate a 24fps FILM LTC signal into a corresponding 30fps SMPTE Non Drop Frame (NDF) LTC signal.

In order to select this AEC-BOX-5 operating mode, which can only be done via the DIP switches inside the box, first review the important cautions and detailed instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Set DIP switches SW1-SW8 to 00001101 (SW5,SW6,SW8 = 1).
- 4) Reassemble the box.
- 5) Plug it in and begin operations.

In this operating mode it is assumed that:

- 1) The LTC input is 24fps FILM LTC format.
- 2) The Video Sync input is 30fps NTSC video format.
- 3) Both inputs are stable and very near their nominal frequencies.
- 4) Best results are obtained when both inputs are frequency locked to each other.

Other LTC or Video Sync input signal formats will be ignored, and will blink the LED, and may also open or close the relay (see page 25), to indicate that a problem exists.

The NDF LTC output will be properly synchronized (phased) to the Video Sync reference input (if one is present). After an initial 5 minute learning period, during which time the box calibrates itself to your video reference frequency, the box will continue to generate LTC with a maximum error of 3 frames per hour should the video reference input signal become disconnected.

The LTC output time will immediately jump to match the LTC input time (after performing a 24fps to 30fps frame number interpolation) whenever there is a +2 frame or larger difference between the generator output time and the reader input time. If a persistent +1 frame offset is noted, one frame count will be added or dropped from the LTC output as needed to bring the generator time back into agreement with the (interpolated) reader time.

If there is a video signal associated with this 24fps to 30fps LTC conversion, it may be delayed several frames during the video conversion process. To compensate for the delay in the video path, a fixed time offset can be added to the incoming time code. For example, an offset of 23:59:59:20 would effectively "delay" the output time code by 10 frames with respect to the input time code. See page 24 for time offset programming details.

The Status Relay (see page 25) may be used to indicate whether or not everything is working properly.

USER BIT OPERATIONS

By default, the AEC-BOX-5 passes along the user bits from the LTC input to the LTC output unchanged, usually with a 2 frame delay inherent in the process of reading and generating LTC. There are 32 user bits (4 bytes) of information included with each LTC frame. This information can represent date codes, reel numbers, or any other information that the person encoding it thought was important. As far as we know, there are no user bit standards.

In some applications it is desirable to modify or delete the incoming user bits before passing them along to the output. These two pages show how to do that.

USER BIT OPERATING MODE SETTING

The user bit operating mode determines what, if anything, will be done to the user bits, as follows:

SW1-SW8	=>	User Bit Mode
01011001	=>	Jamming with selective (non-FFh) overwrite (forces non-FFh data fields into the output data).
01011000	=>	Jamming with selective (non-00h) overwrite (forces non-00h data fields into the output data).
01010011	=>	Ignore reader data, force output to 00:00:00:00.
01010010	=>	Ignore reader data, use internal user bit data.
01010001	=>	Jam only when the box jams the time bits also.
01010000	=>	Jamming continuously (THIS IS THE FACTORY DEFAULT).

Note that the term "jamming" just means that the reader data is transferred over to (jammed into) the generator data.

User Bit Mode Selection Procedure:

First highlight or circle with pencil (for future reference) the appropriate entry in the User Bit Mode table above. Then, to alter the user bit mode, review the important safety instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Set the DIP switches per the "User Bit Mode" table.
- 4) Fully reassemble the box.
- 5) Plug it in and check for proper operation.

Note that the EEPROM will retain this user bit operating mode information indefinitely, even when AC power is removed, unless you install a new EPROM or reset the EEPROM (see page 12).

USER BIT OPERATIONS
(continued)

USER BIT DATA SETTING

You don't need to do this unless you will be selectively or completely overwriting the user bits coming from the LTC input. Unless you requested otherwise, the factory default user bit data are 00:00:00:00.

For future reference (i.e. so that you can never forget), we strongly recommend that you record your user bit settings here:

```
          :           :           :  
----- : ----- : ----- : -----  
"HOURS" "MINUTES" "SECONDS" "FRAMES"
```

User Bit Data Programming Procedure:

To alter the data for each user bit field, first review the important safety instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Write down the existing switch settings for later.
- 4) Set the DIP switches per the "User Bits Field Selector" table.
- 5) Temporarily replace the top cover.
- 6) Turn on power, wait 3 seconds, turn off power.
- 7) Set the DIP switches with the desired user bit data.
- 8) Temporarily replace the top cover.
- 9) Turn on power, wait 3 seconds, turn off power.
- A) Set DIP switches SW1-SW8 back they way they were in step #3.
- B) Fully reassemble the box.
- C) Plug it in and check for proper operation.

For step 7, make use of the top and bottom halves of page 49, and note that SW1 is most significant and SW8 is least significant (we did it this way just to confuse you). For example, to enter 43h for the user bit hours, use step 4 to program in F3h from the table below (selects the hours field), then use step 7 to program in 43h by setting SW1-SW8 to 01000011. Call us if you need help.

Note that the EEPROM will retain this user bits information indefinitely, even when AC power is removed, unless you install a new EPROM or reset the EEPROM (see page 12).

```
SW1-SW8 => User Bits Field Selector  
11110011 => User Bits "Hours" will follow  
11110010 => User Bits "Minutes" will follow  
11110001 => User Bits "Seconds" will follow  
11110000 => User Bits "Frames" will follow
```

TIME OFFSET OPERATIONS

By following the instructions below, a fixed time offset, ranging from 00:00:00:00 to 23:59:59:29, can be added to the LTC reader data before it is jammed into the LTC generator output.

Unless you requested otherwise, the factory default setting is 00:00:00:00 (no offset).

For future reference (i.e. so that you can never forget), we strongly recommend that you record your time offset settings here:

```
      :      :      :
----- : ----- : ----- : -----
HOURS  MINUTES SECONDS  FRAMES
```

Time Offset Programming Procedure:

To alter the offset for each time field, first review the important safety instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Write down the existing switch settings for later.
- 4) Set the DIP switches per the "Time Offset Field Selector" table.
- 5) Temporarily replace the top cover.
- 6) Turn on power, wait 3 seconds, turn off power.
- 7) Set the DIP switches with the desired packed BCD offset data.
- 8) Temporarily replace the top cover.
- 9) Turn on power, wait 3 seconds, turn off power.
- A) Set DIP switches SW1-SW8 back they way they were in step #3.
- B) Fully reassemble the box.
- C) Plug it in and check for proper operation.

For step 7, make use of the top and bottom halves of page 49, and note that SW1 is most significant and SW8 is least significant (we did it this way just to confuse you). For example, to enter a 1 hour offset, use step 4 to program in F7h from the table below (selects the hours field), then use step 7 to program in 01h by setting SW1-SW8 to 00000001. Call us if you need help.

