Adjustment Procedure
For
The 4020/SL Drive

Adjustment Procedure for the 4020/SL Drive

8.0 Introduction

This manual will discuss step by step, the procedure in adjusting the Serial Load card (690D1110) with the 4020 amplifier. At certain test points on the SL card, you will be shown the proper waveform displayed on the oscilloscope and what effect the adjustment of the pots on the 4020 amplifier have on these test points.

8.1 Equipment

The equipment need to perform the adjustments on the 4020/SL drive are as follows:

Oscilloscope (Dual trace)

Digital Multimeter
(Fluke Model 8021 B or Equivalent)

Clock Generator

Assorted Hand Tools

The Clock Generator may be a tester that inputs clock and direction into the remote connector of the SL card or may be included in the chassis in which the drives share with the Model 20 or Model 10 Indexer.

8.2 SL Card Adjustments

There are 5 adjustments that can be made to the SL card. Each pot has the following function:

R8 is the Slew Clock adjustment. The SL card has an internal oscillator which is used to clock the card in the local mode. This clock is also used to generate the clock in the home cycle. This clock is used in the home cycle, even though the SL card is jumpered in REMOTE mode of operation. Rotating the Slew pot clockwise increases the frequency of the Slew clock. C1's value sets the maximum frequency of the Slew oscillator (which is 50KHz Max).

R21 is the Marker Balance pot. This pot is used if the encoder on the motor only outputs the Marker signal with no corresponding $\overline{\text{Marker}}$ signal. The $\overline{\text{Marker}}$ signal on this encoder is set by resistor for a level of +2.5V. The Marker Balance pot shifts this bias so that the proper marker width is obtained at TP4 with respect to TP3 (Cos). Refer to Encoder Manual for more details on the encoder signals.

R55 is the Sin Lock Pot. When the SL card is "In Position" or the counters on the SL card have a count of Zero, the SL card outputs to the 4020 amplifier a smaller amplitude portion of the Sin signal present at TP2. This signal is used to prevent the motor from drifting away from the commanded position. This pot adjusts the amplitude of the Sin signal being outputted to the 4020 Amplifier.

R59 is the Analog Balance pot. The pot's function is dependant on the location of the jumper in pads 20,21, and 22. If the jumper is inserted in pads 21 and 22, this pots adjusts for 0 mV when the SL card is at Count Zero (CZ) or the drive is "In Position". If the jumper is inserted in pads 20 and 22, then this pot adjusts the output of the D/A at TP5 for +10 mV after the SL card has been commanded to take 1 step CCW.

R72 is the Sign Symmetry pot. This pot's function is inverse of the function of the Analog Balance pot R59. If the jumper is inserted in pads 21 and 22, then the Sign Symmetry pot adjusts for +10 mV with the 1 step CCW command. If the jumper is installed 20 to 22, then the Sign Symmetry pot adjusts for 0 mV when the card is at CZ or "In PSN".

8.2.1 D/A Adjustment

This adjustment can be made with either the oscilloscope or the digital multimeter. It is recommended that the digital multimeter is used, since the accuracy of the adjustment is more exact with the multimeter.

STEP

1) Connect the clock generator to the 4020/SL drive if no indexer is used.

2) Jumper the SL card into ½ step mode by inserting a jumper in pads 18 and 19 or by connecting the pins 5 or 6 of M10 to ground. If your system is configured in the ½ step mode, proceed to Step 3.

3) Turn the Sin Lock pot R55 full CCW.

4) Remove the motor fuse in the 4020 amplifier to open the current path to the motor. This can also be done by jumpering TB1-6 to TB1-8 on the 4020 amplifier.

5) Connect the leads from the oscilloscope or meter to TP1 and TP5 of the SL card. The ground lead is connected to TP1 of the SL card and the input lead is connected to TP5 of the SL card.

6) Apply 115VAC to the 4020/SL drive or chassis.

The adjustment procedure to be followed is dependant of the location of the jumper that is installed in pads 20,21 and 22. If the jumper is located in pads 20 and 22, proceed to Procedure A. If jumper is installed in pads 21 and 22, then use Procedure B.

Procedure A: Jumper is installed in pads 20 to 22.

STEP

7) Press reset to set the counters on the SL card for a zero count. The L.E.D. on the Front panel (if present) will be lit.

8) Set the direction switch on the Front panel of your chassis or tester for the counterclockwise direction. (The Direction switch is the second switch from the left and will be locked in the "In" position.)

9) Dial 00001 in the thumbwheel switch assembly on the chassis front panel.

10) Press the "Execute" button on the Front panel switch assembly. This is the first switch on the left (next to the direction switch).

11) Measure the voltage at TP5 on the SL card with an oscilloscope or digital multimeter. The ground lead of the oscilloscope or meter to TP1 of the SL card. The input lead of the oscilloscope or meter to connect to TP5 of the SL card.

The oscilloscope will have a band of fuzz when set at 10 mV per division or lower. This band of fuzz should be centered on the voltage directed by the procedure. If a digital meter is used, the voltage should be adjusted to within ±0.1 mV of the voltage requested in the procedure.

12) With a one step counterclockwise command executed from the Front panel, adjust the Analog Balance pot R59 for +10 mV at TP5 on the SL card. If an oscilloscope is used, center the band of fuss observed on the screen for +10 mV ±1 mV. The use of a digital mulimeter, adjust the voltage at TP5 for +10 mV ±0.1 mV.

13) Press the Reset switch on the Front panel of the chassis or tester (the Reset switch is the fourth switch from the left). This will set the counters on the SL card for a zero count. The "In Position" L.E.D. on the Front panel will again light.

14) Adjust the Sign Symmetry pot R72 for 0 mV ±1 mV (0.1 mV) at TP5 on the SL card.

15) Repeat steps 10 to 12 and verify that the voltage present at TP5 on the SL card is +10 mV. Readjust the Analog Balance pot R59 if necessary.

16) Reset the system and verify that the voltage present at TP5 is 0 mV. Readjust the Sign Symmetry pot if necessary. Repeat steps 15 and 16 until the pots require no more adjustment.

