II. CLOCK INTERFACE MODULE (CIM-1) SETUP

PREFACE

The New England Digital CIM-1 Clock Interface Module is designed to solve many problems encountered while interfacing the Synclavier (R)'s synchronizing circuits with tape machines and other synchronous devices. The CIM-1 is a single-rack-space (1-3/4 inch) unit and operates from 110 VAC power. All controls and connectors are on the front panel. The CIM-1 may be integrated into an existing Synclavier (R) Control Unit or mounted in a separate equipment rack.

The CIM-1 uses FSK (frequency shift key) technology to print clock signals to tape at least 10 db below nominal tape operating level. Digital clock frequencies from DC to 1 kHz can be fed into the unit and then converted into FSK signals which can be reliably recorded on and recovered from tape. Tape send and return level controls are provided on the front panel to aid in setup. The tape interface circuits can be operated either balanced or unbalanced, and ground-lift switches are provided.

A four-position FUNCTION SWITCH provides a convenient method of selecting from operating modes. Three positions of the switch - CONDITION, DECODE, and LIVE TRACK - provide a "conditioned" output at the CLOCK OUT jack. This conditioning guarantees the 5-volt, 10-millisecond pulses required for the EXT.SYNC. function on the Synclavier (R). Select CONDITION to condition digital clock pulses, select DECODE to condition decoded FSK signals from tape, and select LIVE TRACK to condition other analog signals, such as trigger pulses from a drum machine. The fourth position of the switch - BYPASS - sends the digital CLOCK IN input directly to the digital CLOCK OUT output.

In addition to the FSK tape interface and the CLOCK IN/CLOCK OUT circuits, the CIM-1 contains an independent Pulse Divider circuit which can be used to divide down the higher clock rates used on many other synthesizers and drum units. Six simultaneous outputs are provided and divisors from 2 to 768 are available.

As there are undoubtedly many ways the CIM-1 may be used with other equipment, no attempt will be made here to describe them all. The tabbed section "Studio Interfaces" includes several typical applications. However, only through experimentation will you discover the best way to use the CIM-1 with your particular configuration of equipment.

INPUTS

The CIM-1 has two digital inputs: CLOCK IN and DIV IN (the input to the Pulse Divider). Both are identical circuits; 5 volt positive logic is expected, and the rising edge of each clock pulse is used. Input filtering is provided (as clock rates in excess of 1 kHz are not expected), and the inputs are diode-protected to +/-15 volts.

The RETURN input is a balanced, diode-protected analog circuit band-limited at 200 Hz to 7 kHz (approximately). To operate this circuit unbalanced, connect signal hot to pin 2 and connect pin 3 to ground, or vice versa. Pin 1 is connected via the ground-lift switch to internal ground.

NOTE: The "earth" pin on the AC receptacle is internally connected to ground. Should it become necessary to lift this connection, it is best to do this at the male end of the AC line cord, with a suitable adapter. Please contact New England Digital if further difficulties are encountered.

OUTPUTS

The CIM-1 has seven digital outputs: CLOCK OUT and the six Pulse Divider outputs. All are identical circuits with 5 volt positive logic. All have diode protection against driving voltages in the range of -5 to +15 volts. Protection is not guaranteed when more than one of these outputs is connected to driving voltages in this range.

The OUTPUT STATE LED, which indicates the instantaneous state of the CLOCK OUT output, is driven by an independent source before the CLOCK OUT Driver.

The SEND output is electronically balanced, and contains no protection circuitry. The following connection methods are permitted:

Balanced:	Pin 2 & 3 = Signal	Pin 1 = Ground or Lift (via switch)
Unbalanced:	Pin 2 = Signal	Pin 1 or Pins 1 & 3 = Ground
	-or-	
	Pin 3 = Signal	Pin 1 or Pins 1 & 2 = Ground

All pins on the SEND output connector may be shorted to ground indefinitely.

Under normal operation, the SEND output should always consist of either a 2.4 kHz (low state) or a 4.8 kHz (high state) tone, provided that the SEND LEVEL control is not set to minimum. The signal is bipolar with respect to ground on both pin 2 and pin 3.

INTERNAL CIRCUITRY

The various sections of the unit which are shown on the block diagram on the following page will now be described.

CLOCK RECEIVER

The Clock Receiver provides the filtering and protection described above under "Inputs," and converts the input to a TTL-compatible signal. The output from the Clock Receiver always goes to the FSK Encoder. It also goes to the Function Switch where it is sent to the Clock Out Driver directly (BYPASS mode) or to the Clock Out Conditioner and then to the Clock Out Driver (CONDITION mode).

