EXTERNAL SYNCHRONIZATION INCLUDING SMPTE

May 21, 1986

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INTRODUCTION

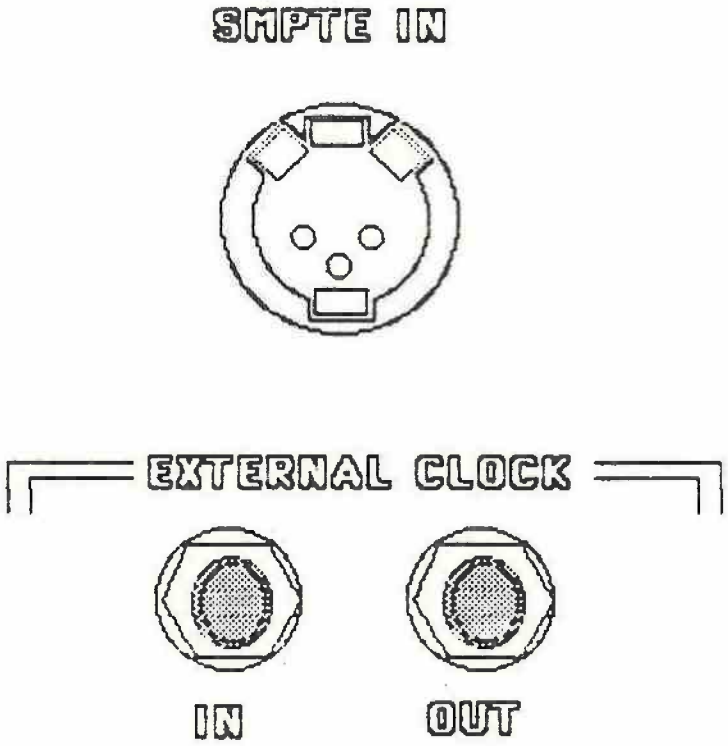
INTRODUCTION

External signals fed into the control unit synchronize the Synclavier (R) to audio and video equipment. The memory recorder, for example, can be controlled externally, or a keyboard performance can be synchronized to an outside beat. Material recorded on tape can then be precisely aligned with material from the Synclavier (R).

External signals come in to the control unit through either

- the EXTERNAL CLOCK IN jack; or
- the SMPTE IN jack.

A third jack, the EXTERNAL CLOCK OUT, allows you to send synchronization signals out of the Synclavier (R) to other equipment.



INPUTS AND OUTPUTS

The Synclavier (R) generates and responds to only two types of signals:

1. TTL Logic Pulses.

2. SMPTE time code.

Pulse Signal Input: EXTERNAL CLOCK IN

Pulse signals received through the EXTERNAL CLOCK IN jack from an external source are automatically conditioned by a signal conditioner built in to the EXTERNAL CLOCK IN jack.

The EXTERNAL CLOCK INPUT only recognizes pulses. All non-pulse signals should be converted to pulses using a signal conditioner such as the CIM-1 clock interface module before attempting pulse synchronization.

External synchronization signals received through the EXTERNAL CLOCK IN jack allow you to sync Synclavier (R) sequences to performances recorded on tape or to drum machines and other sequencers. You can also synchronize the transfer of individual tracks from the Synclavier (R) memory recorder to a multitrack tape recorder or replace a live drum sound with a Synclavier (R) timbre.

When synchronizing using the EXTERNAL CLOCK IN jack, units must be in sync from the beginning of the sequence. Pulse synchronization does not keep track of elapsed time.

Time Code Input: SMPTE IN

SMPTE time code is received through the SMPTE IN jack from external sources such as the SMPTE track on a tape or video recorder or from other SMPTE generators. With SMPTE time code, you can synchronize the Synclavier (R) to a SMPTE track for precise synchronization to film, video and audio equipment.

Sync Signal Output: EXTERNAL CLOCK OUT

The EXTERNAL CLOCK OUT jack sends both pulse and SMPTE signals.

Pulsed signals produced on the Synclavier (R), sent out through the EXTERNAL CLOCK OUT jack and fed through a signal conditioner can be recorded onto tape. SMPTE signals can be recorded directly on tape with no conditioning. Either type of signal can drive other equipment directly, including another Synclavier (R).

SYNCHRONIZATION OPTIONS

Pulse Synchronization Modes

There are four modes of pulse synchronization available.

EXTERNAL SYNC Mode

You enter the EXTERNAL SYNC Mode by pressing the EXT SYNC MODE button in the second panel.

- If you press the EXT SYNC MODE button once, the button lights and the display window shows

  50 Hertz Sync

- If you press the EXT SYNC MODE button twice, the button blinks and the display window shows

  [number] MILLISEC

  Ext Beat Sync

- If you press the EXT SYNC MODE button again the button goes out and the display window shows

  Internal Sync

These modes determine the types of sync signals sent from the EXTERNAL CLOCK OUT jack and way the computer responds to signals received at the EXTERNAL CLOCK IN jack.

EXTERNAL CLICK Mode

You enter the EXTERNAL CLICK mode by holding the CLICK RATE button and pressing the EXT SYNC MODE button. The display window shows

EXTERNAL CLICK

Pulses applied to the EXTERNAL CLOCK IN jack control the click while in the mode.

EXTERNAL REPEAT Mode

You enter the EXTERNAL REPEAT mode by holding the REPEAT/ARPEGGIATE RATE button in the fourth panel and pressing the EXT SYNC MODE button. The display window shows

EXTERNAL REPEAT

Pulses applied to the EXTERNAL CLOCK IN jack control the Repeat/Arpeggiate Rate.

EXTERNAL RETRIGGER Mode

You enter the EXTERNAL RETRIGGER mode by holding the EXT SYNC MODE button while you press the START button. The display window shows

EXT TRIGGER: ON

Pulses applied to the EXTERNAL CLOCK IN jack retrigger the last note or chord played on the keyboard.

You exit the EXTERNAL RETRIGGER mode by holding the EXT SYNC MODE button while you press the STOP button. The display window shows

EXT TRIGGER: OFF

EXTERNAL CLOCK IN FUNCTION	SECTION OF MANUAL	TURN FUNCTION ON	TURN FUNCTION OFF
EXTERNAL SYNC	"External Pulse Synchronization"	Press EXT SYNC MODE once or twice.	Press EXT SYNC MODE once or twice.
EXTERNAL CLICK	"External Click Tracks"	Press CLICK RATE and hold it down while you press EXT SYNC MODE.	Press CLICK RATE and hold it down while you press EXT SYNC MODE.
EXTERNAL REPEAT	"Triggering the Repeat/ Arpeggiate function.	Press (REPEAT/ ARPEGGIATE) RATE and hold it down while you press EXT SYNC MODE.	Press (REPEAT/ ARPEGGIATE) RATE and hold it down while you press EXT SYNC MODE.
EXTERNAL RETRIGGERING	"Drum Replacement"	Press EXT SYNC MODE and hold it down while you press START.	Press EXT SYNC MODE and hold it down while you press STOP.

EXTERNAL CLOCK IN Priorities

The different uses of EXTERNAL CLOCK IN are prioritized so that one feature automatically overrides another if both are activated. The priority is as follows:

1. EXTERNAL SYNC Mode
2. EXTERNAL CLICK Mode
3. EXTERNAL REPEAT Mode
4. EXTERNAL RETRIGGER Mode

Thus, when you prepare to use the EXTERNAL CLOCK IN jack for any function, you must first make sure that each of the more highly prioritized functions of EXTERNAL CLOCK IN is turned off.

Instructions for using each function of EXTERNAL CLOCK IN are in the appropriate section of this manual. A summary of the method for turning on and off each functions is on the following page.

HARDWARE OPTIONS

Several hardware options are available for use with external synchronization.

D16 Timer and High Speed Processor

Under normal circumstances, there is an average delay of 2.5 milliseconds between the time the external signal trigger occurs and the time the Synclavier (R) "notices" the signal. The actual delay may be as little as 0 milliseconds or as much as 5 milliseconds. In cases of playing complex timbres or sequences, delays may be considerably longer.

Variations in delay from one pulse to the next sometimes results in an objectionable "jitter" in the meter of the music.

The D16 Scientific Timer measures time with high resolution. Systems equipped with a D16 Scientific Timer experience external sync delays of about 1.5 milliseconds with variations of only plus or minus 0.5 milliseconds.

The High Speed Processor replaces your current processor to increase overall system performance. For external synchronization functions, the High Speed Processor in conjunction with the D16 Timer reduces sync delays to about 0.5 milliseconds.

Clock Interface Module (CIM-1)

The Clock Interface Module simplifies interfacing to other equipment and improves synchronization timing resolution. The CIM-1 is a signal processing device that was specially designed to interface the Synclavier (R) with tape recorders and other synthesizers. The CIM-1 incorporates four essential sync functions into a single unit:

1. FSK (frequency shift key) technology decodes FSK signals from any source and encodes digital clock pulses into FSK audio signals suitable for recording on tape.

2. Pulse divider circuitry makes the high speed pulse rates used on many synthesizers and drum machines compatible with Synclavier (R) clock rates.

3. Conditioning circuitry conditions digital clock pulses to a uniform pulse width compatible with Synclavier (R) requirements.

4. Analog signal conditioning circuitry converts audio signals such as live drum beats into pulses.

The manual "Clock Interface Module Operating Manual," available from New England Digital, gives detailed instructions on the use of the CIM-1. Basic instructions for its use are included in this manual.

SMPTE Hardware

To operate the SMPTE option, two pieces of hardware must be installed in the computer bin:

- The SMPTE circuit board
- The D16 Timer board

Instructions for installing these boards are in the "Options" sections of Setup and Troubleshooting.

EXTERNAL PULSE SYNCHRONIZATION

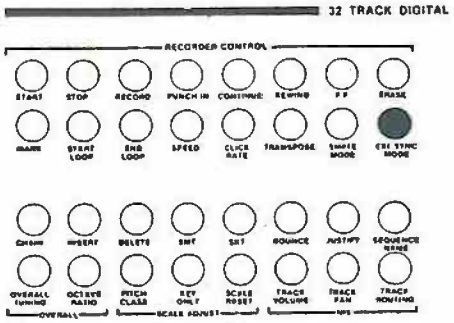
External pulse synchronization can be used for either recording or playing back.

When the Synclavier (R) is in the External Sync mode and you press START, the sequence in the memory recorder does not start playing until a signal from an external source is received at the EXTERNAL CLOCK IN jack on the control unit.