17) Seal the Analog Balance and the Sign Symmetry with Sentry Seal, manufactured by Organic Products Co., Irving, TX 75060 or equivalent sealant.

Procedure B: Jumper is installed in pads 21 to 22.

STEP

7) Press the "Reset" switch on the Front panel to set the counters of the SL card for a zero count. The L.E.D. on the Front panel (if present) will be lit.

8) Set the Direction switch on the Front panel of your chassis or tester for the counterclockwise direction. The Direction switch is the second switch from the left and will be locked in the "In" position.

9) Dial 00001 in the thumbwheel switch assembly on the chassis front panel.

10) Press the "Execute" button on the Front panel switch assembly. This is the first switch on the left (next to the direction switch).

11) Measure the voltage at TP5 on the SL card with an oscilloscope or digital multimeter. The ground lead of the oscilloscope or meter to TP1 of the SL card. The input lead of the oscilloscope or meter connects to TP5.

The oscilloscope will have a band of fuzz when set at 10 mV per division or lower. This band of fuzz should be centered on the voltage directed by the procedure. If a digital multimeter is used, the voltage should be adjusted to within ±0.1 mV.

12) With a one step counterclockwise command executed from the Front panel, adjust the Sign Symmetry pot R72 for +10 mV ±1 mV at TP5 on the SL card. If an oscilloscope is used, center the band of fuzz at +10 mV. The use of a digital multimeter, adjust the voltage at TP5 for +10 mV ±0.1 mV.

13) Press the "Reset" switch on the Front panel of the chassis or tester (the Reset switch is the fourth switch from the left). This will set the counters on the SL card for a zero count. The "In Position" L.E.D. on the Front panel will light again.

14) Adjust the Analog Balance pot R59 for 0 mV ±1 mV (0.1 mV) at TP5 on the SL card.

15) Repeat steps 10 to 12 and verify that the voltage present at TP5 is +10 mV. Readjust the Sign Symmetry R72 to +10 mV if necessary.

16) Reset the system and verify that the voltage present at TP5 is 0 mV. Readjust the Analog Balance pot if voltage is not 0 mV. Repeat steps 15 and 16 until the pots require no more adjustment.

17) Seal the Sign Symmetry and the Analog Balance pots with Sentry Seal.

This completes the adjustment of the D/A output of the SL card. If the card is jumpered, for example, in pads 20 to 22, and the D/A output can not be adjusted according to this procedure, then jumper pads 21 to 22. Use procedure B to adjust the D/A output at TP5. If the SL card cannot be adjusted with procedure A or B, then IC's M2 and A1 should be replaced. After replacement of the IC's has been completed, install a jumper in pads 20 to 22. Adjust the D/A output using Procedure A in this manual. If the D/A output at TP5 can not be adjusted with Procedure A, remove the jumper in pads 20 to 22 and reinstall in pads 21 to 22. Now use Procedure B to adjust the D/A output at TP5.

STEP

18) Turn off the power to the 4020/SL system.

19) Reinstall the motor fuse in the 4020 amplifier.

20) System is now ready for preliminary pot adjustment prior to reapplying power to the system.

8.3 Preliminary adjustment to the 4020/SL drive.

These preliminary adjustments are made to the 4020 amplifier and the SL card to enable stable operation of the drive when power is applied to the system.

STEP

1) Set the Sin Lock pot R55 midrange on the SL card.

2) Set the Slew pot R8 on the SL card midrange.

3) Set the Marker Balance pot R81 midrange on the SL card if the encoder mounted to the motor is a Trump-Ross 200 line encoder. If the encoder mounted to the motor is a Renco 200, 500, or 1000 line encoder, refer to the manual on the Renco encoder for the adjustment of the Marker Balance pot, R81.

4) On the 4020 amplifier, set the following pots midrange:

AC Gain	R5
- Current Limit	R43
+ Current Limit	R44
Balance	R4

5) Set Input 2, R2 full CCW on the 4020 amplifier. In the Aerotech system, Input 2 is not used.

6) If the motor has a 200 line encoder installed, set the Input 1, R1 and Input 3, R3 midrange.

If the motor has either a 500 or 1000 line encoder installed, set Input 1, R1, about 1/8 turn from the full CCW position. Set Input 3, R3, about 1/8 turn from the full CW position.

7) Preliminary adjustments are complete.

8.4 4020/SL Drive Adjustment

Adjustments made to the drive system should be performed with the motor connected to the load. If an Aerotech stage is used with the system, the motor should be installed at this time. If the encoder signals outputted from the encoder mounted on the motor have not been checked for proper phasing and amplitude, the motor may run at a high speed, when power is applied. This may damage the stage. Refer to the encoder manual for proper procedures for the encoder adjustment.

There are 7 adjustment pots on the 4020 amplifier. The function of each pot is as follows:

R1 is the adjustment pot for the velocity command (D/A output) from the SL card. R1 is adjusted so that when an index is clocked into the SL card, the deceleration at the completion of the index does not overshoot the commanded position.

R2 (Input 2) is not normally used in the Aerotech system. This input can be used to input an additional command signal. For examble, a voltage could be applied to temporarily offset the position of the motor without actually clocking the SL card.

R3 adjusts the gain of the tach feedback voltage from the motor. R1 and R3 adjusts the voltage at the summing junction at the input of the preamplifier of the 4020. A voltage applied to the input (1) of the 4020 will command a speed so that the tach feedback voltage inputted through input 3 will cause the summing junction to be 0V. Any different voltage will command the 4020 amplifier to increase or decrease the speed of the motor to eliminate the offset voltage at the summing junction.

R4 is used to adjust the offset voltage outputted from the preamplifier. If the 4020 is used in a rate loop mode, the balance pot R4 is adjusted to stop motor rotation. That is with a 0V input at TB1-1, there is no motor rotation. R4 is adjusted with the SL card so that when the SL card is at count zero, TP2 rests at 0V ±0.2 V on the SL card. This adjustment is usually a different position of the pot for the rate loop operation of the 4020 than when in a position loop mode. (SL card)

R5 adjusts the AC response of the preamplifier.