FSK ENCODER

The FSK Encoder is fed uniquely from the Clock Receiver. Its output is fed to the SEND output jack and always consists of the FSK-encoded form of the instantaneous state of the CLOCK IN input. There are no delays on state changes.

ANALOG RECEIVER

The Analog Receiver accepts any audio signal in the range of 200 Hz to 7 kHz and makes a direct conversion to TTL level. The converted signal is then fed to the FSK Decoder and to one pole of the Function Switch (for LIVE TRACK mode).

The RETURN LEVEL LED lights when sufficient level is received to provide a reliable digital pulse. When using the DECODE mode, this level control may be set at maximum.

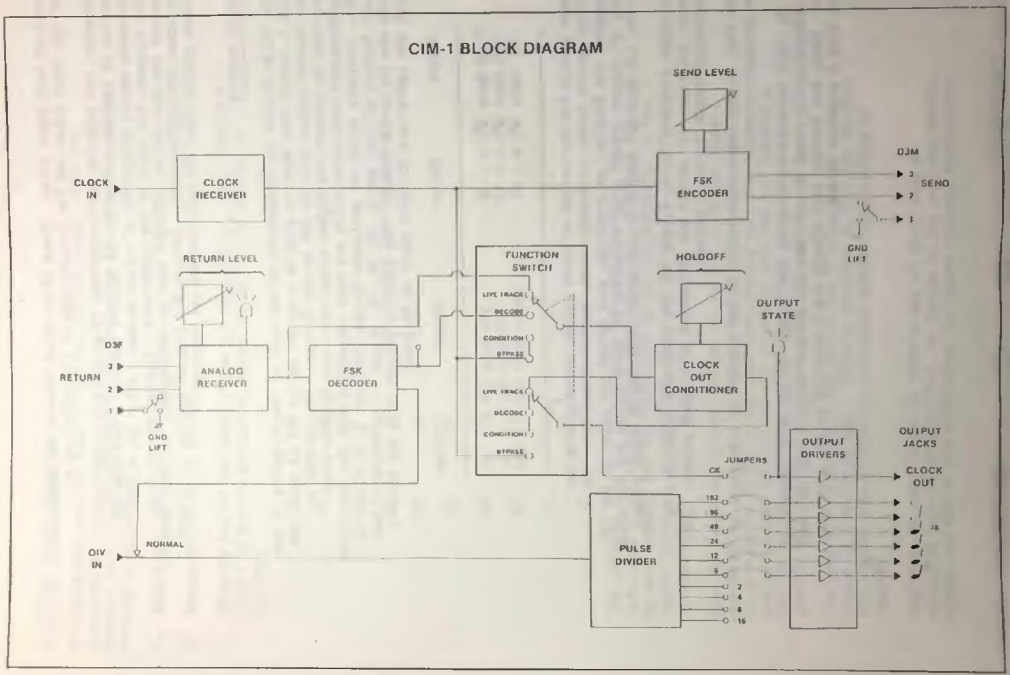
FSK DECODER

The TTL pulses delivered by the Analog Receiver are sent to the FSK Decoder where the two FSK frequencies are converted into their corresponding logic levels. The high tones are converted to logic 1 and the low tones are converted to logic 0. Due to the decoding process, all state changes are subject to a delay of up to 500 microseconds. This is the maximum system delay. The output of the Decoder is sent to the Clock Out Conditioner (in the DECODE mode) and is normalled to the DIV IN jack as well.

If desired, the output from the Decoder can also be routed directly to an output driver.

CLOCK OUT CONDITIONER

The Clock Out Conditioner receives its input from the Function Switch. It outputs a 10 millisecond, 5-volt pulse at the leading


CIM-1 BLOCK DIAGRAM
SEND LEVEL
CLOCK IN
CLOCK RECEIVER
FSK ENCODER
DJM
SEND
GND LIFT
RETURN LEVEL
FUNCTION SWITCH
HOLDOFF
OUTPUT STATE
DSF
RETURN
ANALOG RECEIVER
FSK DECODER
CLOCK OUT CONDITIONER
GND LIFT
JUMPERS
OUTPUT DRIVERS
OUTPUT JACKS
CLOCK OUT
OIV IN
NORMAL
PULSE DIVIDER

edge of each input pulse. There is no delay between the leading edge of the input pulse and the leading edge of the output pulse.

However, the input to the Conditioner is always masked off for a period of time determined by the HOLDOFF setting. This masking prevents double triggering of output pulses. After the HOLDOFF time has elapsed, the input to the Conditioner is again opened up to accept the next pulse. HOLDOFF time is continuously variable from 15 to about 250 milliseconds. Contact New England Digital if holdoff times greater then 250 milliseconds are required.