The external synchronization function of the EXTERNAL CLOCK IN jack has the highest priority and overrides any other function that may be turned on (see "Introduction").

ACTIVATING EXTERNAL SYNC MODES

You use the EXT SYNC MODE button in the second panel to activate the External Sync Modes.



- To place the Synclavier (R) into the 50 Hz External Sync mode, press the EXT SYNC MODE button in the second panel once to make it light. The display window shows

  50 Hertz Sync

- To place the Synclavier (R) into the External Beat Sync mode, press the EXT SYNC MODE button in the second panel twice to make it blink. The display window shows

  [number] MILLISEC
  Ext Beat Sync

  The number at the top of the display is the sync delay setting. Changing this setting with the control knob delays the advance of a sequence by the number of milliseconds displayed.

Lit or blinking, the EXT SYNC MODE button places the memory recorder in the External Sync mode. Neither playback nor recording begins until an external signal is received into the computer.

When the memory recorder is in the 50 Hz sync mode, the computer waits for 50 pulses per second, each one 10 milliseconds wide at the EXTERNAL CLOCK IN jack. For every 50 pulses received, the memory recorder advances playback or recording one second, regardless of the speed or click rate settings.

When the memory recorder is in the External Beat Sync mode, the computer waits for a pulse at the EXTERNAL CLOCK IN jack. For every pulse received, the memory recorder advances one click or click subdivision as determined by the CLICK RATE and CLICK MULTIPLIER settings. The sequence plays all notes recorded between clicks or subdivisions at the speed set using the SPEED button.

GENERATING SYNC SIGNALS

Pulse sync signals can be generated in each of the three external sync modes. Two types of pulse signals are used in external synchronization. These are:

- 50 Hz Sync signals
- Beat Sync pulses

Pulse signals are generated and sent to the CLOCK OUT jack whenever the START button is pressed.

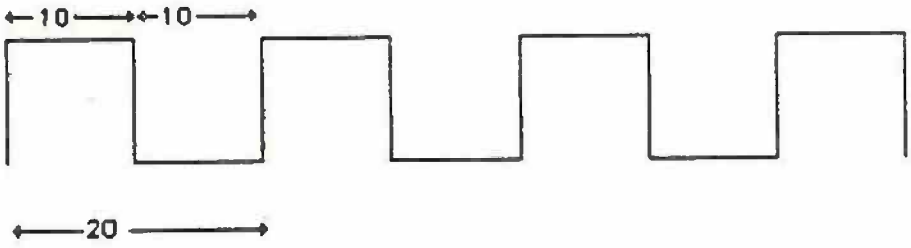
Internal Sync Mode

When the EXT SYNC MODE button is not lit, a 50 Hz sync signal is produced at the CLOCK OUT jack when the START button is pressed. The sequence plays normally.

50 Hertz Mode

When the EXT SYNC MODE button is lit and the START button is pressed, a 50 Hz sync signal is produced at the CLOCK OUT jack. The sequence only plays if the signal is sent back into the CLOCK IN jack.

The 50 Hz sync signal is made up of 10 millisecond pulses occurring 50 times per second. The space between the pulses is also 10 milliseconds. This is called a 50% duty cycle.



During each 20 millisecond period, the computer senses the state of the input signal. Each time the signal is high, the sequence moves forward 1/50th of a second.

The 50 Hz signal is a steady signal. When it is received through the EXTERNAL CLOCK IN jack, the memory recorder moves forward at the steady rate. When the 50 Hz signal stops, the memory recorder stops.

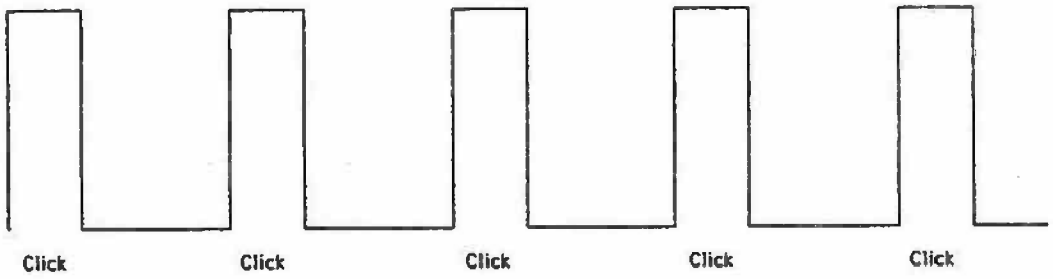
External Beat Sync Mode

When the EXT SYNC MODE button is blinking and the START button is pressed, a pulse is sent to the EXTERNAL CLOCK OUT jack having a frequency determined by the current click rate and click rate multiplier settings. The sequence only plays back if the signal is sent back in to the EXTERNAL CLOCK IN jack.

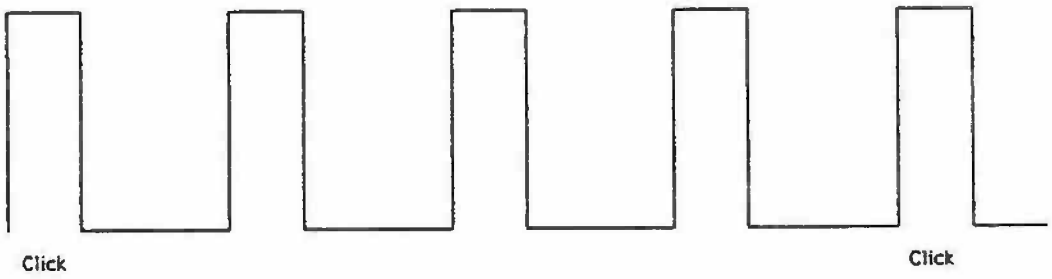
The pulse lasts 15 milliseconds. One pulse is generated for each click rate subdivision. In other words, if the click rate multiplier is set to 1, one pulse is generated for each click. If the click rate multiplier is set to 16, sixteen pulses are generated for each click.

Two beat sync pulses are illustrated below:

Click Rate Multiplier=1



Click Rate Multiplier=4



RECEIVING SYNC SIGNALS

When sync pulses are received through EXTERNAL CLOCK IN, each beat sync pulse advances the sequence a certain amount of time. This amount of time depends on the external sync mode, the click rate, click multiplier and speed settings.

50 Hertz Mode

When you press START while in the 50 Hz Mode, the sequence is advanced 1/50th of a second each time a pulse is received. The memory recorder responds normally to changes in the SPEED, CLICK RATE, and CLICK RATE MULTIPLIER settings.

External Beat Sync Mode

When you press START while in the External Beat Sync Mode, the sequence is advanced one click subdivision each time a pulse is received. Changes in SPEED, CLICK RATE or CLICK MULTIPLIER settings after the sequence has been recorded can yield very interesting and unpredictable results.

Changes in speed do not vary the overall speed of the sequence playback, but only the playback speed of notes recorded between subdivisions.

Changes in the click rate and click rate multiplier change the rate at which the sequence advances, yet the speed of playback between subdivisions remain the same.

If the rate of the sync pulse matches the click rate used during recording, the sequence play back in perfect synchronization with the external signals.

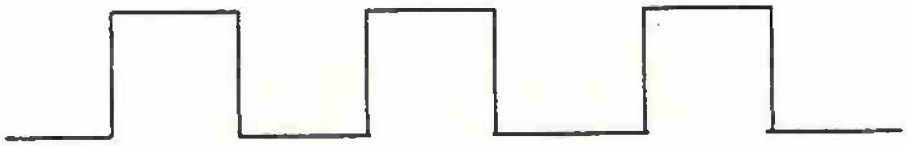
If the rate of the sync pulse is very different from the click rate used during recording, each incoming pulse may trigger several notes or perhaps none at all.

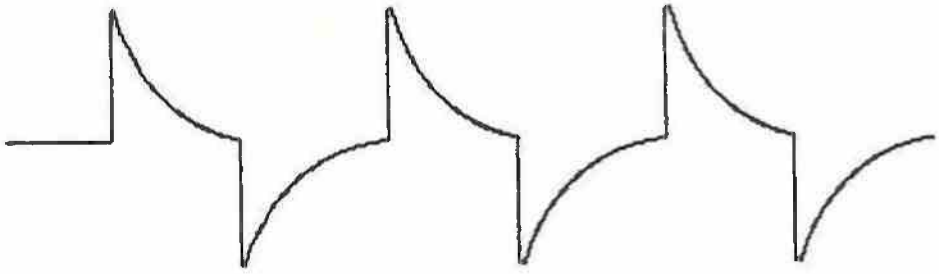
CONDITIONING SYNC SIGNALS

Since the computer only recognizes one kind of sync signal, the DC pulse, all sync signals must be converted to this format for external pulse synchronization. Sync signals longer or shorter than 10 milliseconds are conditioned automatically into 10 millisecond pulses by the EXTERNAL CLOCK IN circuitry.

Sync pulses cannot be accurately recorded on tape, however. A sync pulse is actually the result of a DC voltage being switched on and off. A tape recorder only records changes in voltage. While the pulse is in the "on" state, the voltage is not changing. The tape records the beginning of the pulse fairly accurately, but begins to distort the wave as it continues.

A sync pulse signal and the resulting signal recorded on tape are pictured below.





Synchronization to signals of this type can be unreliable. For this reason, an FSK (frequency shift key) signal encoder, such as the Clock Interface Module (CIM-1) described below, is recommended for synchronization to tape.

FSK (Frequency Shift Key) Sync Signals

As explained above, all logic signals, sync pulses included, are actually the result of a DC voltage being switched on and off. When the pulse is occurring, the voltage is on; when the pulse is not occurring, the voltage is off.

Since these signals cannot be reproduced on tape, a system borrowed from the telecommunications industry is used to encode the pulses in a form easily reproducible on audio tape. This is called FSK (Frequency Shift Key).