Note that the EEPROM will retain this time offset information indefinitely, even when AC power is removed, unless you install a new EPROM or reset the EEPROM (see page 12).

```
SW1-SW8 => Time Offset Field Selector
11110111 => Time Offset Hours will follow (packed BCD)
11110110 => Time Offset Minutes will follow (packed BCD)
11110101 => Time Offset Seconds will follow (packed BCD)
11110100 => Time Offset Frames will follow (packed BCD)
```

RELAY OPERATIONS

A relay is provided as standard equipment on the AEC-BOX-5. This relay is normally used to signal an error condition of some kind, such as a missing LTC or Video Sync input, in which case we call it the "Status Relay" (see chart below). Alternatively, if BINARY POLLED serial control is being used, the relay can be turned on or off under software control, or can be configured to turn on automatically when a time code comparator match is found, in which case we call it the "Comparator Relay" (see page 27).

In either case, the relay is SPST type with normally open (N.O.) contacts. It opens and closes within 2ms of receiving the appropriate command. At all times, your software can control and sense the status of this relay. The relay is intended for switching control signals, not high currents or voltages.

"STATUS RELAY" OPERATING MODE SELECTION

In order to change the AEC-BOX-5 "Status Relay" operating mode, via the DIP switches inside the box, first review the important cautions and detailed instructions on page 12, then proceed as follows (does not apply in "Comparator Relay" mode):

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Set the DIP switches per the table below.
- 4) Reassemble the box.
- 5) Plug it in and test the new "Status Relay" operating mode.

Note that if you subsequently turn off the power and change the DIP switches to some other setting, this relay operating mode information will remain saved in the EEPROM (unless you install a new EPROM or otherwise reset the EEPROM - see page 12).

In the table which follows, "PWR" indicates AC power to the box, "LTC" indicates the LTC input, "VSYNC" indicates the Video Sync input, and "PHASE" indicates the phasing of the LTC output to the LTC and/or Video Sync inputs (depends on box operating mode).

SW1-SW8	=>	"Status Relay" Operating Mode
01110111	=>	Relay is unaffected by error conditions.
01110110	=>	Relay ON only when VSYNC is missing.
01110101	=>	Relay ON only when LTC and/or PHASE is bad.
01110100	=>	Relay ON only when LTC, VSYNC, and/or PHASE is bad.
01110011	=>	Relay ON only when PWR is OK.
01110010	=>	Relay ON only when PWR and VSYNC are both OK.
01110001	=>	Relay ON only when PWR/LTC/PHASE are all OK.
01110000	=>	Relay ON only when PWR/LTC/VSYNC/PHASE are all OK (this is the factory default setting).

When planning which relay operating mode to use, keep in mind that the relay is OFF (open circuit) when power to the box is off.

COMPARATOR OPERATIONS

The AEC-BOX-5 includes time code comparator software, which allows you to have the box transmit a short message whenever the LTC generator time bits (or user bits) reach a predetermined value. This frees up your system for other tasks. A "Comparator Relay" inside the box may optionally be turned on automatically whenever a comparator match is found (see RELAY OPERATIONS on page 25).

At the start (during bit 0) of every LTC frame, the LTC generator data is first compared, then masked, with values which you have set up ahead of time. If a match is detected (after masking), and if enabled, an ASCII "=" character (3Dh) will be transmitted, and/or the relay will be closed. Use of one of the polled modes of operation eliminates transmission of other data which could obscure the "=" character.

If bit 7 of the comparator mode control byte is a "1", a "comparison" will be indicated both when the match first occurs, and again when the match disappears. It detects the "edges", and avoids generating lots of comparison indications when successive frames have the same data (after masking).

If you are using SMPTE drop frame counting, be sure not to set up a comparison time, such as 00:01:00:00, which doesn't exist.

The mask and data bytes may be changed at any time. See the software protocol section for details.

HOW TO USE COMPARATOR MASKS

There are many cases where you don't care what the value of one or more bits is, but you still want to use the comparator. To do this, just set the corresponding mask bit(s) to zero. For instance, if you want to generate a relay pulse every ten seconds, set the seconds mask byte to 0Fh, and set the minutes and hours mask bytes to 00h.

The comparator first does a logical XOR (comparison) of the current time bits (or user bits) data with the data you have supplied ahead of time. It then does a logical AND of the results with the mask data you have supplied. In positions where the mask data is 0, a "match" is always indicated. In positions where the mask data is 1, an exact match is required.

The default masks of 3Fh and 7Fh are used to filter out six special bits, called embedded bits, which are usually mixed in with the time bits. Always mask them out when not being used!

"COMPARATOR RELAY" OPERATIONS

As noted on page 25, the relay in the AEC-BOX-5 can be controlled by serial commands or by the comparator, in which case we call it the "Comparator Relay". To enter this mode of relay operations, you must always set bit 2 of the comparator/relay control byte, as detailed in the next section. This prevents the various conditions noted at the bottom of page 25 from having any effect on this relay. The bit maps shown below maintain compatibility with other AEC-BOX products.

HOW TO MODIFY COMPARATOR AND "COMPARATOR RELAY" OPERATIONS

Comparator and "Comparator Relay" operations are controlled by a single byte, which may be changed by EPROM modifications (see page 11) or by BINARY POLLED mode command 72h (see page 38). The structure of this byte in both cases is as follows:

Bit 7 = 1 if want to enable "edge" comparisons (see page 26)
Bit 6 = 1 if want to transmit "=" when comparator triggers
Bit 5 = reserved
Bit 4 = turn the relay on(1) or off(0)
Bit 3 = 1 if want to turn off relay automatically after 50ms
Bit 2 = 1 if want to turn on relay when comparator triggers
Bit 1 = 1 if want to compare to user bits instead of time bits
Bit 0 = 1 if want to disable all comparator functions

As there is no way to read back the status of these bits, your software needs to keep track of what it has written to the box. The power-up default settings are comparator disabled, relay off (data = 01h).

HOW TO GET COMPARATOR AND RELAY STATUS

Comparator and relay status may be sensed at any time by BINARY POLLED mode command 73h (see page 38). This works in both the "Status Relay" and "Comparator Relay" modes. The status byte which is returned has the following structure:

Bit 7 = reserved
Bit 6 = reserved
Bit 5 = reserved
Bit 4 = indicates relay on(1) or off(0)
Bit 3 = reserved
Bit 2 = reserved
Bit 1 = 1 if the comparator currently has a match
Bit 0 = 1 if the comparator has been triggered

Note that bit 0 gets cleared whenever you read this register.

SERIAL INTERFACE SETUP

The serial port on the AEC-BOX-5 can do a lot of different things, as required by its variety of applications. Some setup work may be required for your particular application.

Unless you requested otherwise, the factory default setting is BROADCAST mode, 9600 baud, BINARY message protocol (8 bits), and ODD parity. One(1) stop bit is used for all serial operations, and is not programmable to other values.