PULSE DIVIDER

The Pulse Divider is independent of the rest of the circuitry in the CIM-1, except that when no plug is inserted in the DIV IN jack, the the Decoder output will be fed to the Divider. The Divider is provided to convert the higher clock rates used by many other synthesizers into rates which are more compatible with the Synclavier (R). Divisors which are available in the CIM-1 are 2, 4, 8 and 16 (all factors of two) and 6, 12, 24, 48, 96 and 192 (factors of two with one factor of three). The CIM-1 is shipped from the factory with the latter six divisors wired as follows:

Output	Divisor	Output	Divisor
1/32 Note (𝅘𝅥𝅯)	: 6	1/4 Note (♩)	: 48
1/16 Note (♪)	: 12	1/2 Note (𝅗𝅥)	: 96
1/8 Note (♪)	: 24	Whole Note (𝅝)	: 192

These permit the derivation of clock pulses corresponding to thirty-second notes, sixteenth notes, eighth notes, etc. For example, the Divider, as prewired, will output one pulse to the 1/4 Note (♩) Output Driver after receiving 48 input pulses and one pulse to the 1/8 Note (♪) Output Driver after receiving 24 input pulses.

The other divisors (2, 4, 8, and 16) are available internally by jumper selection and permit the derivation of triplet pulses. (See "Rerouting Output Signals" below).

Note that in all cases pulse width at the outputs is a function of the divisor number.

If no input pulse is received by the Divider within four seconds, it is automatically reset to zero and all divider outputs will be reset low. Thus, the Divider will always start counting pulses from zero each time a sequence is begun.

REROUTING OUTPUT SIGNALS

The CLOCK OUT jack and each of the six Divider output jacks are hardwired to output driver circuits. The inputs to these drivers, however, are jumper selectable. The procedure to change this signal routing is as follows:

1. Remove the power cord to the CIM-1.

2. Remove the cover (4 screws).

3. Directly behind the jack labeled 1/4 Note (♩) = : 48, observe a 20-pin IC socket containing jumper wires. It is labeled as follows:

6	𝅘𝅥𝅯	
12	𝅘𝅥𝅮	
24	𝅘𝅥	
CK	CK	Hardwired to Output Drivers
192	𝅝	
96	𝅗𝅥	
48	♩	
NC	NC	
4	2	
8	16	

The numbered pins are the outputs from the Divisor. The left-hand CK pin is the output from the clock. The pins labeled by note symbols and the right-hand CK pin are hardwired to the Output Drivers. In addition, there are two pins labeled NC (no connection).

You may jumper any Divisor output to any Output Driver input. For example, to change the Whole Note (𝅝) Output Driver so that it provides a divide-by-two function, merely pull the jumper wire out of the pin labeled 192 and insert it into the pin labeled 2. Now the pulses coming out of the Whole Note jack will be at exactly half the rate of pulses going into the Divider.

The long wire between R18 and one of the NC pins contains the output of the FSK Decoder. This is provided so that the decoded FSK signals can be directly outputted without conditioning if desired.

CAUTION: Do not attempt to connect any of these pins to circuitry outside of th) CIM-1, or damage to the unit may result. Always use #22 or #24 solid wire, to assure reliable connections

and to prevent damage to the pins. Bare wire is not recommended, due to the possibility of damage due to shorts.

OTHER CONSIDERATIONS

Interfacing the Synclavier (R) with a tape machine is a straightforward matter. When interfacing with other synthesizers, sequencers or drum machines, however, numerous other factors may need to be taken into account. Some of these factors are mentioned below. In some cases, special circuitry may need to be constructed, but for most applications, problems which are not solved by the CIM-1 can be solved by other devices on the market. Consult New England Digital if difficulties are encountered.

Rising or Falling Clock Edges

As described earlier in this manual, circuits in the CIM-1, such as the Clock Out Conditioner, the Holdoff, and the Divider, are rising-edge sensitive. This means that the triggering voltage in these circuits is normally low, and at the moment the voltage goes high, the output or the state of the rest of the circuit changes. Most of the synthesizers currently available are rising-edge sensitive, but some have inputs which trigger on the falling edge of the clock signal. A "conditioned" pulse from the CLOCK OUT of the CIM-1 would trigger such a synthesizer 10 milliseconds late. Consult New England Digital if this problem is encountered.