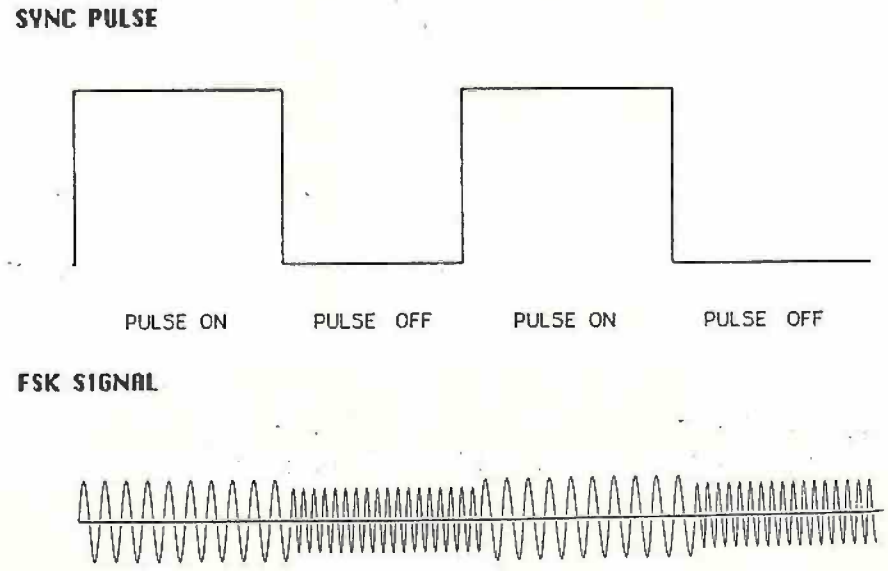
The priniciple of FSK is quite simple. When the logic signal is in the off state, a low tone is sent. When the logic signal is in the on state, a higher tone is sent.

Both tones are in the middle range of the audio spectrum and are easily reproduced on tape. Typically, the low tone is between 1000 and 3000 Hz and the high tone is between 2000 and 6000 Hz. The tones generated by the CIM-1 Clock Interface Module are 2400 Hz (low) and 4800 Hz (high).

If the signal being processed is a 50 Hz sync signal (pulses occurring 50 times per second) the FSK signal switches from high to low 50 times per second. If the pulses are beat sync pulses occurring at, for example, 120 pulses (beats) per minute, the FSK signal switches from high to low 120 times per minute.

These signals recorded on tape can then be decoded reliably to produce sync pulses suitable for use with the Synclavier.

Below is an illustration of a pulse sync signal and its encoded FSK signal.



USING THE CIM-1 CLOCK INTERFACE MODULE

The CIM-1 may be thought of as having two separate parts.

The Clock Interface

The Clock Interface, the most-used part of the CIM-1, receives audio signals, clock pulses, or FSK-encoded audio and translates or conditions it into clock pulses or FSK signals.

The Pulse Divider

The Pulse Divider, a completely separate processor, counts clock pulses received at the DIV IN jack and sends a smaller number pulses to each of the divider outputs (the jacks with notes above them).

The left-most jack (below the thirty-second note) emits one pulse for every six pulses received at the DIV IN jack. Each of the remaining divider outputs requires twice the number of input pulses as its neighbor to the left.

The table below lists the outputs of each divider output.

DIVIDER OUTPUT	PULSES RECEIVED	PULSES SENT
Whole	192	1
Half	96	1
Quarter	48	1
Eighth	24	1
Sixteenth	12	1
Thirty-second	6	1

Inputs, Outputs and Controls

Inputs

The Clock Interface section receives audio and FSK signals through the balanced XLR input marked RETURN.

Clock pulses are received at the CLOCK IN jack and the DIV IN jack. There are no indicators or controls for clock pulse inputs. Pulses are assumed to be standard TTL level (0-5 volts).

Outputs

Clock pulses are sent from the CLOCK OUT JACK and all divider outputs. FSK signals are sent from the balanced XLR connector marked SEND.

Send and Return Level

The RETURN LEVEL knob controls the level received at the RETURN input. The level of the FSK signal is controlled by the SEND LEVEL knob.

The HOLDOFF Control

The HOLDOFF control sets the minimum time allowed between clock pulses. This is used to eliminate double-pulses caused by secondary peaks in live audio sources.

LED Indicators

The light-emitting diode (LED) just to the right of the RETURN LEVEL knob indicates adequate triggering level. The LED marked OUTPUT STATE lights each time a pulse is sent to the CLOCK OUT jack.

FSK Decoder Output

With no plug inserted in the DIV IN jack, the output from the FSK decoder is connected (normalled) to DIV IN. Inserting a plug in the DIV IN jack disconnects it from the FSK Decoder output.

Ground Lift Switches

Ground lift switches are supplied for the audio input and output. These switches make and break the connection between the CIM-1 chassis and pin 1 of the XLR connector.

The FUNCTION Selector

The different functions of the CIM-1 are selected with the FUNCTION Selector.

LIVE TRK: Live Track Mode

When the LIVE TRK mode is selected, the audio signal at the RETURN input is used to trigger clock pulses directly. Input level is controlled with the RETURN LEVEL control, and adequate triggering level is indicated with the RETURN LEVEL LED.

The CIM-1 sends out a clock pulse every time the input voltage exceeds a threshold set by the RETURN LEVEL. The OUTPUT STATE LED lights each time a pulse is sent.

Obviously, percussive sounds produce the most reliable clock pulses, as sustained notes may produce voltages above or below the threshold many times within the same note, or may not reach the threshold at all.

The HOLDOFF control is then set to eliminate any extra pulses caused by secondary peaks or reverberations.

FSK signals corresponding to the clock pulses are also available at the SEND output. The SEND level controls the level of the FSK signal at this output.

DECODE: FSK Decoder Mode

Recorded FSK signals received at the RETURN input are decoded using this mode. The RETURN level controls the input level, and adequate triggering level is indicated by the RETURN LEVEL LED.

HOLDOFF should be adjusted fully clockwise (15 ms) when decoding FSK signals.

Decoded pulses are sent from the CLOCK OUT jack. With no plug inserted in the DIV IN, the decoder output is also connected (normalled) to the divider circuitry, so pulses are also being sent from all divider outputs while in the DECODE mode.

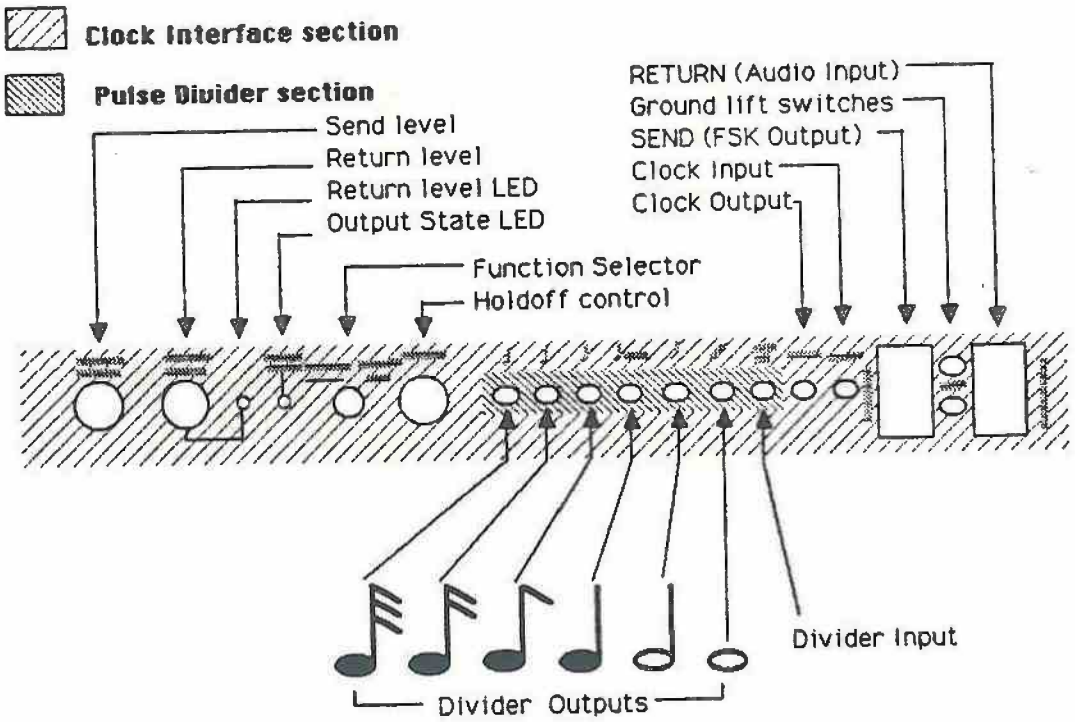
CONDITION: Pulse Conditioning Mode

The EXTERNAL CLOCK input on the Synclavier (R) has circuitry which automatically conditions incoming pulses so that they are all 10 milliseconds in duration. This mode duplicates that function.

The HOLDOFF can be set in this mode to avoid double pulses if incoming pulses are longer that 15 milliseconds.

BYPASS: Bypassing the CIM-1

This mode connects the CLOCK IN jack directly to the CLOCK OUT jack.



USING SYNC SIGNALS

There many ways to use sync signals with the Synclavier (R). They include

- synchronizing a Synclavier (R) sequence to tape;
- synchronizing a Synclavier (R) sequence to other systems such as sequencers or drum machines;
- replacing recorded percussion tracks with Synclavier (R) sounds;
- synchronizing Repeat or Arpeggiate rates with tape or other systems.

SYNCHRONIZING TO TAPE

Synchronization of the Synclavier (R) or any other computer-based music system takes three basic forms:

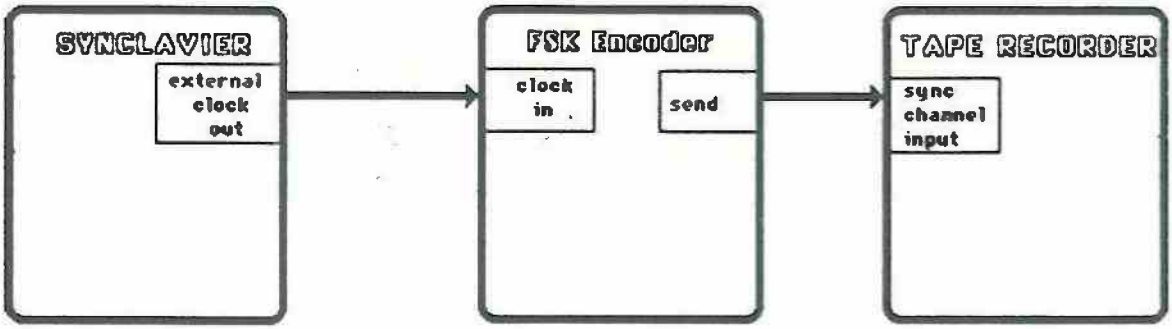
- creating a sequence, then recording additional information on tape;
- recording basic audio or video tracks on tape and enhancing them with sequences created on the Synclavier (R);
- recording live tracks and Synclavier (R) tracks simultaneously.