If you purchased an Adrienne Electronics RS232 or RS422 serial cable, you may skip to the next paragraph. Otherwise, see the INSTALLATION section (page 7) for details on how to connect the AEC-BOX-5 to your serial device. Note that when using RS232 connections, a nonstandard RS232 cable is required. Note also that the AEC-BOX-5's transmit(TX) lines should be connected to the other device's receive(RX) lines, and vice-versa.

There are presently four(4) different serial protocols, and more may be added in the future. At present, the message protocol chosen also determines the number of data bits being sent per serial character, because it does not make sense to send 8-bit time and user bits data in binary form over a 7-bit data link, since the top bit will be lost.

For the serial interface setup procedure below, you will first need to highlight or circle in pencil (for future reference) one row from each of the tables on the next page. Note that if you are changing the data from only one or two tables, you may skip steps as indicated below, making the procedure much shorter.

Serial Interface Setup Procedure:

To set the serial interface protocol, baud rate, parity, address, and other serial parameters, first review the important safety instructions on page 12, then proceed as follows:

- 1) Unplug the box from its AC power source.
- 2) Remove the top cover.
- 3) Skip to step 7 if you are not changing the serial protocol.
- 4) Set the DIP switches per the "Serial Protocol" table (page 29).
- 5) Temporarily replace the top cover.
- 6) Turn on power, wait 3 seconds, turn off power.
- 7) Skip to step B if you are not changing the baud rate or parity.
- 8) Set the DIP switches per the "Baud Rate & Parity" table.
- 9) Temporarily replace the top cover.
- A) Turn on power, wait 3 seconds, turn off power.
- B) Skip to step D if you are not changing the address (etc.).
- C) Set the DIP switches per the "Address & Other" table.
- D) Fully reassemble the box.
- E) Plug it in and check for proper operation.

Note that the EEPROM will retain this serial setup information indefinitely, even when AC power is removed, unless you install a new EPROM or reset the EEPROM (see page 12).

SERIAL INTERFACE SETUP
(continued)

SW1-SW8 => Serial Protocol
00010011 => 7-bit ASCII POLLED mode
00010010 => 7-bit ASCII BROADCAST mode
00010001 => 8-bit BINARY POLLED mode
00010000 => 8-bit BINARY BROADCAST mode (factory default)

SW1-SW8 => Baud Rate & Parity

00101111 => 38400 baud, ODD parity
00101101 => 38400 baud, EVEN parity
00101100 => 38400 baud, NO parity

00101011 => 19200 baud, ODD parity
00101001 => 19200 baud, EVEN parity
00101000 => 19200 baud, NO parity

00100111 => 9600 baud, ODD parity (factory default)
00100101 => 9600 baud, EVEN parity
00100100 => 9600 baud, NO parity

00100011 => 1200 baud, ODD parity
00100001 => 1200 baud, EVEN parity
00100000 => 1200 baud, NO parity

SERIAL ADDRESS & OTHER SETUP

This third and last serial setup register determines the box's address offset and other miscellaneous serial setup bits. Unless you requested otherwise, the factory default address offset setting is "0". This offset address (normally 0) is added to the protocol specific base address to form the box's full address.

Most of the time you will be using the default address, or will be in a broadcast mode where no address is required. Only in a case where two(2) or more boxes share the same RS422 data lines will a different address have to be assigned to each box.

SW1-SW8 => Address & Other
00110110 => Address Offset "6"
00110100 => Address Offset "4"
00110010 => Address Offset "2"
00110000 => Address Offset "0" (factory default)
(The "Other" bits are presently undefined.)

BINARY BROADCAST MODE

At the start of every LTC generator frame, the AEC-BOX-5 will use eight(8) data bits per character to transmit the following message, which indicates the current LTC generator status:

Byte 0 = BREAK (20 bits low, then 2 bits high)
Byte 1 = Xh Status and length byte:
Bit 7 = 1
Bit 6 = 1 if the LTC input is OK
Bit 5 = 1 if the video input is OK
Bits 3-0 = # of bytes which follow (including checksum)

Byte 2 = 00h-29h Time bits frames (packed BCD) (EBU=24h max)
Byte 3 = 00h-59h Time bits seconds (packed BCD)
Byte 4 = 00h-59h Time bits minutes (packed BCD)
Byte 5 = 00h-23h Time bits hours (packed BCD)

Byte 6 = 00h-FFh User bits frames
Byte 7 = 00h-FFh User bits seconds
Byte 8 = 00h-FFh User bits minutes
Byte 9 = 00h-FFh User bits hours

Byte 10 = Xh Embedded bits (plus the EBU flag):

	SMPTE	EBU
Bit 7 = reserved	-----	-----
Bit 6 = EBU flag	0	1
Bit 5 = LTC bit 59	bin flag	phase bit
Bit 4 = LTC bit 58	reserved	reserved
Bit 3 = LTC bit 43	bin flag	bin flag
Bit 2 = LTC bit 27	phase bit	bin flag
Bit 1 = LTC bit 11	color frame flag	color lock flag
Bit 0 = LTC bit 10	drop frame flag	reserved

Byte 11 = Xh Ignore this byte.

Byte 12 = Xh Checksum (sum of bytes 1-12 should be 00h)

Notes:

- 1) All embedded bits have been removed from the time bits data, and appear instead in byte 10.

BINARY POLLED MODE

In this mode, the box does not send any data until requested to do so. The protocol conforms closely with the ESBUS machine control standard (when 38400 baud and EVEN parity is selected) which is widely used in the television equipment industry. We highly recommend that you obtain a copy of the RP113 standard from SMPTE (see page 50). If you are not familiar with this standard, the state diagram (for AEC-BOX's) on page 33 will be very helpful. Eight(8) data bits are used for all messages in this mode.

Controllers and Tributaries:

In the ESBUS standard, there is one "controller" (typically your computer) which controls one or more "tributaries". In this case, each AEC-BOX is a "tributary", and must have its own unique SELECT address and its own unique (but related) POLL address.

SELECT Address:

The default SELECT address of AEC0h is stored in the EPROM, and may be changed if needed (see page 11). Offset addresses of 0000h, 0002h, 0004h, and 0006h can be created via the serial interface setup procedure (see page 28). This EEPROM offset address is then added to the base address stored in the EPROM to form the SELECT address for this particular box. For instance, if an offset address of 0004h is chosen, the box SELECT address will become AEC4h. This allows you to have up to four boxes on the same data line, each with a different address, without having to do any EPROM modifications. The most significant bit (MSB) of both SELECT address bytes must be "1", and the least significant bit (LSB) of the lower SELECT address byte must be "0".

POLL Address:

The POLL address is equal to the SELECT address plus 1.

Inter-Character Timeouts:

In all cases where two or more bytes are being sent in a message, including two-byte addresses, if the space between any two of these bytes exceeds six character periods, a timeout error will be indicated. The box will set its internal NAK flag and revert to the IDLE state if it detects any such errors.