Pulse Width

Partly to minimize the problem just described, many manufacturers provide a fairly short pulse width at their synchronizing clock outputs, often 1 millisecond or less. Thus, both rising and falling clock edges are quite close together, and the synchronizing delay is generally insignificant (on the order of 1 millisecond). Because the Synclavier (R) EXT.CLOCK INPUT is not edge-sensitive, pulses this short will have to be lengthened. This function is performed by the CIM-1 Conditioner circuit.

Microprocessor Delays

All computerized musical devices are subject to delays between the time a clock signal is received and the time the computer acts on the sequencer. While the Synclavier (R) is sufficiently fast to keep these delays below 5 milliseconds, many instruments which are designed around a microcomputer may generate much longer delays. In order to maintain synchrony with other tracks on a tape, or in live synchronization, clock signals to the faster machines may need to be delayed by an appropriate amount. When other tracks are already recorded on tape, the sync track for the slower machine may need to be ahead of the other tracks. This can be accomplished by turning the tape over, sending the sync track through a delay line and re-recording on another track. This bounce can be performed on an FSK-encoded track directly, without having to decode it.

System Clock Voltages

The CIM-1 and most synthesizers operate their clock circuits in the 0- to 5-volt range. Some, however, have clock outputs as high as 15 volts, and require 15-volt signals at their clock inputs. As described above in "Inputs and Outputs," injection of a 15-volt signal into any of the 1/4-inch jacks on the CIM-1 will cause no damage, and the inputs should operate properly on such a signal. The CIM-1 outputs are not capable of generating 15-volt signals, however, so this problem will have to be solved in some other manner. We recommend that you solve this problem by converting the unit requiring 15-volt input to 5-volt operation.

Note: The EXT.CLOCK INPUT on the Synclavier (R) is susceptible to damage from voltages greater than 5 volts, so it is highly recommended that all 15-volt clock signals fed into this input be padded down to 5 volts to avoid potential damage.

Clock Ratios Other Than 48 to 1

In the manual "External Synchronization" in the tabbed section "Studio Interfaces," we describe how to use a Linndrum, which requires a clock input rate of 48 pulses per quarter note. If you want to use a unit which runs on 96 pulses per quarter note, you must the 1/2 Note (𝅗𝅥) output jack to obtain quarter note pulses, since this output is internally jumpered to "divide by 96." Also, sixteenth note pulses are available at the 1/8 Note (♪) jack when operating from this clock. You can also jumper the "divide by 2" output from the Divider to some unused output driver in the CIM-1, to run the Linndrum with a 48-pulse clock simultaneously. Many combinations are obviously possible.

For further information on any aspect of the CIM-1, contact the Customer Service Department at New England Digital.

CIM-1 FINAL TEST

If you have doubts about whether the CIM-1 is working correctly, you may perform the following factory test.

1. Connect the SEND output to the RETURN input with a standard mike cable. Set the SEND LEVEL control to maximum and the RETURN LEVEL control to minimum. Verify that the RETURN LEVEL LED lights when the RETURN LEVEL control is brought up to about 9 o'clock.

2. Next, set the SEND LEVEL control to minimum and the RETURN LEVEL control to maximum. Verify that the RETURN LEVEL LED lights when the SEND control is brought up to about 9 o'clock. Make sure that the mike cable is in place and that the RETURN LEVEL LED is on for the following tests.

   a. Set the FUNCTION SWITCH to LIVE TRACK. Connect the CLOCK OUT of the CIM-1 to the CLOCK IN of the Synclavier (R). Set the HOLDOFF control to "15 ms" (maximum clockwise). Call up a justified sequence, and first play it in the "non-sync" mode. Then press the EXT. SYNC button on the Synclavier (R) once to put the system in the "50 Hz sync" mode. The sequence should speed up slightly, and you should be able to govern the speed of the sequence with the HOLDOFF control.

   b. Now set the HOLDOFF control so that it is generating pulses at a rate that is appropriate for the current sequence click rate. Press the EXT. SYNC button a second time to put the Synclavier (R) in the "beat sync" mode. Once again, the speed of the sequence playback should be variable with the HOLDOFF control, and should be completely reliable for all settings. Verify that the OUTPUT STATE LED lights once for each clock pulse coming from the CIM-1 CLOCK OUTPUT.

3. Connect an oscillator at 48 Hz to the CIM-1 CLOCK IN (1/4" phone). Connect the "1/4 note = :48" jack on the CIM-1 to the click track input of the test monitor (speaker) system. Verify that you hear quarter notes, at a 120 bpm rate. Check each of the other 5 outputs in a similar fashion, to verify that the appropriate rate is coming out.