All of these applications require tape machines capable of recording and playing back tracks independently. Three-head machines must have a "sync" mode which allows the use of the Record head as a Play head.

Recording Signals Onto Tape

When recording pulse synchronization signals onto tape, set up the Synclavier (R), CIM-1 and tape recorder as follows:

- Synclavier (R) EXTERNAL CLOCK OUT to CIM-1 CLOCK IN.
- CIM-1 SEND to tape input of the selected sync track channel.



Set up the CIM-1 and tape recorder as follows:

1. Set the FUNCTION switch to DECODE.
2. Turn the HOLDOFF control to 15 ms.
3. Place the sync track channel of the tape recorder into the "Record" mode.
4. Adjust the SEND LEVEL control of the CIM-1 to obtain a reading of -10dB on the VU meter of the tape recorder. This reading is of the FSK signal coming from the CIM-1, not the signal coming from the Synclavier (R).

CROSSTALK and sync track selection

Selection of a sync track is an important consideration. The track adjacent to the sync track is vulnerable to crosstalk from the sync track. This means that signal from the sync track can leak over onto the adjacent track.

Likewise, and more important, the sync track is vulnerable to crosstalk from the adjacent track. Percussive signals can leak onto the sync track and cause erratic pulses to be generated upon playback.

Sync tracks should always be recorded on edge tracks (highest and lowest track numbers) and if recording on adjacent tracks is necessary, the tracks should only contain low level or sustained signals.

Narrower track formats and lower tape speeds are more vulnerable to crosstalk problems.

The basic procedure for recording either kind of Synclavier (R) pulse is the same. However, since recording beat sync pulses onto tape is somewhat more complex, the two kinds of recording are treated separately in this section.

Recording a 50 Hz Signal Onto Tape

1. Set up the tape recorder, CIM-1 or other FSK encoder, and the Synclavier (R) as described above.

2. Press the EXT SYNC MODE button once to select the 50 Hz mode. The button lights.

3. Press START on the Synclavier (R). A steady 50 Hz signal is sent out from the EXTERNAL CLOCK OUT through the FSK encoder to the sync channel input on the tape recorder. If there is a sequence in the memory recorder, it does not start to play. If you need to listen to the playback to determine the length of the sync track, you must also send the sync pulse to the Synclavier (R) EXTERNAL CLOCK IN.

4. Set the recording level on the tape recorder low enough so that the signal does not bleed onto other tracks (usually -5 to -10 dBvu).

5. Press STOP on the Synclavier (R).

6. Start the tape in the Record mode.

7. Let the tape get up to speed, allow the low FSK tone to record for 5 seconds, then press START on the Synclavier (R). The 50 Hz pulse is encoded in FSK on the tape track as long as the memory recorder is running. Continue the recording until sufficient signal is recorded for the entire Synclavier (R) sequence to be synchronized.

8. Press STOP on the Synclavier (R).

9. Stop the tape recorder and rewind the tape to the zero point.

10. Connect the recorded sync track output through the FSK decoder to the CLOCK IN jack on the Synclavier (R).

11. Place the sync track's channel in the "sync" mode when recording on tape or "play" for final playback and mixing.

12. Press START on the Synclavier (R) and play the tape.

    Adjust the FSK decoder for adequate input trigger level. The sequence begins playing when the sync track reaches the encoded 50 Hz sync signal.

Recording a Beat Sync Pulse Onto Tape

1. Set up the tape recorder, CIM-1 or other FSK encoder, and the Synclavier (R) as described above.

2. Recall or create a sequence. Make sure the SPEED is set at 1.000.

3. Select the External Beat Sync mode by pressing EXT SYNC MODE twice so that it is blinking.

4. Press START on the Synclavier (R).

   Beat sync pulses with a frequency equal to the click rate of the sequence (or the click rate times the click rate multiplier, if used) are sent from the EXTERNAL CLOCK OUT through the FSK encoder to the sync channel input of the tape recorder.

   If you need to listen to the playback to determine the length of the sync track, you must also send the sync pulse to the Synclavier (R) EXTERNAL CLOCK IN.

5. Set the recording level on the tape recorder low enough so that the signal does not bleed onto other tracks (usually -5 to -10 dBvu).

6. Press STOP on the Synclavier (R).

7. Start the tape in the Record mode.

8. Let the tape get up to speed, allow the low FSK tone to record for 5 seconds, then press START on the Synclavier (R). The beat sync pulses is recorded on tape as long as the tape and memory recorders are running. Record enough tape for the entire sequence to be synchronized.

9. Press STOP on the Synclavier (R).

10. Stop the tape recorder and rewind the tape.

11. Connect the recorded sync track output through the FSK decoder to the CLOCK IN jack on the Synclavier (R).

12. Place the sync track's channel in the "sync" mode when recording on tape or "play" for final playback and mixing.

13. Press START on the Synclavier (R) and play the tape.

    Adjust the FSK decoder for adequate input trigger level. The sequence begins playing when the sync track reaches the encoded beat sync signal.

Tempo Changes and Sychronization

50 Hz Sync

When playing back a sequence synchronized to a 50 Hz signal, you can make tempo changes by changing the SPEED setting. You can also change the CLICK RATE or CLICK RATE MULTIPLIER without affecting synchronization.

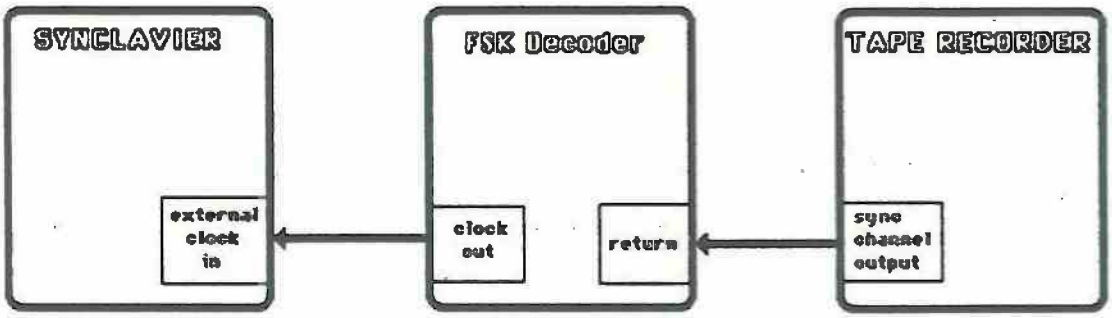
Beat Sync

A sequence synchronized to a beat sync pulse is actually stepped at a rate determined by the CLICK RATE, CLICK RATE MULTIPLIER and SPEED settings combined. If you change the tempo by changing the CLICK RATE, you must also change the SPEED setting, or the playback between clicks occurs at the previous SPEED setting.

Recording Synclavier (R) Tracks to Tape

When a sync track has been recorded and verified as outlined in the preceding two sections, set up the Synclavier (R), FSK decoder and tape recorder as follows:

- Synclavier (R) audio output(s) to tape recorder selected channel input(s). If the selected timbre is a stereo timbre you will need two tracks to record the stereo information.
- Tape recorder sync track output to FSK decoder input.
- FSK decoder clock output to Synclavier (R) EXTERNAL CLOCK IN.



1. Place the tape recorder in "sync" mode and the selected input track(s) in the "input" mode. Make sure the tape is rewound to a point prior to the beginning of the low FSK tone.
2. Select the Internal Sync mode (unlit) with the EXT SYNC MODE button.
3. Solo the Synclavier (R) track to be recorded press START on the Synclavier (R) and set the recording level(s) on the tape recorder.
4. Press STOP on the Synclavier (R).
5. Select the appropriate External sync mode (50 Hz or Beat Sync).
6. Start recording on the selected channel.
7. Watch the VU meter of the sync track. When the low FSK tone begins, press START on the Synclavier (R).
8. When the sequence is finished playing, stop the tape recorder and the Synclavier (R).

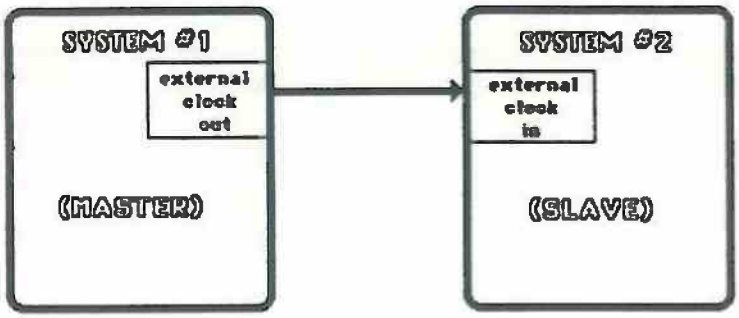
SYNCHRONIZING TO OTHER SYSTEMS

When synchronizing to other systems, one system acts as a "master" and one as a "slave." For example, if you recorded a drum track on a Synclavier (R) that you wanted to play back synchronized to a melody recorded on a second Synclavier (R), Synclavier (R) #1 would be the master and Synclavier (R) #2 would be the slave.

A 50 Hz or SMPTE signal is best for this application. (SMPTE sync is described below) If the second system cannot synchronize to one of the three sync signals generated by the Synclavier (R), the other system needs to be set up as the master system, with the Synclavier (R) as the slave. (See the following section on synchronization to high speed time bases).

Set up the two systems as follows:

- System #1 clock output to System #2 clock input.



When the systems are set up as illustrated, follow these directions:

1. Select the appropriate External Sync mode on the slave system.

2. Select the appropriate sync signal for output from the master system.

   The Synclavier can send 50 Hz or beat sync while playing. Beat sync signal must be sent to the Synclavier (R) CLOCK IN as well as to the slave system. The 50 Hz signal is automatically sent to the CLOCK OUT when in the internal sync mode.

3. Start the slave system playing (it does not start).

4. Start the master system playing.

When you start the slave system playing, it waits for an external signal. When you start the master system playing, it emits a sync signal through its clock output. Both systems play in synchronization.

When one of the two systems is a Synclavier (R), sequence tracks may be recorded while the systems are synchronized, and the new tracks are synchronized.