R43 adjusts the peak current in the negative direction. Minimum current is 5 amps and the maximum current is 20 amps.

R44 adjusts the peak current in the positive direction. Minimum and maximum current is the same as the negative direction.

8.4.1 Adjustment Procedure

STEP

1) Perform the D/A output adjustments if necessary.

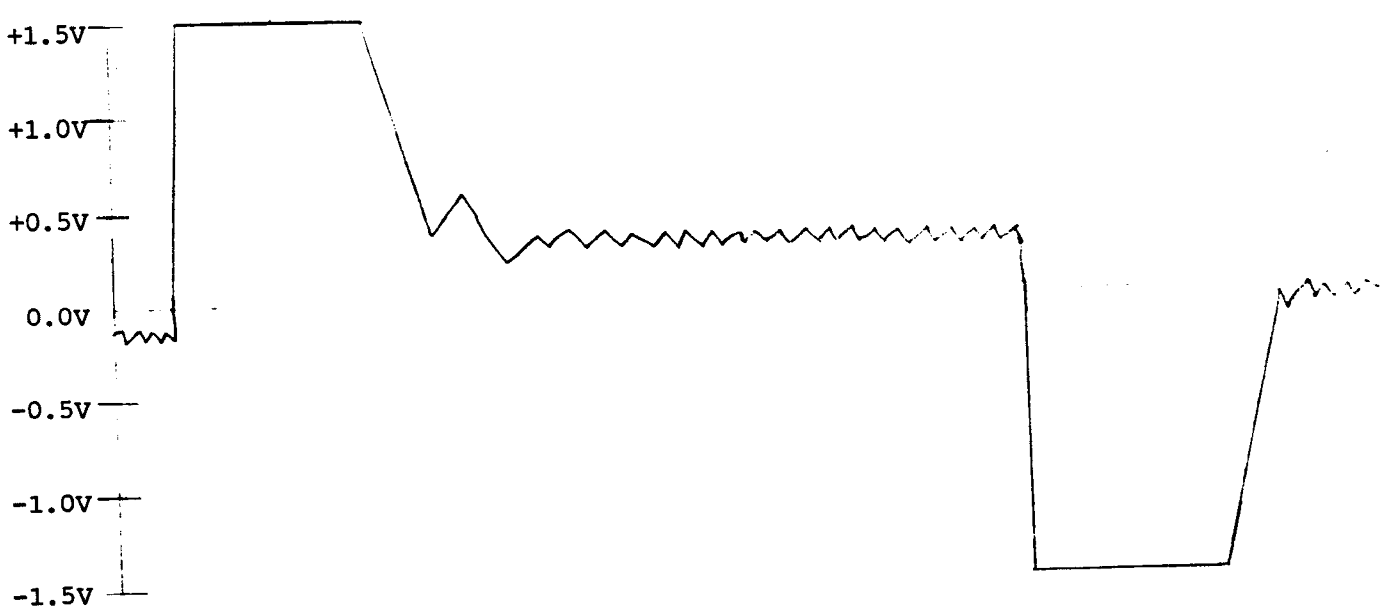
2) Check encoder signals for proper phasing and amplitude at TP2 and TP3 on the SL card.

3) Perform preliminary adjustments according to section 8.3.

4) Adjust the + current limit and - current limit pots R44 and R43.

There are several ways in adjusting the peak currents of the 4020 amplifier. To measure the current, connect an oscilloscope across the current sense resistor, R45, on the 4020 amplifier. The ground lead of the scope is connected to the resistor lead closest to the outside edge of the PC board. The input lead of the scope is connected to the other resistor lead. Set the scope for 0.5 V per division and a sweep rate of 5 mV per division. If the load that is connected to the motor shaft can be twisted, then turn the motor shaft slightly clockwise. The voltage on the scope will be a - 0.5 Volts. Adjust R43 (- current limit) for a voltage of - 1.5 Volts. Do not hold the motor shaft for too long, since this will cause the motor fuse to blow. Repetively twist the motor shaft clockwise. Once the voltage on the scope is 1.5 Volts peak, seal R43. By twisting the motor shaft counterclockwise, the + current limit can be adjusted. The voltage displayed on the scope will be + 1.5 Volts.

Another way of adjusting the current limits is to index the drive with short indexes at a commanded high speed. The current through the motor will be at peak current during the acceleration and deceleration of the motor. The current observed on the oscilloscope connected across the current sense resistor R45 should have the appearance shown below:



If the waveform does not have a flat top as depicted, the gain of the amplifier may be too low. Turn Input 1, R1, slightly clockwise to increase the bandwidth of the 4020 amplifier. Indexing the drive, to observe the current through the current sense resistor. If the waveform still does not have the appearance of the waveform on the previous page, continue turning R1 clockwise. After adjusting R44 and R43 for the proper peak current, seal the pots.

STEP

5) Adjust the gain of the 4020 amplifier for the proper bandwidth.

The gain of the 4020 amplifier is adjusted by pots R1 and R3. R1 is the pot that adjusts the velocity command voltage that is outputted by the D/A circuitry of the SL card. R3 is the pot that adjusts the tach feedback voltage. These two pots are inversely proportionate in adjusting the gain of the 4020 amplifier. The same identical gain can be obtained with different settings of R1 and R3.