Response Timeouts:

Whenever the controller expects a reply from the AEC-BOX, the first character in the reply message must arrive within six character periods of the end of the previous message. Otherwise the controller can assume that the box is not responding.

BINARY POLLED MODE
(continued)

IDLE State:

The IDLE state is entered:

- 1) When power is first applied or the box resets itself.
- 2) Whenever any protocol errors are detected.
- 3) Whenever any parity or framing errors are detected.
- 4) Whenever a timeout error is detected.

The IDLE state is exited whenever a BREAK character is received.

ACTIVE State:

The ACTIVE state is entered whenever a BREAK character is received, no matter what else the box was doing. The box immediately ceases all transmissions, then waits for a two byte address (with inter-character timeout):

- 1) If the box's POLL address is received, it immediately jumps to the POLL state.
- 2) If some other POLL address is received, it reverts to the ACTIVE state.
- 3) If the box's SELECT address is received, it immediately jumps to the SELECT state.
- 4) If some other SELECT address is received, it goes back to the IDLE state and waits for a BREAK character.

POLL State:

This state is used to quickly determine which tributary devices (such as our box) have information ready for the controller. The AEC-BOX immediately transmits a single byte response, then reverts to the ACTIVE state. The POLL response byte may be:

- 1) 07h (RST) - Indicates that the box has powered up or reset.
- 2) 05h (NAK) - Indicates that a communications or protocol error of some kind has been detected.
- 3) 08h (SVC) - Indicates that the box needs to be serviced.
For the AEC-BOX-5, this means that a new frame of LTC generator data started, or that the comparator found a match.
- 4) 04h (ACK) - Indicates that nothing has changed.

The above responses are listed in order of priority (RST highest).

A typical POLL sequence from the controller might be:

Byte 0 = BREAK (20 bits low, then 2 bits high)
Byte 1 = AEh Upper POLL address byte.
Byte 2 = C1h Lower POLL address byte (LSB=1 !).

The POLL response byte from the AEC-BOX might then be:

Byte 1 = 04h ACK response byte indicating all is OK.

BINARY POLLED MODE
(continued)

SELECT State:

This state is used for sending messages back and forth between the AEC-BOX and the controller. It includes the ability to place the box in the BINARY BROADCAST mode. If any errors are detected, the box sets the NAK flag and jumps to the IDLE state.

A typical SELECT sequence from the controller might be:

Byte 0 = BREAK (20 bits low, then 2 bits high)
Byte 1 = AEh Upper SELECT address byte.
Byte 2 = C0h Lower SELECT address byte (LSB=0 !).

Once in the SELECT state, the box will remain there unless errors are detected or a BREAK character is received. The following commands may be sent to the AEC-BOX-5 whenever it is in the SELECT state:

- 1) GET BOX ID command format (to AEC-BOX) is:
Byte 1 = 3Fh Question mark ("?")

The response to this command (from AEC-BOX) is:

Byte 1 = 5d AEC-BOX Number (5 in this case)
Byte 2 = 41h-5Ah Software Revision Letter (major) (A-Z)
Byte 3 = 31h-39h Software Revision Number (minor) (1-9)
Byte 4 = XXh Checksum (sum of bytes 1-4 should be 00h)

BINARY POLLED MODE
(continued)

- 2) GO TO BROADCAST MODE command format (to AEC-BOX) is:
Byte 1 = 1Bh(ESC) Escape to BINARY BROADCAST mode.

The response to this command (from AEC-BOX) is:
Byte 1 = 04h(ACK) Acknowledges receipt of this command.

The box will now be in the BINARY BROADCAST mode. You can force it back to the ACTIVE state with a BREAK character.

- 3) READ FULL MESSAGE command format (to AEC-BOX) is:
Byte 1 = 09h(TEN) Transmit Enable

The response to this command is a single message identical to what you would expect from the BINARY BROADCAST mode.

- 4) READ TIME BITS command format (to AEC-BOX) is:
Byte 1 = 40h Requests time bits (with no embedded bits).

The response to this command (from AEC-BOX) is:
Byte 1 = 00h-29h Time bits frames (packed BCD) (EBU=24h max)
Byte 2 = 00h-59h Time bits seconds (packed BCD)
Byte 3 = 00h-59h Time bits minutes (packed BCD)
Byte 4 = 00h-23h Time bits hours (packed BCD)
Byte 5 = XXh Checksum (sum of bytes 1-5 should be 00h)

If you are reading LTC reader data instead of the usual LTC generator data, and if the LTC reader data is no good, the sum of bytes 1-5 will be 5Ah.

- 5) SET TIME BITS command format (to AEC-BOX) is:
Byte 1 = 41h Sets generator time bits.
Byte 2 = 00h-29h Time bits frames (packed BCD) (EBU=24h max)
Byte 3 = 00h-59h Time bits seconds (packed BCD)
Byte 4 = 00h-59h Time bits minutes (packed BCD)
Byte 5 = 00h-23h Time bits hours (packed BCD)
Byte 6 = XXh Checksum (sum of bytes 1-6 should be 00h)

The response to this command (from AEC-BOX) is:
Byte 1 = 04h(ACK) Acknowledges receipt of this command.

This command must be received before the midpoint of video field 2 in order for this data to be used in the next frame. Otherwise it will be used in the following frame.

BINARY POLLED MODE
(continued)

6) READ USER BITS command format (to AEC-BOX) is:

Byte 1 = 42h Requests user bits.

The response to this command (from AEC-BOX) is:

Byte 1 = 00h-FFh User bits frames

Byte 2 = 00h-FFh User bits seconds

Byte 3 = 00h-FFh User bits minutes

Byte 4 = 00h-FFh User bits hours

Byte 5 = XXh Checksum (sum of bytes 1-5 should be 00h)

If you are reading LTC reader data instead of the usual LTC generator data, and if the LTC reader data is no good, the sum of bytes 1-5 will be 5Ah.

7) SET USER BITS command format (to AEC-BOX) is:

Byte 1 = 43h Sets generator user bits.

Byte 2 = 00h-FFh User bits frames

Byte 3 = 00h-FFh User bits seconds

Byte 4 = 00h-FFh User bits minutes

Byte 5 = 00h-FFh User bits hours

Byte 6 = XXh Checksum (sum of bytes 1-6 should be 00h)

The response to this command (from AEC-BOX) is:

Byte 1 = 04h(ACK) Acknowledges receipt of this command.

This command must be received before the midpoint of video field 2 in order for this data to be used in the next frame.