Synchronizing to High Speed Clock Signals

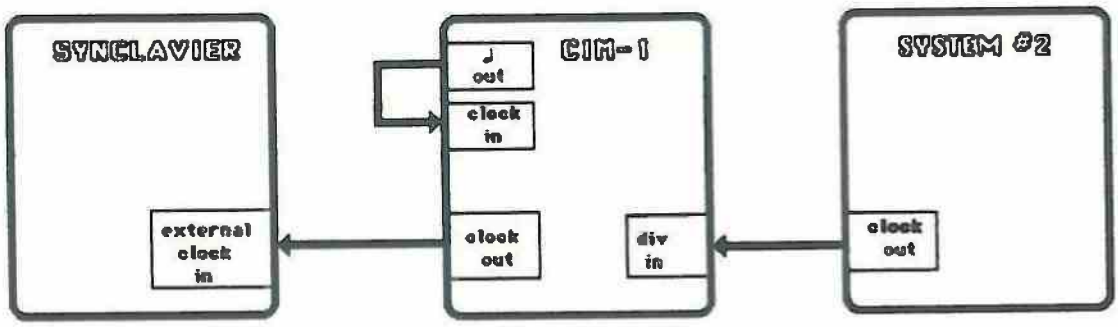
Many synthesizers and drum machines generate a high speed clock signal. This signal is usually a multiple of the click rate and is defined in pulses-per quarter note. Common time bases are 12, 24, 48, or 96 pulses per quarter note beat.

Such systems may be synchronized to the Synclavier (R), but must be set up as the master system. The sync signal from the system must be divided using a pulse divider such as the one built into the CIM-1 Clock Interface Module.

The following instructions describe synchronization to a system using a pulse rate of 48 pulses per quarter note.

Set up the Synclavier (R), pulse divider and System #2 as follows:

- System #2 time base output to pulse divider input
- Pulse Divider 1/48th output (quarter note output on CIM-1) to Synclavier (R) EXTERNAL CLOCK IN.



To play or record a sequence synchronized to System #2:

1. Place the Synclavier (R) in the beat sync mode by pressing EXT SYNC MODE twice to make it blink.

2. Press START.

3. Start System #2. Each beat of System #2's sequence triggers a beat in the Synclavier (R) memory recorder.

SMPTE SYNCHRONIZATION

The types of synchronization explained in previous sections simply start the sequence playing and keep it synchronized until the signal stops. They do not deal with the amount of time elapsed since the sequence started, either in terms of beats or seconds.

While MIDI sync does deal with elapsed time (in beats) to a certain extent, MIDI sync cannot be recorded on tape, and therefore cannot by itself be synchronized to tape.

SMPTE* time code provides a means of recording a sync signal on tape that includes information on elapsed time. It can measure elapsed times up to twenty-four hours.

With the other types of sync signals mentioned, one must always start a sequence at the beginning in order to synchronize it to tape. Using SMPTE time code, one can start the tape at any desired location and the sequence begins at that point.

In video productions, the SMPTE time code is recorded onto the audio or cue track. When the original material is dubbed onto a work tape, a time code display is burned in over the picture. The display can be easily read at slow shuttle speeds and in still-frame for a quick and accurate reference point. In post-production editing, the time code is used to make an edit list which is then programmed into a computer editing system.

Audio recording studios use SMPTE time code as an accurate tape locator as well as a sync reference for such applications as auto-mix, sync-to-film, or synchronization to computer-based instruments like the Synclavier (R). Time code is also used to synchronize multiple recording machines, allowing them to act as a single machine with multiple audio channels.

Overdubbing of music, narration or sound effects onto film or television soundtracks is done by matching the SMTPE time code of the picture with that of the sound.

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* SMPTE stands for the Society of Motion Picture and Television Engineers.

For further information on SMPTE time code, see Walter A. Hickman, Time Code Handbook, Boston:Cipher Digital, 1984.

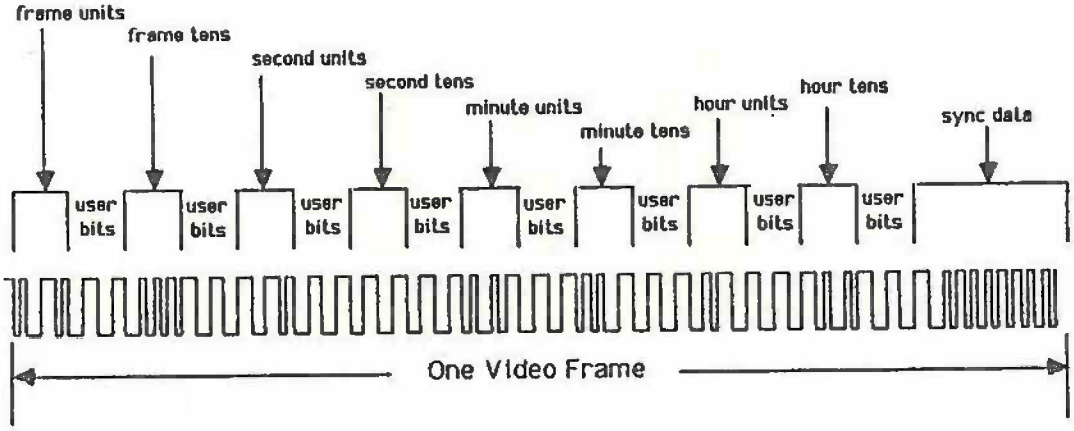
SMPTE SIGNALS

SMPTE time code is a digital signal which expresses time in terms of frames. Each frame has its own time code address, an eight digit number that locates the frame in time (hours:minutes:seconds:frames). The frame address is further divided into 80 bits spaced evenly over the entire frame. A point of reference for a particular overdubbed sound might be, for example,

01:29:14:09.51

The overdubbing of this sound should begin at exactly 1 hour, 29 minutes, 14 seconds, 9 and 51/80 frames after the beginning of the time code.

The time code address numbers are recorded in sequence. Each time a frame advances, the time code number is advanced by one frame count.



In each group of eight bits, the second four is reserved for "user information". Many SMPTE generators use these bits for various purposes such as reel numbers, location codes, take I.D.'s, or dates.

The Synclavier (R) acknowledges these codes, but does not make use of them.

SMPTE Signal Types

There are four types of SMPTE code currently in use by the audio, video and film industries. Each is used for synchronization to a different type of visual medium. Using the SMPTE Option, the Synclavier (R) can generate and read all four types, and each can be recorded on audio tape for sychronization purposes.

30 Frame SMPTE (Non-Drop)

In American black-and-white video, there are 30 video frames per second. Therefore, the time code frame address returns to "00" after "29," at which point the seconds column advances.

Drop-Frame SMPTE

The American color video frame rate is approximately 29.97 frames per second (.03 frames per second fewer than black-and-white signals). This means that if 30 frame SMPTE code were used with color video signals, it would pick up an extra 0.03 frames every second. Over the course of an hour, this would be 108 frames or 3.6 seconds.

Drop-frame SMPTE code counts 30 frames-per-second and compensates for the added frames by "dropping" frames in a regular pattern.

25 Frame SMPTE

In European video, there are 25 video frames per second. Therefore, the time code counts 25 frames ("00" through "24") before the seconds advance.

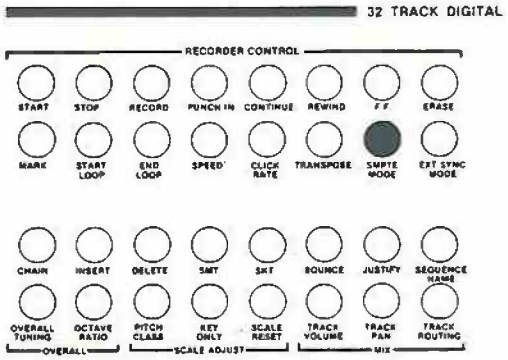
24 Frame SMPTE

In the film industry, the standard frame rate is 24 frames per second.

SMPTE MODE	FRAME SPEED	USE
30 Frame (Non-Drop)	30 frames/second	American black & white video
Drop-Frame	30 frames/second drops 108 frames/hour (effective speed= 29.97 frames/sec.)	American color video
25 Frame	25 frames/second	European video
24 Frame	24 frames/second	Film

ACTIVATING SMPTE

The SMPTE software is activated from the SMPTE MODE and EXT SYNC MODE buttons in the second panel.



To turn on SMPTE,

1. Press and hold the SMPTE button.

   The display window shows

   ```
   00:00:00:00.00
   SMPTE IS OFF
   ```

2. Press the EXT SYNC button.

   The display window shows

   ```
   00:00:00:00.00
   DROP FRAME SMPTE
   ```

   The upper display represents the SMPTE starting time in hours:minutes:seconds:frames.SMPTE bits. When this time corresponds to the running time of the incoming SMPTE signal, the memory recorder starts.

   The lower display represents one of the four SMPTE modes available on the Synclavier (R). You select the mode that corresponds to the signal to which you are synchronizing the Synclavier (R) (see below).

Hardware Messages

SMPTE Circuit Board

If you try to activate the SMPTE option without having the SMPTE circuit board installed in the computer, the display window shows

```
SMPTE OPTION IS
NOT IN SYSTEM
```

D16 Timer Board

The D16 Timer is required in order to activate SMPTE. If you try to activate SMPTE when the D16 Timer is not in the system, the error message

```
D16 TIMER NOT IN SYSTEM
```

appears in the display window.

Selecting a SMPTE Mode

Four SMPTE modes are available.

- Drop-Frame SMPTE (U.S. black & white video)
- Non-Drop (30 frame) SMPTE (U.S. color video)
- 25 frame SMPTE (European video)
- 24 frame SMPTE (Film)

To select the desired mode, activate SMPTE and press the EXT SYNC MODE button repeatedly. The bottom half of the display window steps through the four modes. Once a mode is selected, SMPTE code is generated and read in the selected format.

If the code received does not match the SMPTE mode, the display window shows

SIGNAL DOES NOT
MATCH SMPTE MODE

or

SMPTE ERROR

It is important to note the type of SMPTE code recorded in order to read the code correctly.

Setting the SMPTE Starting Time

The SMPTE starting time is the time at which the first click of a sequence starts. Code generated also begins with this starting time.

When you activate SMPTE, the starting time is displayed on the upper line of the display window.

You set the SMPTE starting time with the control knob. The ten-digit figure in the display window represents

[hours]:[minutes]:[seconds]:[frames].[bits]

When you turn the control knob, the starting time increases by SMPTE bits. Since a SMPTE bit is equal to 1/80th of a frame, the number to the right returns to 00 after reaching 79, at which point the second number from the right, the frame number, advances.

The frame number returns to zero after reaching 29, 24 or 23, depending on the selected SMPTE mode.

If you hold the SMPTE button while you turn the control knob, the starting time advances by whole seconds, making it easier to dial in large starting times.