The bandwidth is determined by the encoder feedback frequency divided by 2 Pi times the following error. The formula is:

$$\text{BW (Hz)} = \frac{\text{Encoder feedback clock}}{\text{2 Pi X (NO. of STEPS)}}$$

The encoder feedback clock frequency is observed at TP2 on the SL card. If the SL card is in full step mode, the frequency is 1/ the time period of one sinwave at TP2. If the SL card is in ½ step mode, multiply the frequency for full step mode by 2. This frequency is divided by 2 Pi times the number of steps in the counters of the SL card. The number of steps can be solved by measuring the voltage at TP5 of the SL card and dividing by 5 mV per bit. For example, 1.0V at TP5 divided by 0.005 V equals 200 steps. If the encoder clock frequency was 1000 Hz, then the bandwidth would be:

$$\text{BW} = \frac{1000}{\text{2 Pi (200)}} = 0.398 \text{ Hz}$$

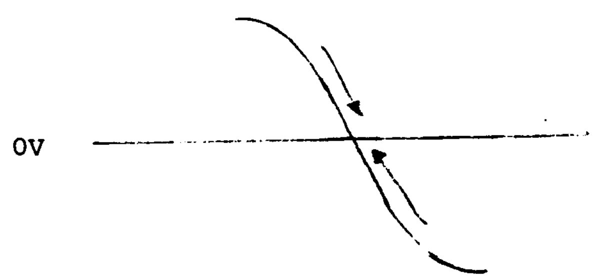
In this example, the bandwidth is 0.398 Hz. This bandwidth is too low for most Aerotech Systems. If the motor's have 200 line encoders, the bandwidth of the system should be between 2 to 5 Hz, with 500 line encoders - 5 to 10 Hz and with 1000 line encoders - 10 to 15 Hz. Once the bandwidth has be calculated for a system, then adjustment of R1 and R3 is simple. All that is required to adjust the 4020 gain, is clock the drive at a certain frequency and adjust R1 and R3 for the proper following error voltage at TP5 of the SL card. In the back of this manual is a table with the values for setting the pots in the system. Sometimes the system may have to be adjusted with no settings available. This requires that other signals be checked for verifying proper adjustment of the 4020 and SL card.

To adjust the Tach input pot R3 on the 4020 amplifier, turn Input 1, R1, full counterclockwise. Adjust R3 until the waveform shown in Fig. 2 is observed on an oscilloscope at TB1-1 of the 4020 amplifier. The waveform in Fig. 1 shows that there is too much tach feedback which is causing the motor to overshoot the command speed. By turning the Tach input pot R3 CCW, will decrease the tach feedback voltage and increase the gain and bandwidth of the amplifier. Once the waveform of Fig. 2 is observed, further CCW settings of the tach input pot will increase the acceleration and deceleration times for the motor motion.

After R3 has been adjusted, R1 (velocity command input from SL card) is adjusted for no overshoot at TP5 on the SL card. Fig. 3 shows the D/A output overshooting the commanded position on a CCW index. By turning the input 1 pot CCW, will decrease the gain and bandwidth of the 4020, eliminating the overshoot shown in Fig. 3. Figures 4 and 5 depicts proper deceleration rates of the D/A voltage at TP5 of the SL card. Fig. 5 shows a lower bandwidth than Fig. 4. The waveform of Fig. 4 is the optimum setting for R1 and R3 of the 4020 amplifier. The waveform of Fig. 7 displays the least deceleration time while Fig. 6 shows that the gain of the 4020 is a bit too high, since there is some overshoot of the D/A voltage. Figure 8 shows a typical acceleration/deceleration waveform present at TP5 of the SL card on a long index motion of the motor. Any adjustment made to the Input 1 pot of the 4020 amplifier requires the balance pot on the 4020 to be readjusted.

STEP

6) Adjust the Balance pot R4 on the 4020 amplifier for 0V ±0.2V at TP2 of the SL card. The 4020/SL drive is held in position by the SL card by outputting the sin signal to the input of the 4020 amplifier. Any drifting of the motor is sensed by the encoder, and this offset voltage generated by the sin signal causes the amplifier to cancel the motion of the motor by commanding the motor in the opposite direction.