BINARY POLLED MODE
(continued)

- 8) READ EMBEDDED BITS command format (to AEC-BOX) is:
Byte 1 = 44h Command Code

The response to this command (from AEC-BOX) is:

Byte 1 = XXh Embedded bits:

	SMPTE	EBU
Bit 5 = LTC bit 59	bin flag	phase bit
Bit 4 = LTC bit 58	reserved	reserved
Bit 3 = LTC bit 43	bin flag	bin flag
Bit 2 = LTC bit 27	phase bit	bin flag
Bit 1 = LTC bit 11	color frame flag	color lock flag
Bit 0 = LTC bit 10	drop frame flag	reserved

Byte 2 = XXh Checksum (sum of bytes 1-2 should be 00h)

If you are reading LTC reader data instead of the usual LTC generator data, and if the LTC reader data is no good, the sum of bytes 1-2 will be 5Ah.

- 9) SET EMBEDDED BITS command format (to AEC-BOX) is:
Byte 1 = 45h Command Code
Byte 2 = XXh Has same format as returned by command 44h.
Byte 3 = XXh Checksum (sum of bytes 1-3 should be 00h)

The response to this command (from AEC-BOX) is:

Byte 1 = 04h(ACK) Acknowledges receipt of this command.

If you are using SMPTE time code, the DROP FRAME flag (bit 0) can be used to force generator drop frame counting.

While the COLOR FRAME and COLOR LOCK flags can be set as you wish, our AEC-BOX's cannot properly color align the LTC output with the video input. To us, fields 1,3(,5,7) are identical.

The phase bit information you supply is ignored, as the phase bit is calculated internally each frame by the generator.

This command must be received before the midpoint of video field 2 in order for this data to be used in the next frame. Otherwise it will be used in the following frame.

BINARY POLLED MODE
(continued)

- 10) READ TIME CODE STATUS BITS command format (to AEC-BOX) is:
Byte 1 = 46h Command Code

The response to this command (from AEC-BOX) is:

Byte 1 = XXh Time code STATUS byte #1:
 Bit 7 = reserved
 Bit 6 = reserved
 Bit 5 = 1 if the video input is OK (normal)
 Bit 4 = reserved
 Bit 3 = reserved
 Bit 2 = 1 if the LTC generator output is disabled
 Bit 1 = reserved
 Bit 0 = reserved
Byte 2 = XXh Time code STATUS byte #2:
 Bit 7 = reserved
 Bit 6 = reserved
 Bit 5 = reserved
 Bit 4 = reserved
 Bit 3 = reserved
 Bit 2 = reserved
 Bit 1 = reserved
 Bit 0 = reserved
Byte 3 = XXh Checksum (sum of bytes 1-3 should be 00h)

- 11) SET TIME CODE MODE BITS command format (to AEC-BOX) is:

Byte 1 = 47h Command Code
Byte 2 = XXh Time code MODE byte #1 (default = 00h):
 Bit 7 = reserved
 Bit 6 = reserved
 Bit 5 = reserved
 Bit 4 = reserved
 Bit 3 = reserved
 Bit 2 = reserved
 Bit 1 = reserved
 Bit 0 = reserved
Byte 3 = XXh Time code MODE byte #2 (default = 00h):
 Bit 7 = 1 if want LTC reader data, not LTC generator data
 Bit 6 = reserved
 Bit 5 = reserved
 Bit 4 = reserved
 Bit 3 = reserved
 Bit 2 = 1 if want to disable the LTC generator output
 Bit 1 = 1 if want to freeze the LTC generator count
 Bit 0 = reserved
Byte 4 = XXh Checksum (sum of bytes 1-4 should be 00h)

The response to this command (from AEC-BOX) is:

Byte 1 = 04h(ACK) Acknowledges receipt of this command.

These bits can also be modified via the EPROM (see page 10).

BINARY POLLED MODE
(continued)

- 12) SET USER BIT MODE command format (to AEC-BOX) is:
Byte 1 = 53h Command Code
Byte 2 = XXh User Bit Mode byte (see page 22).
Byte 3 = XXh Checksum (sum of bytes 1-3 should be 00h)
(Note - This command was added in software revision "A2").

The response to this command (from AEC-BOX) is:
Byte 1 = 04h(ACK) Acknowledges receipt of this command.

- 13) SET COMPARATOR DATA command format (to AEC-BOX) is:
Byte 1 = 70h Command Code
Byte 2 = 00h-FFh Comparator frames DATA
Byte 3 = 00h-FFh Comparator seconds DATA
Byte 4 = 00h-FFh Comparator minutes DATA
Byte 5 = 00h-FFh Comparator hours DATA
Byte 6 = XXh Checksum (sum of bytes 1-6 should be 00h)

The response to this command (from AEC-BOX) is:
Byte 1 = 04h(ACK) Acknowledges receipt of this command.

- 14) SET COMPARATOR MASK command format (to AEC-BOX) is:
Byte 1 = 71h Command Code
Byte 2 = 00h-FFh Comparator frames MASK
Byte 3 = 00h-FFh Comparator seconds MASK
Byte 4 = 00h-FFh Comparator minutes MASK
Byte 5 = 00h-FFh Comparator hours MASK
Byte 6 = XXh Checksum (sum of bytes 1-6 should be 00h)

The response to this command (from AEC-BOX) is:
Byte 1 = 04h(ACK) Acknowledges receipt of this command.

- 15) SET COMPARATOR/RELAY MODE command format (to AEC-BOX) is:
Byte 1 = 72h Command Code
Byte 2 = XXh Comparator MODE byte (see page 27).
Byte 3 = XXh Checksum (sum of bytes 1-3 should be 00h)

The response to this command (from AEC-BOX) is:
Byte 1 = 04h(ACK) Acknowledges receipt of this command.

- 16) READ COMPARATOR/RELAY STATUS command format (to AEC-BOX) is:
Byte 1 = 73h Command Code

The response to this command (from AEC-BOX) is:
Byte 1 = XXh Comparator STATUS byte (see page 27).
Byte 2 = XXh Checksum (sum of bytes 1-2 should be 00h)

BREAK CHARACTER DETECTION

The transmit data line on the microcomputer chip is normally high (inactive). When a normal serial data character is transmitted, the transmit pin first goes low for 1 bit period (the START bit), followed by 7 or 8 DATA bits, then a PARITY bit (if enabled), then finally goes high for 1 bit period (the STOP bit). The START bit for the next serial data character may start immediately thereafter.

Break characters are very different. A "break" character is defined as a special pulse which goes low for 20 bit periods, then goes back high for at least 2 bit periods.

The break character guarantees that the receiving UART will be properly locked to the serial data stream, even under worst case conditions. Since the binary mode message string may include user bits data, which can assume any value from 00h to FFh, the break character is also necessary to unambiguously define the start of a message string.

The break character can be detected in several ways:

- a) Some UART's have a break character flag and/or interrupt, which makes your job real easy.
- b) A break character will be received as 00h data together with a framing error.
- c) If odd parity is being used, a break character will cause reception of 00h data with a parity error.

RS232 Note:

The RS232 output signal on the 9-pin "D" connector has a polarity opposite from that described above. The TX232 line, which is normally low (at -6V), pulses high (to +6V) for 20 bit periods when the break character is transmitted, then goes back low.