SMPTE is a twenty-four hour system. Starting times may be set from 00:00:00:00.00 to 23:59:59:29.79. When generating SMPTE time code for large projects, you normally use the zero setting for the first reel of tape and set a starting time for each subsequent reel that corresponds to the end of each preceeding reel. When using SMPTE time code to drive the memory recorder, you set the starting time for the exact moment you want the memory recorder to begin to play.

You can set SMPTE starting times prior to zero. For example, if the video image began at 00:00:00:00.00 and you wanted music two minutes before the video began, you would dial in a SMPTE starting time of 23:58:00:00.00.

You can adjust the starting time while a sequence is playing. Small adjustments in SMPTE starting times can be used to precisely control the time relationships between sequences and taped tracks to provide the correct "feel".

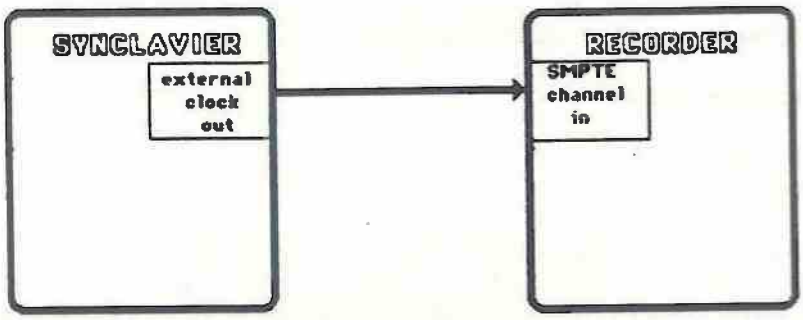
GENERATING SMPTE TIME CODE

The Synclavier (R) can generate SMPTE time code in any of the four modes listed above. The SMPTE signal is output through the EXTERNAL CLOCK OUT jack on the computer control panel.

Playback of the recorded signal is then received through the SMPTE IN jack on the Control Unit and used to synchronize the memory recorder for either recording or playback.

To record a SMPTE signal on tape, set up the Synclavier (R) and video recorder or tape recorder as follows:

- Synclavier (R) EXTERNAL CLOCK OUT to recorder SMPTE track input.



On a video tape, you record the SMPTE signal on the cue track. On an audio tape, record on an edge track (highest or lowest track number) if possible. Where track availability allows, leave a blank track between the SMPTE track and other recorded tracks to avoid cross-talk. Avoid recording percussive signals on tracks adjacent to the SMPTE track. Crosstalk from the percussion signals may affect the SMPTE code.

When the tape or video recorder and Synclavier (R) are set up, follow these instructions:

1. Activate the SMPTE feature by holding the SMPTE button and pressing the EXT SYNC MODE button.

2. Select the desired SMPTE mode as described above.

3. Set a SMPTE starting time. The time you select is the starting time of the generated code.

4. Place the recorder in the input or record mode (metering the input level).

5. Start the SMPTE generator by pressing and holding the SMPTE button while you press the START button.

   The display window shows

   SMPTE GENERATOR
   00:00:00:00

   As the SMPTE generator runs, the lower display advances by frames. Except for the STOP button, all control panel buttons and keyboard keys remain inactive while the generator is running.

6. Set the recording level on the tape recorder.

   On professional tape decks, a signal level of -10 dBvu is recommended with SMPTE when synchronizing at normal speeds. On semi-pro machines (narrower track formats such as half-inch or quarter-inch eight-track) a -3dBvu level is recommended. If you anticipate a playback at very slow speeds (for video spotting, for example), a higher signal level may be necessary to provide a better error margin.

7. Press STOP on the Synclavier (R).

8. Start recording on the tape recorder.

9. Restart the SMPTE generator by holding down the SMPTE button while pressing START, as before.

10. Record the SMPTE signal for a period of time equal to or greater than the duration of the sequence you intend to synchronize.

11. When you have recorded enough SMPTE signal, press the STOP button.

12. Stop the tape recorder and rewind the tape.

RECEIVING SMPTE TIME CODE

The Synclavier (R) reads time code in the plus-one-frame mode. In other words, it reads the incoming code and adds one frame, playing the sequence one frame ahead of the current code. Since the time code address is not acted upon until after all the information for that frame is read, the plus-one-frame mode is necessary for the time code display to be the same as the current time code address.

The Synclavier (R) can read SMPTE signals at rates as slow as approximately one frame per second (current SMPTE technology does not yet allow for still-frame reading). Reading time code at the slower speeds makes operations such as video spotting easily accomplished.

When the Synclavier (R) is in the SMPTE mode, the memory recorder does not start when you press START or RECORD. Instead, the Synclavier (R) waits until the designated SMPTE time code address is decoded by the computer.

Other buttons on the memory recorder panel, such as the FAST FORWARD and REWIND buttons, becomes entirely inactive, since these processes are controlled by the in-coming SMPTE signal.

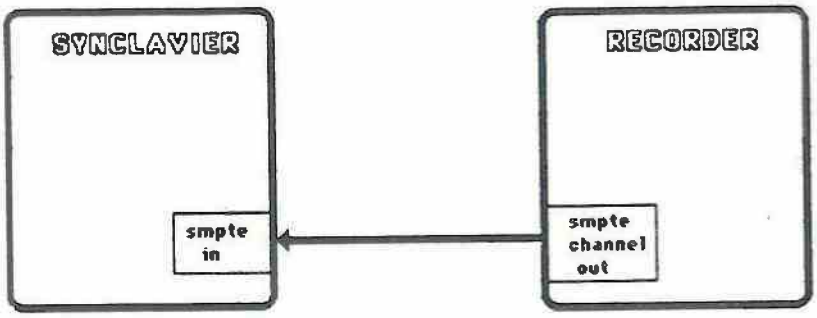
The MARK button also becomes inactive, but any mark start points remain in memory. The MARK button becomes active as soon as you de-activate SMPTE by pressing the SMPTE and EXT SYNC MODE buttons.

Synchronizing the Synclavier (R) to SMPTE Time Code

Once SMPTE time code has been recorded on tape, a sequence in the Synclavier (R) memory recorder can be synchronized to precise SMPTE cues. For example, if you set the SMPTE starting time to a SMPTE time code address such as 00:03:45:12.00, you are instructing the computer to wait 3 minutes, 45 seconds and 12 frames after the beginning of the SMPTE time code before starting the memory recorder.

You can use the SMPTE time code to trigger a sequence in the memory recorder or to record a new sequence. In either case, you connect the Synclavier (R) and recorder as follows:

- Recorded SMPTE track output to Synclavier (R) SMPTE IN.



Playing Back a Sequence On SMPTE Cues

To play back a sequence in the memory recorder, follow these instructions:

1. Activate SMPTE as before, by holding down the SMPTE button while you press EXT SYNC MODE.

2. Select the appropriate SMPTE mode, as described above. This must match the SMPTE mode stored with the sequence to be synchronized.

3. Use the control knob to set the SMPTE starting time. In general, there should be a pre-roll SMPTE signal for at least one second before the SMPTE starting time used for playback. For example, if the SMPTE signal recorded on tape starts at time 00:00:00:00.00, the starting time dialed in for playback should be at least 00:00:01:00.00 to provide precise synchronization of the first click.

4. Adjust the output level of the recorded SMPTE track. This level should match or exceed the level at which it was recorded.

5. Press START on the Synclavier (R). The START button lights up but the memory recorder does not begin to play. The system is waiting for the correct SMPTE time code address to be fed into the SMPTE IN jack.

6. Start the video or tape recorder. When the address on the SMPTE track matches the dialed-in SMPTE starting time, the sequence in the memory recorder starts to play.

If the time code address received by the Synclavier (R) is earlier than the memory recorder starting time, the memory recorder waits for the correct address.

If the tape recorder or video tape is fast forwarded to a time code address after the memory recorder starting time, the fast forward function on the Synclavier (R) automatically moves the memory recorder forward to the correct address.

Each time the tape recorder or video recorder is stopped, fast forwarded or rewound, the Synclavier (R) automatically synchronizes the sequence in the memory recorder to the correct SMPTE frame when the recorder starts to play again.

If the tape has been wound a long distance there may be a substantial lag time before synchronization takes place. This is because the memory recorder must read through the entire sequence to find the sync point, in order to maintain accuracy of real-time effects and other information.

Recording a Sequence on SMPTE Cues

Once SMPTE code has been recorded on tape, you record a sequence on the Synclavier (R) while using SMPTE synchronization using the following instructions:

1. Activate SMPTE and select the SMPTE mode that matches the mode of the incoming signal and dial in the desired starting time, as described above.

2. Press the STOP button to clear any previous functions.

3. Select the "repro" or "play" mode and adjust the output level of the SMPTE track on the video recorder or tape recorder to equal or exceed the level at which it was recorded.

4. Select a keyboard timbre for recording.

5. Press the RECORD button. The Synclavier is now ready to record on the selected track when the correct SMPTE time address is received.

   If you press a key on the keyboard, the display window shows

   ```
   WAITING FOR
   SMPTE SIGNAL
   ```

   This means that recording can only take place when SMPTE code is being received.

6. Start the tape playing. The SMPTE starting time is shown in the upper half of the display window while the running SMPTE time code is shown in the lower half.

   When the incoming code reaches the address set as the starting time, the memory recorder begins recording.

If you try to play any notes on the keyboard before the running SMPTE time code has reached the starting time, the display window shows

```
WAITING FOR
SMPTE SIGNAL
```

When you release the key(s), the display window becomes blank. To bring back the SMPTE displays, press the SMPTE button.

You cannot place overall loops on the sequence, since overall looping is incompatible with SMPTE. You can, however, use independent loops on individual tracks.

Storing SMPTE Information

When you store a sequence, the current SMPTE mode and starting time are automatically stored with it. When recalling a sequence that uses SMPTE, make sure that SMPTE has been activated before pressing START.

When you recall a sequence that has been stored with SMPTE information, you can change the stored mode to match a different incoming signal without affecting the sequence in any way. Starting times may also be changed.

Turning Off SMPTE

To leave the SMPTE mode:

1. Press and hold down SMPTE MODE while you. . .

2. . . .press EXT SYNC MODE.

The display window shows

```
00:00:00:00.00
SMPTE IS OFF
```

DRUM REPLACEMENT

DRUM REPLACEMENT

While in the EXTERNAL RETRIGGER mode, clock pulses received at the EXTERNAL CLOCK IN jack re-triggers the last note played on the keyboard. Each time a pulse is received, the note is triggered again.