Sin Lock Output

Tach Waveform

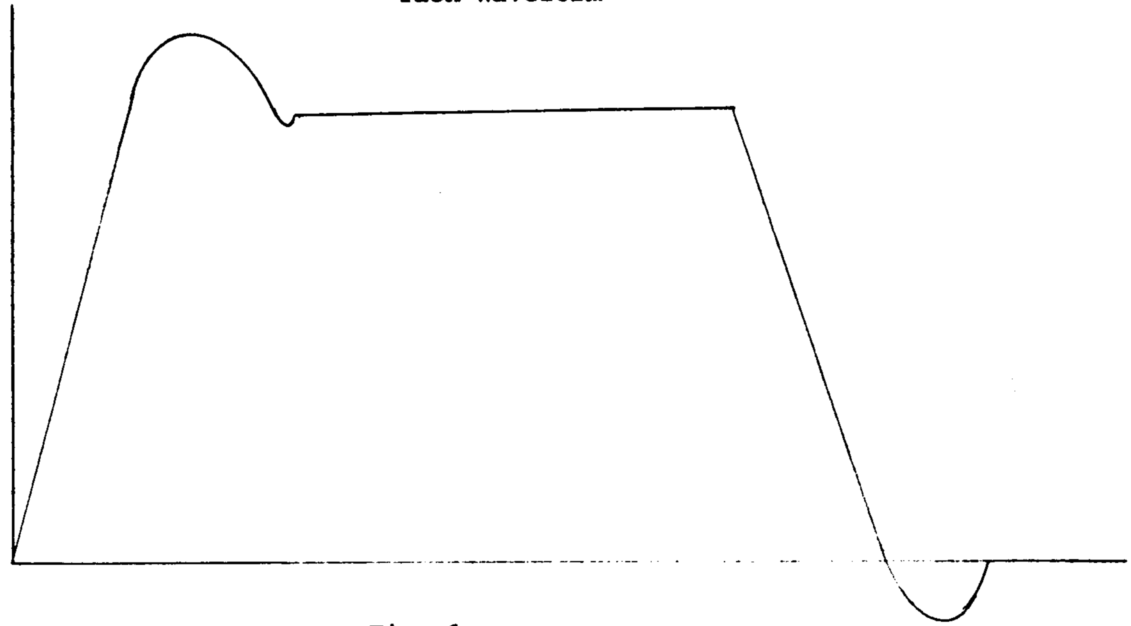


Fig. 1

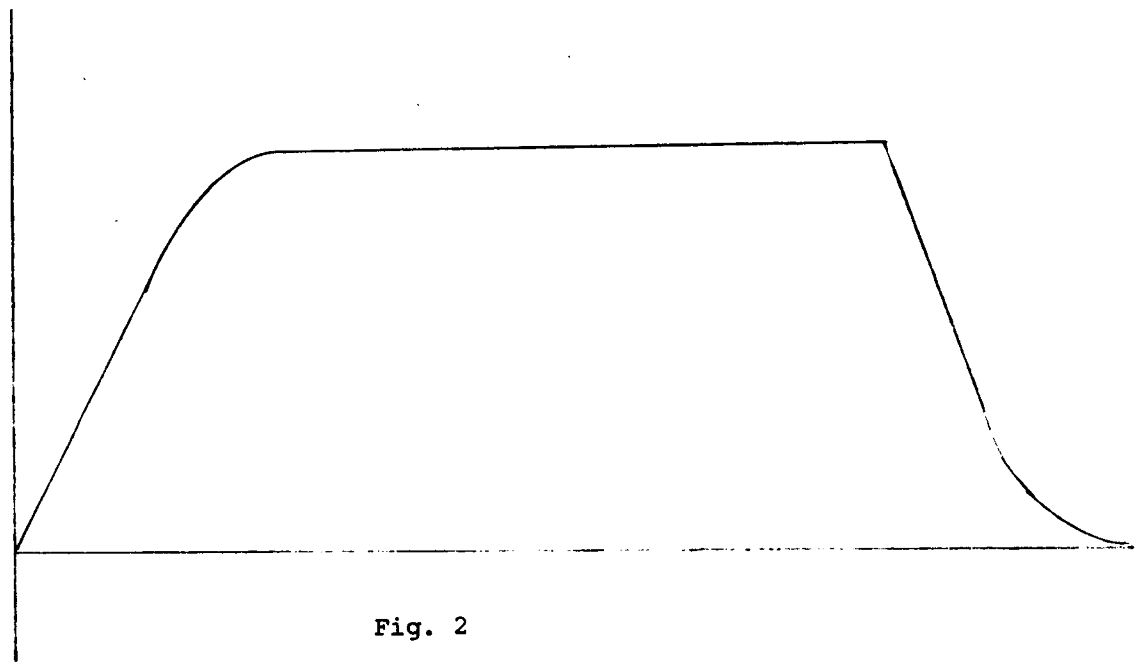


Fig. 2

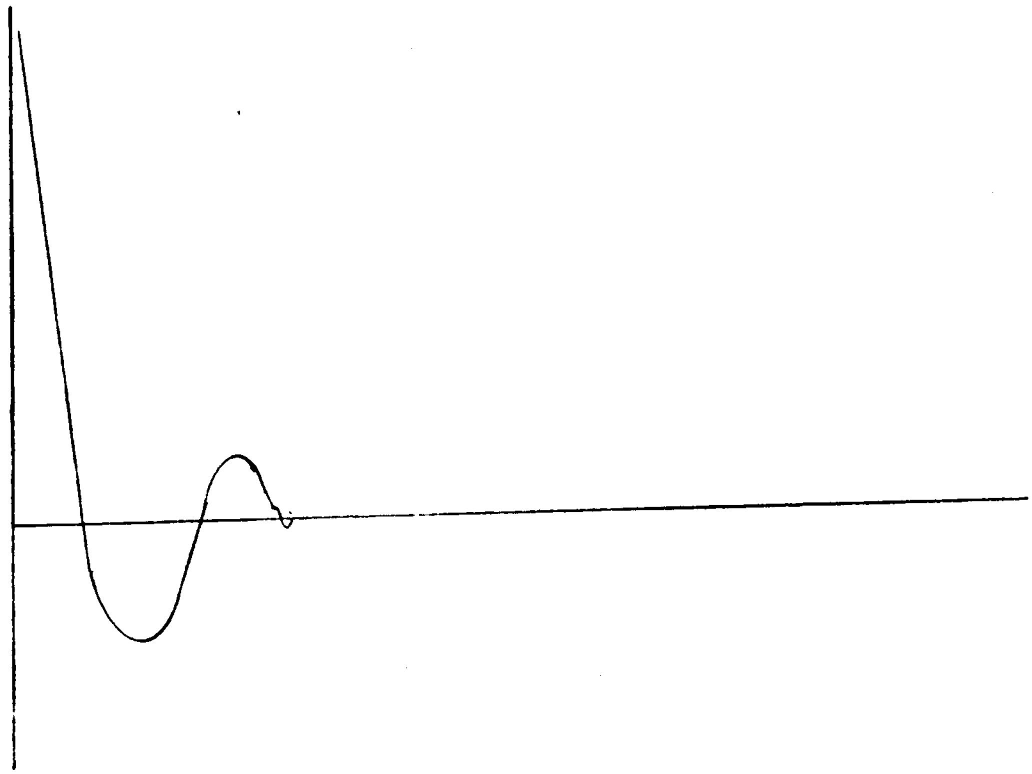


Fig. 3

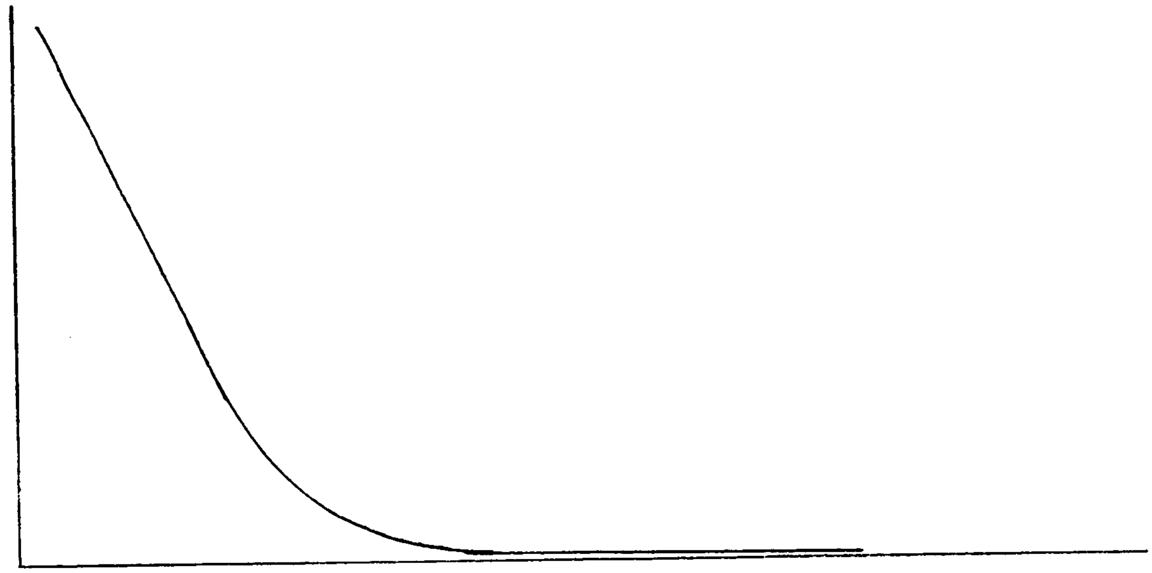


Fig. 4

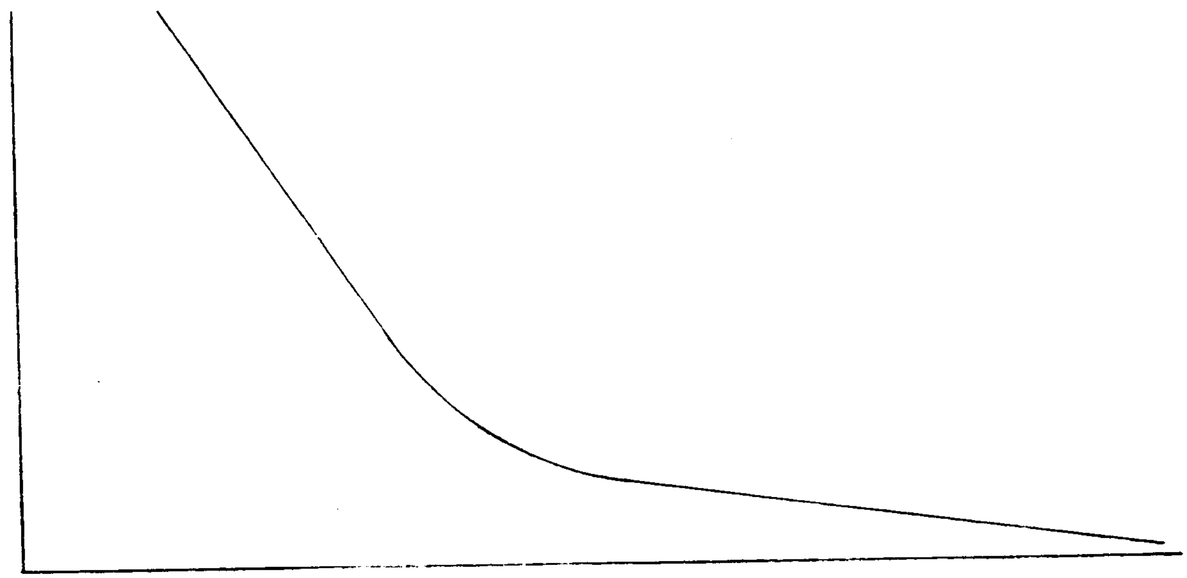


Fig. 5

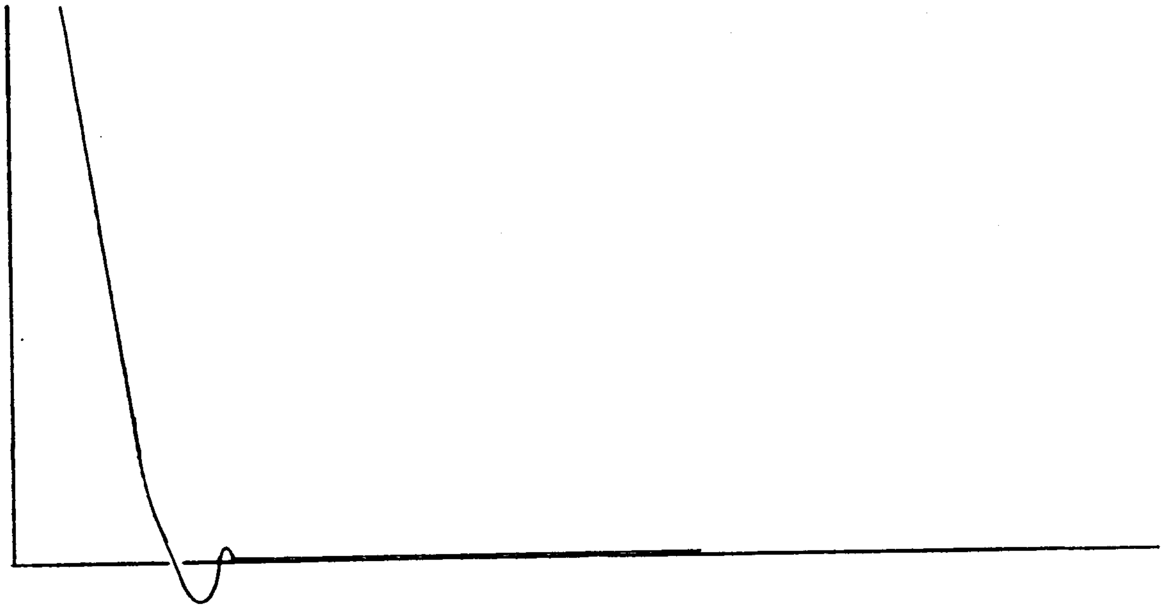


Fig. 6

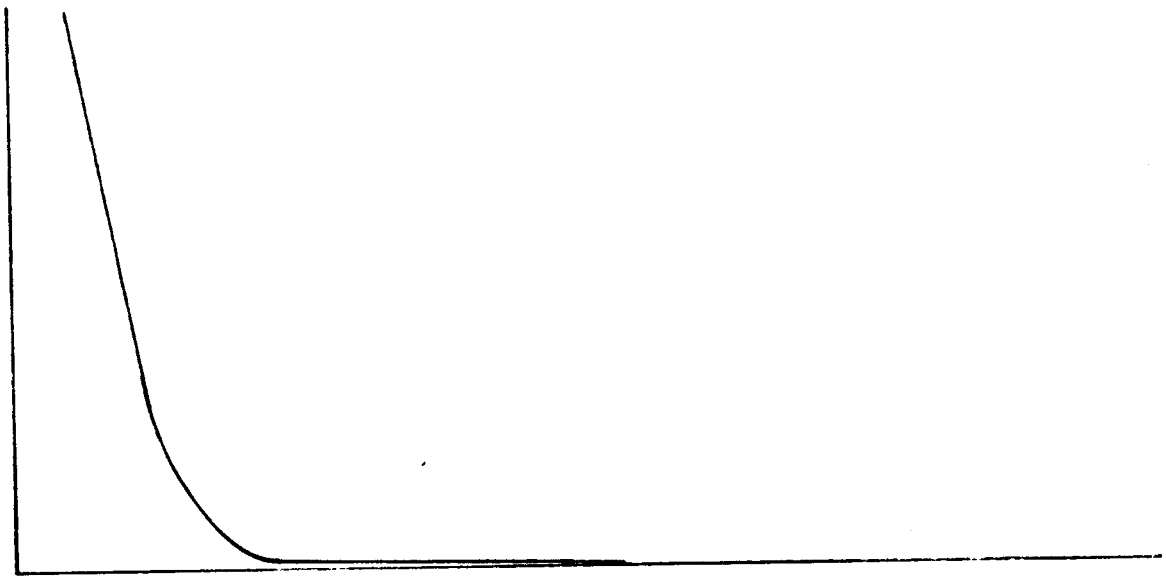


Fig. 7

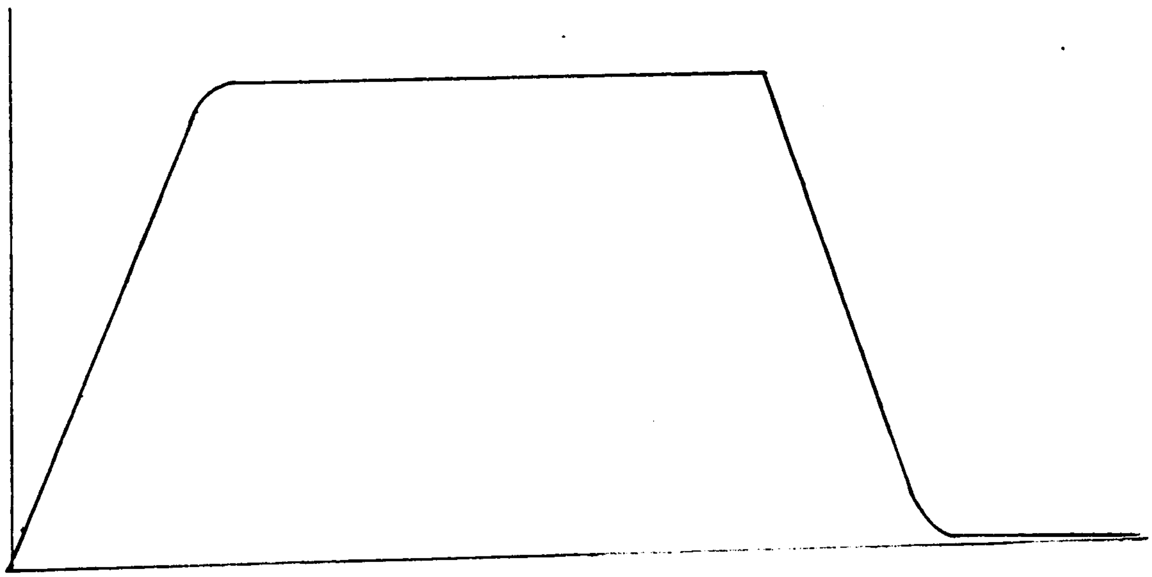