ASCII BROADCAST MODE

This protocol is much simpler than the BINARY BROADCAST protocol, but it is also much more limited in its capabilities. At the start of every LTC generator frame, the AEC-BOX-5 will use seven(7) data bits per character to transmit the following message:

Byte 1	=	30h-32h	0-2	Time bits hours, tens digit.
Byte 2	=	30h-39h	0-9	Time bits hours, units digit.
Byte 3	=	3Ah	:	Separator
Byte 4	=	30h-35h	0-5	Time bits minutes, tens digit.
Byte 5	=	30h-39h	0-9	Time bits minutes, units digit.
Byte 6	=	3Ah	:	Separator
Byte 7	=	30h-35h	0-5	Time bits seconds, tens digit.
Byte 8	=	30h-39h	0-9	Time bits seconds, units digit.
Byte 9	=	3Ah/2Eh	:/.	Separator (see note 1 below)
Byte 10	=	30h-32h	0-2	Time bits frames, tens digit.
Byte 11	=	30h-39h	0-9	Time bits frames, units digit.
Byte 12	=	20h/3Fh	/?	Status character (see note 2 below)
Byte 13	=	0Dh	CR	Carriage Return

Notes:

- 1) Byte 9 will be an ASCII period (2Eh) if SMPTE drop frame counting is being used. Otherwise it will be a normal ":" separator (3Ah).
- 2) Byte 12 will be an ASCII question mark (3Fh) if any LTC read errors are found or if the video sync input is missing or bad. Otherwise byte 12 will be an ASCII space (20h).

ASCII POLLED MODE

This protocol is much simpler than the BINARY POLLED protocol, but it is also much more limited in its capabilities. The box does not send any data until requested to do so. Seven(7) data bits per character are used for all messages in this mode.

- 1) TIME REQUEST command format (to AEC-BOX) is:
Byte 1 = 02h STX Start Transmission
Byte 2 = 30h-39h 0-9 Upper Address Byte (from EPROM)
Byte 3 = 30h-39h 0-9 Lower Address Byte (from EPROM) (3)
Byte 4 = 05h ENQ Enquiry
- 2) TIME REQUEST response format (from AEC-BOX) is identical to that listed for the ASCII BROADCAST mode on the previous page.
- 3) BOX ID REQUEST command format (to AEC-BOX) is:
Byte 1 = 02h STX Start Transmission
Byte 2 = 30h-39h 0-9 Upper Address Byte (from EPROM)
Byte 3 = 30h-39h 0-9 Lower Address Byte (from EPROM) (3)
Byte 4 = 3Fh ? Question Mark
- 4) BOX ID REQUEST response format (from AEC-BOX) is:
Byte 1 = 5d --- AEC-BOX Number (5 in this case)
Byte 2 = 41h-5Ah A-Z Software Revision Letter (major)
Byte 3 = 31h-39h 1-9 Software Revision Number (minor)
Byte 4 = 0Dh CR Carriage Return
- 5) BROADCAST MODE command format (to AEC-BOX) is:
Byte 1 = 02h STX Start Transmission
Byte 2 = 30h-39h 0-9 Upper Address Byte (from EPROM)
Byte 3 = 30h-39h 0-9 Lower Address Byte (from EPROM) (3)
Byte 4 = 1Bh ESC Escape
At this point, the box will enter the ASCII BROADCAST mode.
It will exit this mode upon receipt of an STX (02h) byte.

Notes:

- 1) If any transmission or protocol errors are detected, the LED on the front panel will blink off for about 500ms, and the software will wait for the next 02h STX byte.
- 2) There are no timeout periods between bytes.
- 3) The lower address byte is actually the sum of the EPROM value (normally ASCII "0"), plus the offset address determined by the serial interface setup procedure (see page 28), which allows offset addresses of 0, 2, 4, and 6. Thus if the offset address is 4, the default box address is "04". As shipped from the factory, the address will normally be "00".

SERIAL INTERFACE STANDARDS

For more information on any of these standards, contact the appropriate agency as indicated on page 50.

RS232 Standard:

Interface signals are inverted versions of the UART (TXD & RXD) signals. A valid "1" is -5V to -15V. A valid "0" is +5V to +15V. Since RS232 drivers are always on, you can't bus them together, which makes RS232 strictly a point-to-point communication link. RS232 is THE most commonly used interface in the computer industry, and is usually seen as a 25pin "D" connector on modems, terminals, serial ports (like IBM PC COM1 and COM2), and just about any type of peripheral you can think of. Cables should be limited to 30 meters max, and the data rate should be limited to 19200 baud max, in accordance with the RS232 standard. This AEC-BOX does not have (and does not need) any of the handshake lines which are used by many RS232 devices.

RS422 Standard:

The RS422 transmission standard allows for cables up to 1200 meters long, and data rates up to 10Megabaud. It uses differential (2 complementary line) transmitters and receivers, which greatly reduces sensitivity to common mode noise. In addition, the transmitters can be set to a high impedance (Hi-Z) state, which allows several transmitters to share a pair of data lines. Thus many pieces of equipment can share the same data bus. For the "+" output, typical output low voltages are about 0V, and typical output high voltages are about +4V. For the "-" output, the signal polarity is reversed.

In BROADCAST modes, the RS422 transmitter is always enabled. In POLLED modes, the RS422 transmitter is enabled only while messages are being sent. This enables multiple AEC-BOX's (and other devices) to be controlled from one RS422 port.

ESbus Standard:

The ESbus (EBU/SMPTE Machine Control Bus) is used in the television industry to control VTR's, routers, switchers, mixers, and other equipment. The pinout of the AEC-BOX's 9-pin "D" connector is that of an ESbus tributary. Experienced users will also note that the BINARY POLLED mode message protocol conforms with ESbus standards for a tributary device.

AEC-BOX-5 LED OPERATIONS

The so called "POWER" LED on the front of the box behaves in a variety of ways so that you can have some clues as to what is (or is not) going on inside the box.

When power is first turned on, a hardware reset circuit forces the LED to blink ON for a short (barely noticeable) time. If this fails to happen, there is something seriously wrong with the power supply or LED. Check the TROUBLESHOOTING section on page 44 for details.

If the LED blinks on initially, but then fails to come on any more, there must be some kind of serious hardware/software problem. Again, check the TROUBLESHOOTING section on page 44 for details.

If the "POWER" LED blinks OFF occasionally (or constantly), the box is working OK, but it is indicating that the DIP switches are set wrong, or there is something unusual with the time code, video, and/or serial data signals which are coming into the box.

Possible LED blink patterns for the AEC-BOX-5 are as follows:

- 1) blinks OFF once (1x) every second
=> LTC missing or wrong type
- 2) double blinks OFF every second (blink-blink, wait 1 second)
=> Video missing or wrong type
- 3) blinks OFF for 500ms occasionally
=> serial communications error detected when it blinks
- 4) blinks ON once (1x) every 2 seconds
=> EPROM checksum error (call factory)
- 5) blinks ON twice (2x) every second (heartbeat pattern)
=> one of the diagnostics modes is active
(blinks much faster when TX/RX loopback diagnostic is OK)
- 6) toggles ON/OFF every 125ms (4Hz square wave)
=> the DIP switches must be changed
- 7) toggles ON/OFF every 500ms (1Hz square wave)
=> watchdog timeout (hardware/software problem) (call factory)
- 8) other blink patterns
=> displaying EEPROM register information if SW1-SW8 = 101xxxxx

If both LTC and Video are missing, they take turns flashing the LED (blink, wait 1 second, blink-blink, wait 1 second, etc.). This is the blink pattern you will see if you power up the box with the DIP switches properly set and no cables attached.

Note that no matter what is going on inside the box, the LED should always come on at least once per second. This way you will know that the internal power supply and software are OK.

If the "POWER" LED stays on all the time, everything must be running perfectly, and you can go read something else.

AEC-BOX-5 TROUBLESHOOTING GUIDE

This guide lists anticipated problems and their solutions. If you really get stuck, contact our Service Department:

Problem #1: Power LED does not blink ON when power is applied:

Solutions :

- a) Check for presence of external AC power source.
- b) Make sure AC voltage agrees with box wiring.
- c) Leave off for 1 minute, then turn back on. Thermal "fuse" will then be cooled and reset.
- d) Fix broken LED wiring.
- e) Return AEC-BOX for power supply repairs.

Problem #2: Power LED blinks ON initially, then stays off:

Solutions :

- a) May be an EPROM checksum error. If you have modified the EPROM, the checksum byte may be wrong. See EPROM MODIFICATIONS (page 10).
- b) Return AEC-BOX for repairs.

Problem #3: Power LED blinks OFF during operations:

Solutions :

- a) See the LED OPERATIONS section of this manual (page 43). The box is OK, but something is wrong with your signal source(s).

Problem #4: Box is not transmitting anything:

Solutions :

- a) Turn off power, set SW1-8 to 11100000, turn power back on. Box will transmit an ASCII "Z" (5Ah) character every 10ms, using serial setups determined elsewhere.
- b) Use oscilloscope to check the transmit lines.
- c) Remove external serial cabling - works now?
- d) In POLLED mode, will not respond to incorrect box address, data errors, protocol errors, etc.
- e) Where multiple boxes share the same RS422 cable, make sure each box has a different address.

Problem #5: Box is not receiving anything:

Solutions :

- a) Turn off power, set SW1-8 to 00010010 (ASCII BROADCAST mode), turn power back on. Then short the transmit/receive lines together. LED blinks much faster if loopback test is OK (indicates transmit/receive hardware is OK).
- b) In POLLED mode, will not respond to incorrect box address, baud rate, # of data bits, parity, data errors, protocol errors, etc.

Problem #6: Box transmits, but I can't receive anything:

Solutions :

- a) Check cables for shorts, opens, crossed wires.
- b) Make sure UART parameters (baud rate, etc.) are the same for both the box and your serial device.
- c) If using RS232, limit cable length to 30 meters.

AEC-BOX-5 TROUBLESHOOTING GUIDE
(continued)

Problem #7: Bytes are missing in the received data stream:

- Solutions :
- a) The receiving device must be able to receive ALL bytes in a message without any OVERRUN errors, even if interrupts occur during reception. Change interrupt priorities, disable some, etc.
 - b) Use a lower baud rate (more time per character) and see if the problem goes away.

Problem #8: Some time code messages and/or counts are missing:

- Solutions :
- a) Use a higher baud rate so that the entire message can be sent before the next LTC frame finishes.
 - b) SMPTE drop frame counting eliminates some counts.
 - c) The LTC input may be counting faster than play speed, but the LTC generator is always at play speed, so has to skip some counts to keep up.
 - d) When converting from one LTC format to another, sometimes must add or drop a few frame counts in order to keep them synchronized.
 - e) Once per day the box may add or drop a few counts in order to prevent long-term time drift.

Problem #9: Video sync is present, but the box says it's bad:

- Solutions :
- a) Check box operating mode (see pages 16-21). If the box is expecting NTSC, and you are supplying PAL (for example), the box will indicate that the video sync input is bad.
 - b) Provide a stable, clean video reference, not something coming directly off tape.

Problem #A: LTC is present, but the box isn't reading it:

- Solutions :
- a) Check box operating mode (see pages 16-21). If the box is expecting SMPTE LTC, and you are supplying EBU LTC (for example), the box will indicate the LTC input is bad.
 - b) Check box operating mode (see pages 16-21). If the box is expecting NDF SMPTE LTC, and you are supplying DF SMPTE LTC, (or vice-versa), the box will indicate the LTC input is bad.
 - c) Provide a clean "play speed" LTC input signal. Perhaps the signal you are providing is faster than play speed, slower than play speed, or may be too distorted to be readable.

(continued)

AEC-BOX-5 TROUBLESHOOTING GUIDE
(continued)

Problem #B: There is a time offset between input and output LTC:

Solutions : a) Somebody may have intentionally or accidentally programmed in a time offset (see page 24), in which case the box is doing exactly what it was told to do. Either write 00h into each of the four offset data fields (=> 00:00:00:00), or reset the EEPROM (erases everything).

Problem #C: The user bits aren't being transferred to the output:

Solutions : a) Somebody may have intentionally or accidentally programmed in a user bit mode which overwrites (ignores) some or all of the user bit data. See page 22 for details. Either change back to the default (50h) user bit mode, or reset the EEPROM (erases everything) (see page 13).

WARRANTY REGISTRATION

We no longer have a formal warranty registration procedure, but do like to keep in touch with our end users. If you did not purchase this product directly from us, please copy the User Feedback Request form in the back of this manual, fill it out, then fax or mail it back to us. This way we will know who and where you are and be able to provide you with the following:

- 1) product upgrade and and bug reports,
- 2) manual updates and application notes,
- 3) safety/recall notices, and
- 4) better service in many other ways.

OUR WARRANTY

For the first two years following the shipment of an AEC product, we will repair or replace, at our option, any such product which is found to be inoperative due to defects in materials or workmanship. Not covered is damage due to unusual electrical and/or physical abuse. Altered hardware, software, labels, or other identifying marks may also void the warranty.

GENERAL GUIDELINES

Before sending a product back to us for service, please do the following (we've found over 90% of returned items work fine):

- 1) Check the "Troubleshooting Guide" in this manual.
- 2) Call our Service Department for assistance if needed.
- 3) Obtain our current return address, and possibly an RMA number, before shipping anything back to us.
- 4) Package the unit carefully before shipping it (it's yours).

WARRANTY SERVICE PROCEDURES

All you have to do is call our Service Department and describe the nature of the problem. We will attempt to fix it over the phone, but if that doesn't work we will give you an RMA number and you can ship the defective product back to us. We will repair or replace the product and return it to you as soon as possible.

OUT-OF-WARRANTY SERVICE PROCEDURES

If the two year warranty period has expired, or if the product has been altered or damaged, we will repair the product for a charge to be agreed upon before the repairs are begun. Call our Service Department for assistance. We have the test equipment, parts, and experience to quickly find and fix any problems.

7-BIT ASCII CODE CHART

Dec	Hex	Key	Char	Description	Dec	Hex	Char	Dec	Hex	Char
0	00h	^2	NUL	null char.	43	2B	+	86	56	V
1	01h	^A	SOH	start heading	44	2C	,	87	57	W
2	02h	^B	STX	start of text	45	2D	-	88	58	X
3	03h	^C	ETX	end of text	46	2E	.	89	59	Y
4	04h	^D	EOT	end of trans.	47	2F	/	90	5A	Z
5	05h	^E	ENQ	enquiry	48	30	0	91	5B	[
6	06h	^F	ACK	acknowledge	49	31	1	92	5C	\
7	07h	^G	BEL	ring bell	50	32	2	93	5D]
8	08h	^H	BS	backspace	51	33	3	94	5E	^
9	09h	^I	HT	horiz. tab	52	34	4	95	5F	~
10	0Ah	^J	LF	line feed	53	35	5	96	60	`
11	0Bh	^K	VT	vertical tab	54	36	6	97	61	a
12	0Ch	^L	FF	form feed	55	37	7	98	62	b
13	0Dh	^M	CR	carriage ret.	56	38	8	99	63	c
14	0Eh	^N	SO	shift out	57	39	9	100	64	d
15	0Fh	^O	SI	shift in	58	3A	:	101	65	e
16	10h	^P	DLE	data link esc	59	3B	;	102	66	f
17	11h	^Q	DC1	device ctrl 1	60	3C	<	103	67	g
18	12h	^R	DC2	device ctrl 2	61	3D	=	104	68	h
19	13h	^S	DC3	device ctrl 3	62	3E	>	105	69	i
20	14h	^T	DC4	device ctrl 4	63	3F	?	106	6A	j
21	15h	^U	NAK	no acknowldge	64	40	@	107	6B	k
22	16h	^V	SYN	synch. idle	65	41	A	108	6C	l
23	17h	^W	ETB	end TX block	66	42	B	109	6D	m
24	18h	^X	CAN	cancel	67	43	C	110	6E	n
25	19h	^Y	EM	end of medium	68	44	D	111	6F	o
26	1Ah	^Z	SUB	substitute	69	45	E	112	70	p
27	1Bh	^[	ESC	escape	70	46	F	113	71	q
28	1Ch	^\ ^	FS	file sepratr.	71	47	G	114	72	r
29	1Dh	^] ^	GS	group sep.	72	48	H	115	73	s
30	1Eh	^6 ^	RS	record sep.	73	49	I	116	74	t
31	1Fh	^- ^	US	unit sepratr.	74	4A	J	117	75	u
32	20h	SPC		space	75	4B	K	118	76	v
33	21h	!	!	exclamation	76	4C	L	119	77	w
34	22h	"	"	double quote	77	4D	M	120	78	x
35	23h	#	#	number sign	78	4E	N	121	79	y
36	24h	\$	\$	dollar sign	79	4F	O	122	7A	z
37	25h	%	%	percent sign	80	50	P	123	7B	{
38	26h	&	&	ampersand	81	51	Q	124	7C	|
39	27h	'	'	apostrophe	82	52	R	125	7D	}
40	28h	(	(	left parenth	83	53	S	126	7E	~
41	29h	)	)	right parenth	84	54	T	127	7F	DEL
42	2Ah	*	*	asterisk	85	55	U			

ASCII is an abbreviation for
"the American Standard Code for Information Interchange".

NOTE: The keystrokes indicated above are for IBM PC's,
and may be slightly different for your equipment.

NUMBER SYSTEM CONVERSION TABLE

This chart will help you make conversions between the various numbering systems which are used in this manual.

Hexadecimal	(MSB) Binary (LSB)	Decimal	BCD
0	0 0 0 0	0	0
1	0 0 0 1	1	1
2	0 0 1 0	2	2
3	0 0 1 1	3	3
4	0 1 0 0	4	4
5	0 1 0 1	5	5
6	0 1 1 0	6	6
7	0 1 1 1	7	7
8	1 0 0 0	8	8
9	1 0 0 1	9	9
A	1 0 1 0	10	invalid
B	1 0 1 1	11	invalid
C	1 1 0 0	12	invalid
D	1 1 0 1	13	invalid
E	1 1 1 0	14	invalid
F	1 1 1 1	15	invalid

(base 16)

(base 2)

(base 10)

(BCD is an abbreviation for "Binary Coded Decimal")

PACKED BCD NUMBERS

A "packed BCD" byte contains two BCD digits in an 8-bit byte. Bits 7-4 (upper nibble) contain the upper BCD digit, and bits 3-0 (lower nibble) contain the lower BCD digit.

For example, incrementing BINARY 09h leaves you with 0Ah, but incrementing PACKED BCD 09h leaves you with 10h. A packed BCD number such as 0Ah would be invalid, because "A" is not a valid BCD digit.

Here is one more example, showing the packed BCD format as used for time bits I/O. The 30 second (half minute) mark would be read (or written) as a 30h byte, even though 30 decimal is the same as binary 1Eh.

WHERE/HOW TO ORDER COPIES OF STANDARDS

We suggest that you fax, call, or write the organizations below for current prices and ordering/payment procedures. Due to copyright restrictions, we cannot provide standards copies for you. It takes some of these organizations up to 2 months to respond, so plan ahead. Also, please let us know if you find anything on this page which needs updating. Thanks.

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White Plains, NY 10607
U.S.A.

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4) SMPTE RP139-1992	ESbus Tributary Interconnection	\$16.00
5) SMPTE RP163-1992	ESbus System Service Messages	\$16.00
6) SMPTE RP170-1993	ESbus VTR-Specific Messages	\$24.00
7) SMPTE RP172-1993	ESbus Common Messages	\$18.00
8) SMPTE 12M-1986	Time and Control Code for Television	\$16.00
9) SMPTE 262M	Data Storage & Trans. - Binary Groups	\$13.00
A) SMPTE RP159-1991	VITC and LTC Relationship	\$10.00
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European Broadcasting Union (EBU)
Technical Department
Case Postale 67
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SWITZERLAND

Tel: +41-22-717.21.11 Fax: +41-22-717.24.81
You must order the "Annual Volume of EBU Official Technical Texts",

which (for 250 Swiss Francs) includes the following:

- 1) N12 Time & Control Codes for Television
- 2) N18 Relationship Between Time Code and PAL 8-Field Sequence
- 3) I29 Recording of Information in User Bits

Telecommunications Industry Association (TIA)
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