Any percussive audio signal, conditioned through the CIM-1 Clock Interface Module or other audio-to-pulse converter and fed into EXTERNAL CLOCK IN of the control unit, can be used to drive this function. You can, for example, record a live drum onto tape and feed it through the CIM-1, using the resulting pulse to retrigger a Synclavier (R) sound.

It is possible to use this feature to replace or augment a recording of an acoustic percussion instrument with any of the timbres of the Synclavier (R).

Since the retriggering function has the lowest priority of the four EXTERNAL CLOCK IN functions, the remaining three functions must be disabled. The following functions must be set to their internal modes:

- EXT SYNC
- EXT CLICK
- EXT REPEAT

(See "Introduction" for summary of the methods for turning off each EXTERNAL CLOCK IN function.)

The following section describes the process of replacing or augmenting taped drum sounds with sounds from the Synclavier (R).

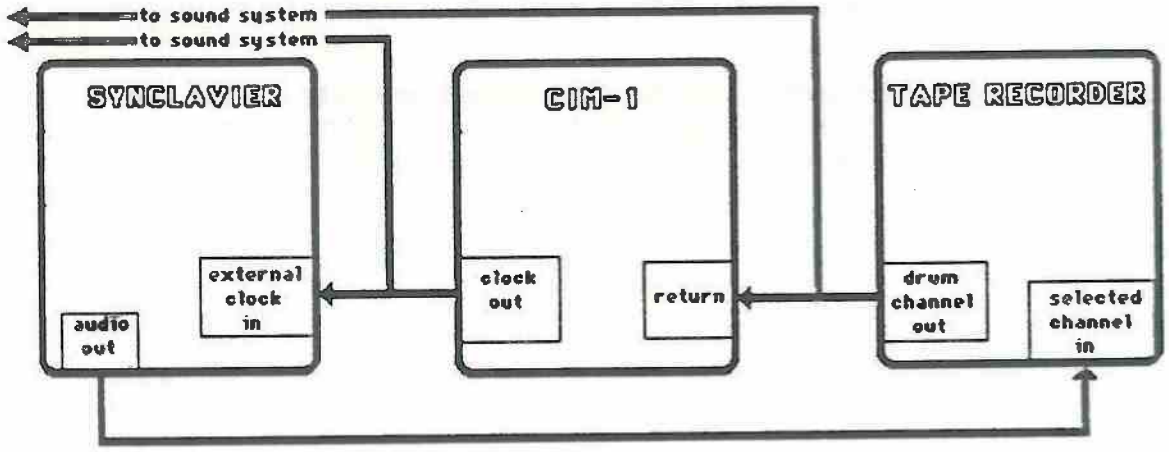
A minimum of two tape tracks is required for this procedure; and additional tracks are recommended.

The audio-to-pulse converter described here is the CIM-1 Clock Interface Module from New England Digital. Other converters may be used; the process is the same.

Setting Up the Equipment

Once you have recorded the live percussion track on tape, set up the Synclavier (R), CIM-1 and multitrack recorder as follows:

- Taped percussion track output of to CIM-1 RETURN.
- CIM-1 CLOCK OUT to sound system audio input (for verification of audio-to-pulse conversion.
- Taped percussion track output to sound system audio input (for comparison with pulse verify conversion)
- Synclavier (R) audio output to selected track of tape recorder.



Set up the CIM-1 as follows:

- Set the FUNCTION switch to LIVE TRACK.
- Set the RETURN LEVEL to zero (fully counterclockwise).

Converting the Percussion Attacks Into Digital Pulses

Once the connections are made and the CIM-1 controls set, you are ready to convert the drum hits into digital clock pulses.

1. Start the playback of the recorded percussion track.

2. Turn the CIM-1 RETURN LEVEL up slowly until the RETURN LEVEL LED lights on each percussion attack.

Listen to the pulses being generated, particularly in relation to the percussion attacks. If the pulses and OUTPUT STATE LED flashes do not correlate exactly with the percussion attacks, adjust the HOLDOFF control. If the LED lights more than once for a single attack, decrease the HOLDOFF; if it misses some attacks, increase the HOLDOFF.

You may need an external noise gate or, for tracks with a wide dynamic range, an external gate with a limiter.

Replacing the Taped Percussion Sound

When you have ascertained that each percussion attack reliably triggers a digital clock pulse, you are ready to replace the taped percussion sound with a timbre from the Synclavier (R).

1. Connect the CIM-1 CLOCK OUT to the Synclavier (R) EXTERNAL CLOCK IN.

2. Select the timbre you want to use for replacement or augmentation.

3. Activate the retriggering function by holding EXT SYNC MODE and pressing START.

   The display window shows

   EXT TRIGGER: ON

4. Play a single note or chord on the keyboard.

5. Rewind the tape and start the playback of the recorded drum sound.

Each trigger pulse received by the Synclavier (R) EXTERNAL CLOCK IN triggers the most recently played note or chord. Thus the single note is retriggered again and again until the recorded drum track ends.

Recording the New Percussion Sound to Tape

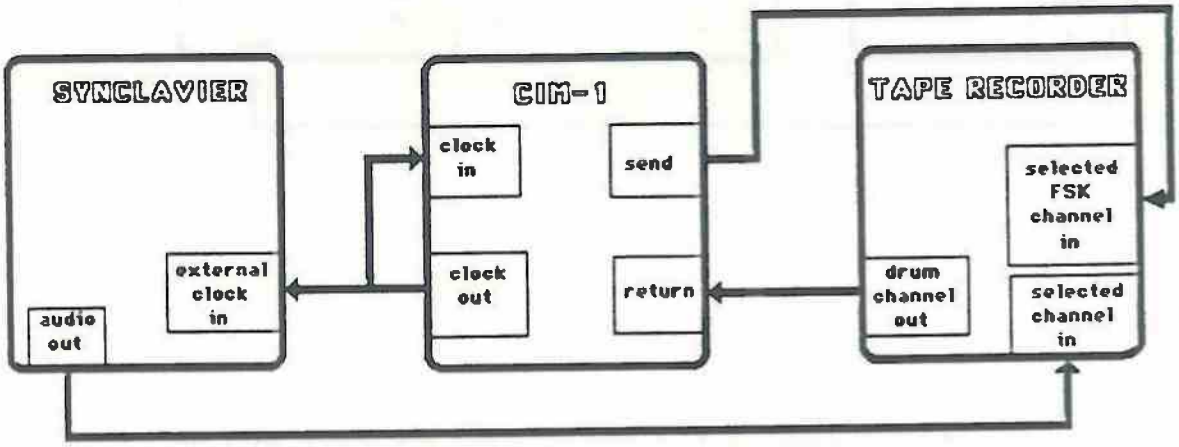
You can record the converted percussion sound directly to tape by connecting the audio output of the Synclavier (R) to the selected input channel of the tape recorder as shown in the diagram above.

You can simultaneously record FSK encoded percussion pulses on the tape recorder. To do this, add the following connections to the set up described above:

- Using a Y-connector or patch bay tie line, send the CIM-1 CLOCK OUT to both the Synclavier (R) EXTERNAL CLOCK IN and the CIM-1 CLOCK IN.
- Connect CIM-1 SEND to the selected tape track input.

  This is the encoded FSK signal. (See the section "Conditioning Sync Signals" above.)

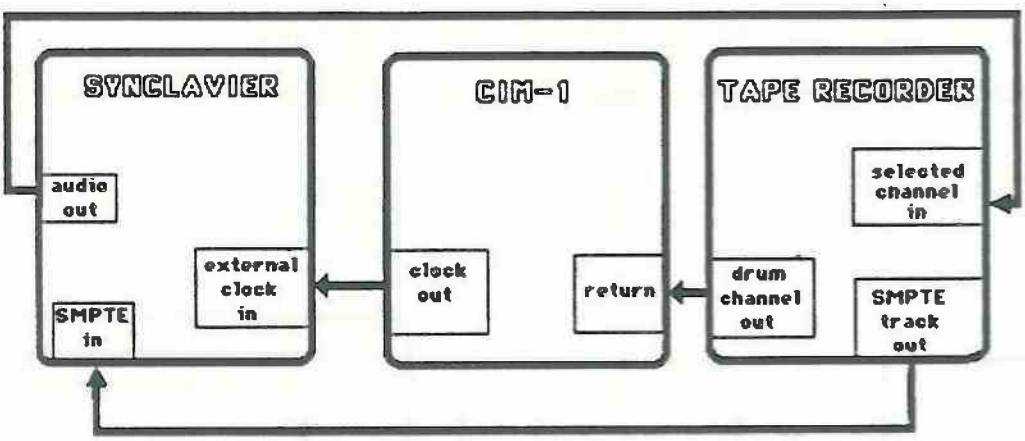
Tape playback should be in the "sync" mode (monitoring the record head) so that the attacks are recorded in sync with the rest of the tracks.



Recording the New Percussion Track into the Memory Recorder

You can also record the Synclavier (R) output directly into the memory recorder. If you do this, you should use SMPTE synchronization so that the new drum track precisely matches other music recorded on tape.

Set up the Synclavier (R), the CIM-1 and the tape recorder as follows:



Then follow these instructions:

1. Press the SMPTE button, select the appropriate SMPTE mode and dial in the desired starting time.

2. Record a SMPTE track as described above and connect the SMPTE track output to the Synclavier (R).

3. Rewind the tape and place all taped tracks in the "Repro" mode (monitoring the Play head).

4. Press the Synclavier (R) RECORD button.

5. Start the tape in the playback mode.

Sync Delay

There may be times when you want to delay the response of the Synclavier (R) to the incoming sync pulse. This might be to correct the delay between the click pulse and the actual sound sent from a taped track or from certain drum machines. Or you might want the special effect of the Synclavier (R) lagging behind the incoming signal.

When you first select the External Beat Sync mode, the upper half of the display window shows a number representing the current sync delay (0.00 by default). You can dial in any sync delay from 0.0 to 75.0 milliseconds.

EXTERNAL CLICK TRACKS

You can use a sync pulse or percussive signal from an external source to control the click while recording on the Synclavier (R).

Using a timing interface module such as the CIM-1 Clock Interface Module, you can control the click with a sync signal or percussive audio track recorded on tape. Pulses controlling the external click tracks are received through the EXTERNAL CLOCK IN jack.