Fig. 8

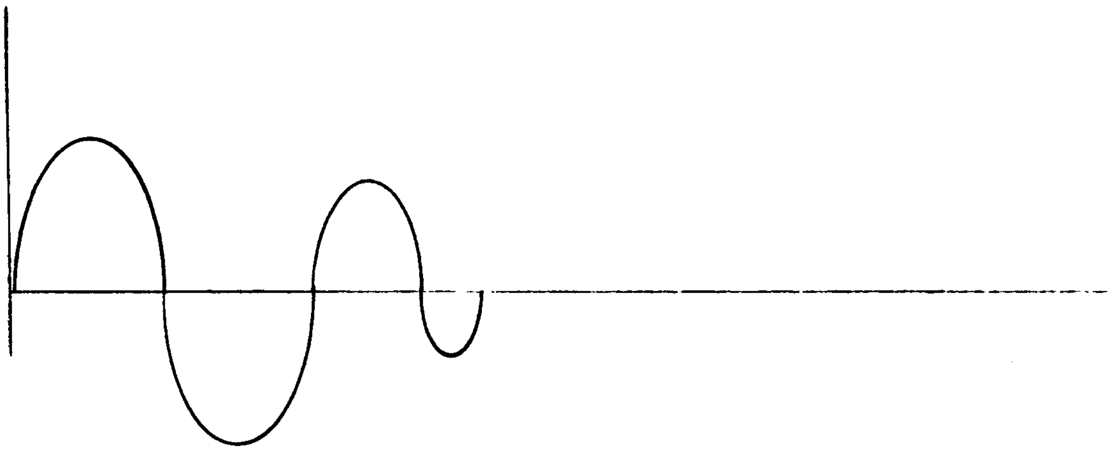
To adjust the Balance pot R4 on the 4020 amplifier, press and hold "Reset" on the front panel of the chassis or tester. With an oscilloscope connected to TP2 of the SL card, adjust the balance pot on the 4020 until the line on the screen in motionless or the motion is very slow. Once the "Reset button has been released, the balance pot can be adjusted so that the sin signal present at TP2 is at 0V ± 0.2V. Single step by inputting 1 clock pulse to the SL card and observe that the sinewave at TP2 returns to 0V. If during each step executed, the sin signal wanders from the 0V setting, adjust the Sin Lock pot, R55, for higher Sin Lock gain. This is done by turning the Sin Lock pot clockwise. If input 1 on the 4020 amplifier is adjusted, the balance pot may also have to be readjusted.