For example, you might feed a track from a drum machine through the CIM-1 into EXTERNAL CLOCK IN and use that sound as a click track while recording a sequence into the memory recorder. Or you might synchronize your recording to a live drum sound recorded on a tape recorder and fed through the CIM-1 into EXTERNAL CLOCK IN.

You could also record either of these signals onto a track in the memory recorder and then use that track as a click track to synchronize additional tracks recorded into the memory recorder.

An external click track is useful when recording new rhythm tracks into the Synclavier (R) using SMPTE synchronization. For example, if you had recorded several musical tracks, a click track and a SMPTE track on tape, you could create additional tracks in the Synclavier (R) that precisely matched the tempo on tape. This method would be particularly useful if the original tracks recorded on tape used more than one tempo.

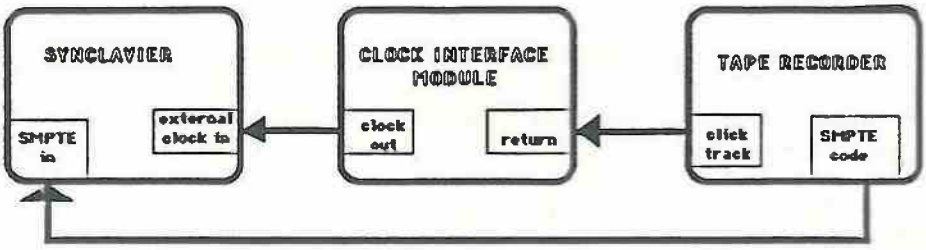
The EXTERNAL CLICK function has second priority of the EXTERNAL CLOCK IN functions. When using an external click, be sure that the EXT SYNC MODE button is set to internal synchronization (see "Introduction").

Creating an External CLick Track

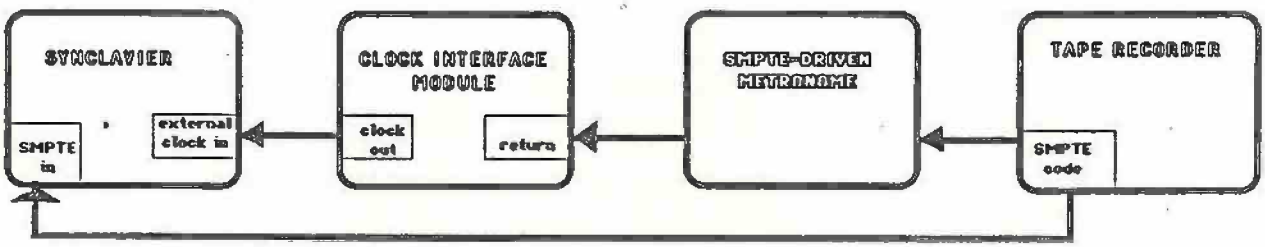
An external click track can be created using

- a live click or percussive sound that has been recorded on tape and conditioned using a timing interface module such as the CIM-1;
- a SMPTE-driven metronome that generates a click track from SMPTE time code recorded on tape;
- a drum machine or sync box that generates a trigger pulse based on a sync signal such as FSK recorded on tape;
- any TTL standard trigger pulse (2 volts or more).

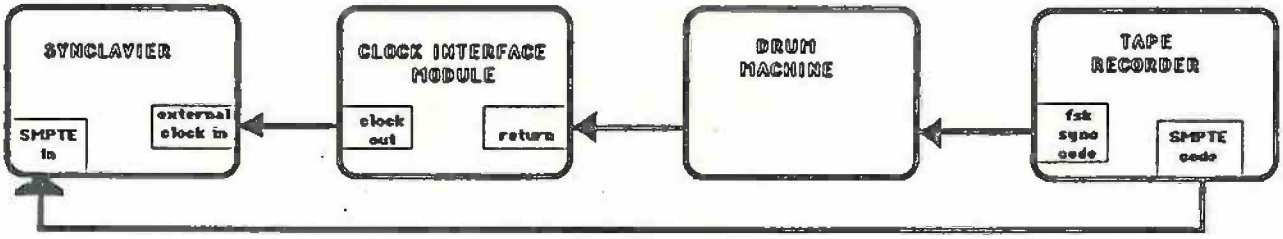
Each of these external trigger pulses can be fed into the EXTERNAL CLOCK IN jack. The three diagrams on the following page show how to set up the equipment for each type of external click.



Click Recorded on Tape



Click Generated By a SMPTE Metronome



Click Track Generated by a Drum Machine or Sync Box

Recording to an External Click

To record using any of the external click tracks shown above, follow these instructions:

1. Connect the external click to the EXTERNAL CLOCK IN jack as shown in the diagrams. The Clock Interface Module or other pulse conditioner is necessary to create a 10-millisecond trigger pulse.

2. Turn on SMPTE, select the appropriate SMPTE mode and set the SMPTE starting time.

3. Activate the external click mode by pressing the CLICK RATE button and holding it down while you. . .

4. . . .press the EXT SYNC MODE button.

   The display window shows

   EXTERNAL CLICK

   The internal click track disabled. Each pulse received at the EXTERNAL CLOCK IN jack produces a click when recording.

5. Place the Synclavier (R) in the justified recording mode by pressing the BOUNCE button twice to make it blink.

6. If desired, set the click rate multiplier by holding the BOUNCE button while you turn the control knob.

7. Press RECORD. The memory recorder does not start recording until the SMPTE signal is received through the SMPTE IN jack.

8. Start the SMPTE signal.

9. Start the external click.

10. Start recording on the Synclavier (R). The recorded notes are precisely justified to the external click track.

11. When you are finished recording the first track, stop the memory recorder, the SMPTE signal and the external click.

Playing Back a Sequence Recorded To an External Click

To play back the sequence, make sure the Synclavier (R) is still in both the SMPTE mode and the external click mode. Then follow these instructions:

1. Press START. The memory recorder waits for the SMPTE signal.
2. Start the SMPTE signal.

The sequence plays back synchronized to the external clicks (which are not be heard now) and SMPTE.

To return to the internal click track mode,

1. Press CLICK RATE and hold it down while you. . .
2. . . .press EXT SYNC MODE.

   The previously used internal click rate, such as

   120.0 BEATS/MIN

   appears in the display window.

Recording an External Click Track Into the Memory Recorder

You can record any of the previously described external clicks onto a track of the memory recorder. You may find this advantageous when recording in the justified mode since the computer is then able to make more intelligent choices for the justification.

Recording an external click track into the memory recorder uses the retriggering function of external synchronization. It is identical to the method of drum replacement described in the preceding section, "Drum Replacement."

Set up the Synclavier (R), the CIM-1 and the source of the external click (the multitrack recorder, the SMPTE-driven metronome or the drum machine) as shown previously. Then follow these instructions:

1. Select the timbre you want for the click track.

2. Make sure the following are set to their internal functions:

   - external synchronization,
   - click,
   - repeat/arpeggiate rate.

3. Turn on SMPTE, select the appropriate SMPTE mode and select a SMPTE starting time.

4. Turn on the retriggering function by pressing EXT SYNC MODE and START.

   The display window shows

   EXT TRIGGER: ON

5. Play a single note (or chord) on the keyboard.

6. Press RECORD.

7. Start the SMPTE signal source.

8. Start the external click source.

   If the Synclavier (R) audio outputs are connected to the sound system, the last-played note or chord sounds each time a pulse is received from the external click source.

9. When the external click has been recorded onto the memory recorder track, press STOP.

10. Turn off the SMPTE source.

11. Turn off the retriggering function by holding EXT SYNC MODE and pressing STOP.

Using the Recorded Click Track to Synchronize the Memory Recorder

Once you have your click track recorded in the memory recorder, you must direct the Synclavier (R) to use the recorded track to control the click instead of using the internal click. To do this, follow these instructions:

1. Press CLICK RATE and hold it down while you. . .

2. . . .press the appropriate TRACK SELECT button.

   The message

   CLICK:TRACK [number]

   appears in the display window.

3. Press TRACK VOLUME and and hold it down while you. . .

4. . . .press the same TRACK SELECT button.

   The display window shows

   TRK [number] VOL:100.0

5. Use the control knob to set the track volume at zero.

When you press START or RECORD, the Synclavier (R) emits a click for every note recorded on the selected track. The click numbers in the lower half of the display window follows the click track. The original recorded sound is not heard.

Leaving the EXTERNAL CLICK Function

You can return to the internal click by following these instructions:

1. Press CLICK RATE and hold it down while you. . .
2. . . .press the appropriate track button under track select.

   The previously set internal click rate, such as

   120.0 BEATS/MIN

   appears in the display window.

TRIGGERING THE REPEAT/ARPEGGIATE FUNCTION

You can trigger the repeat/arpeggiate function from an external signal received through the EXTERNAL CLOCK IN jack.

The EXTERNAL REPEAT function is third priority external sync function. Be sure the EXTERNAL SYNC and EXTERNAL CLICK modes are disabled.

To activate EXTERNAL REPEAT function, follow these instructions:

1. Recall the desired timbre to the keyboard.

2. Press the repeat/arpeggiate RATE button (in the fourth panel under KEYBOARD CONTROL). Hold it down while you. . .

3. . . .press EXT SYNC MODE. This directs the Synclavier (R) to use the signal coming in through the EXTERNAL CLOCK IN jack for the repeat/arpeggiate function.

4. Press REPEAT or ARPEGGIATE or both, as desired.

5. Feed an appropriate trigger pulse into the EXTERNAL CLOCK IN jack. Use the Clock Interface Module or other source to generate a suitable pulse. A 10-millisecond pulse is suggested.

When a note or chord is played on the keyboard, no sound is heard right away. Instead, the Synclavier (R) waits until the next clock pulse is received and then plays the note on time.

To return to the internal sync mode, follow these instructions:

1. Press the repeat/arpeggiate RATE button and hold it down while you. . .

2. . . .press EXT SYNC MODE.

Using the External Repeat/Arpeggiate with the Memory Recorder

The use of an external clock pulse for the repeat/arpeggiate function is designed primarily for use in live performances or when recording to tape. However, it can be used with the memory recorder provided SMPTE synchronization is also used. You need a SMPTE metronome or some other source of SMPTE and trigger pulses that are synchronized.

To control the Repeat/Arpeggiate rate in this way, follow these instructions:

1. Feed the trigger pulse into the EXTERNAL CLOCK IN jack.
2. Feed the SMPTE time code into the SMPTE IN jack.
3. Record into the memory recorder using SMPTE.
4. Feed the repeat arpeggiate pulses into the Synclavier (R) during playback as well as record.