STEP

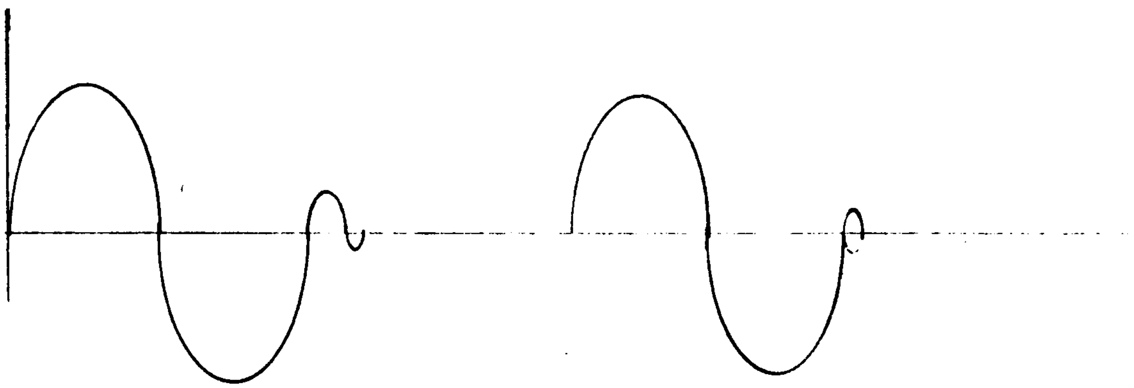
7) Adjust the AC Gain pot on the 4020 amplifier clockwise until the amplifier becomes unstable and turn the pot 1/8 of a turn counterclockwise. This will give the system a course AC gain adjustment. Figure 9 shows how the AC Gain affects the drive when a single step move is executed. If the system is in ½ step mode, the execution of 2 steps is required. The operation of the AC Gain affects the response of the 4020 preamplifier to an AC signal. The higher the AC Gain of the preamplifier, the faster the 4020 responses to a changing input voltage from the SL card. That is exactly what the Sin Lock signal from the SL card functions.

8) The Slew pot on the SL card is used to clock the SL card when in a home cycle. This pot should be adjusted so that the home speed is ½ the maximum clock frequency of the system.

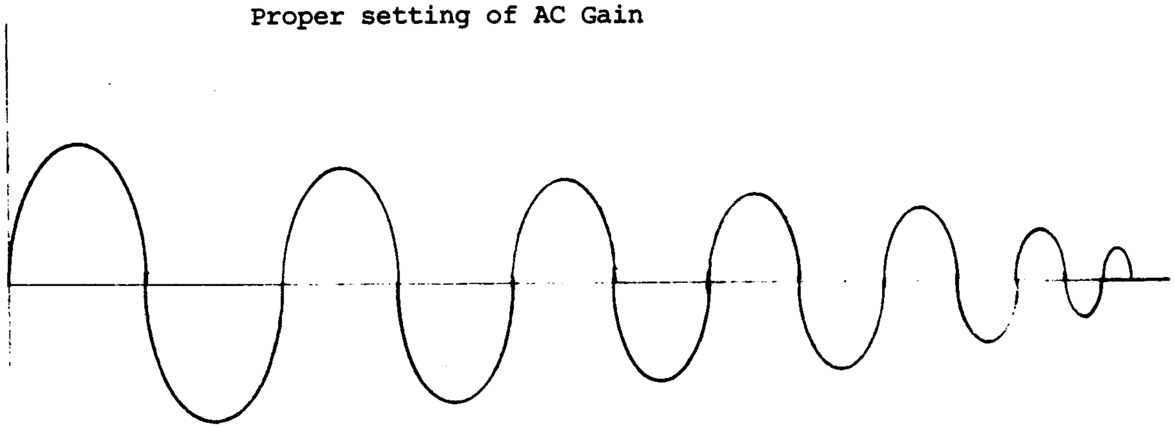
Waveform at TP2 of SL card



AC Gain too low



Proper setting of AC Gain



AC Gain or Sin Lock too high

Fig. 9

System Adjustments:

Indexer (Model 10 or Model 20) Clock Frequency______________________________

Home Clock Frequency (SL card)______________________________

System Bandwidth______________________________

Bandwidth Input Clock Frequency______________________________

D/A output Voltage at BW input Clock Frequency______________________________

Amplifier Current Limits______________________________

Other:

Indexer (Model 10 or Model 20) Clock Frequency______________________________

Home Clock Frequency (SL card)______________________________

System Bandwidth______________________________

Bandwidth Input Clock Frequency______________________________

D/A output Voltage at BW input Clock Frequency______________________________

Amplifier Current Limits______________________________

Other:

Indexer (Model 10 or Model 20) Clock Frequency______________________________

Home Clock Frequency (SL card)______________________________

System Bandwidth______________________________

Bandwidth Input Clock Frequency______________________________

D/A output Voltage at BW input Clock Frequency______________________________

Amplifier Current Limits______________________________

Other:

Indexer (Model 10 or Model 20) Clock Frequency______________________________

Home Clock Frequency (SL card)______________________________

System Bandwidth______________________________

Bandwidth Input Clock Frequency______________________________

D/A output Voltage at BW input Clock Frequency______________________________

Amplifier Current Limits______________________________

Other: