SPEX

Instructions

1702/1704 Spectrometer

80004-6/85

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CONTENTS

Page No.

1 GENERAL INFORMATION

1.1 Unpacking

CAUTION! Do not use the slit housing or other protrusions for lifting.

If any shipping damage is noticed at delivery, the carrier should note such evidence on the delivery receipt and sign all copies.

Remove the top of the shipping box and all inside braces. Carefully lift the instrument by the two canvas straps only, not instrument knobs or counter, etc. Four people are needed. The spectrometer, including the shipping base, should be placed on a sturdy table in a room where temperature gradients are not excessive, preferably kept at a temperature constant to ±2°C. Inspect for previously hidden damages and notify carrier immediately if any are found.

Support the instrument so that all shipping bolts are accessible (e.g. by putting across a narrow table). Remove shipping bolts; lift the instrument and remove the shipping base. Install leveling legs (part #22420) making sure that two outer rear legs are shorter than the other three. Move the instrument to its permanent position; place pads (part #22219) under legs. Level the instrument with reference to the bubble on the baseplate inside, using the two front legs and rear center leg only; the two outer rear legs are safety outriggers and should be lowered until they touch the table without supporting any weight.

1.2 Inspection for Damage

Inspect the instrument for visible evidence of any damage. Check that all readily visible mechanical and electrical components are in their proper place and intact. If damage is evident, do not operate the instrument but notify *SPEX Industries, Inc. and the carriers at once.*

Many public carriers do not recognize claims for concealed damage if reported later than 15 days after delivery. In case of a shipping damage claim, the carrier agent's inspection is required. For this reason, the original packing should be retained as evidence of mishandling or abuse. While SPEX Industries, Inc. is not liable for damage in transit, the company will extend every effort to aid and advise.

1.3 Handling Tips

CAUTION: Many parts of your spectrometer are extremely precise and delicate. Mishandling can cause serious and irreparable damage.

2 PRINCIPLES OF OPERATION

2.1 General

The 1702 (1704) is a 0.75 (1.0) meter spectrometer whose drive is linear in wavelength. To control the stepper motor and drive the spectrometer through selected spectral regions, SPEX offers the CD2 COMPUDRIVE, the DM1B Spectroscopy Laboratory Coordinator and 1673C MINIDRIVE. Alternatively, the user provide some other external control such as a mini-computer. Whatever the choice, consult the specific manual for interconnection and operation.

2.1.1 Direction Convention

All SPEX spectrometers follow the convention that forward and high denote *increasing wavelength.*

2.2 Spectrometer Unit Controls

The entrance and exit slits on the front of the spectrometer are controlled by micrometer type knobs above the slits. An electrical connection on the rear panel receives signals from the control unit. Limit switches inside the spectrometer send stop signals to the control unit to reduce the chance of damage to the drive mechanism.

2.2.1 Wavelength Counter

There is a 5-digit mechanical counter on the lower side of the spectrometer which displays wavelength in Angstrom units. A needle-point at right, and white marks on the right-hand counter wheel, permit reading to 0.1A.

2.2.2 Limit Stops

Although limit stop switches at both ends of the scanning drive are present to signal SPEX drive units, the operator should avoid scanning to the ends of the drive. One switch is mounted at each end of the wavelength drive within the spectrometer. The normal range of operation is from 0 Angstroms to 15000 Angstroms.

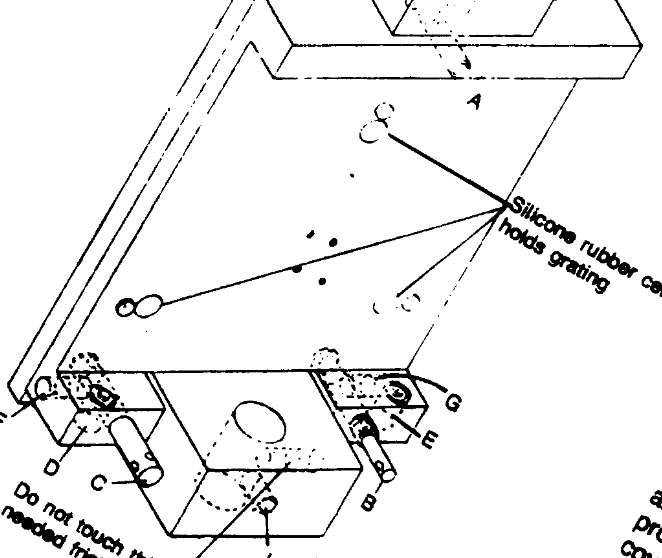
2.3 Spectrometer Pin Assignments

Assignments are as follows (others are unused):

Pin #	Assignment
1	motor lead 1
2	motor lead 2
3	motor lead 3
4	motor lead 4
17	+5 Vdc
18	reverse limit switch (low)
20	motor lead return
21	motor lead return
22	motor lead return
23	motor lead return
36	0 Vdc (ground)
37	forward limit switch (high)

2.4 Backlash

To assure accurate reproducibility, scan start positions should always be approached from at least 200 units



...g forward or backward on X axis.
...ing on Y axis. This is wavelength adjustment.
...g on Z axis. This is rocking adjustment.
...ng in place.
...tion or drag.

Figure 1
...AND BACKING PLATE ASSEMBLY
(1500M)

...MENT

...spectrometer carefully ...r right and lower left) ...overs on the mirrors. ...ion the covers and ...rror covers, being ...ce.

... of the slits. ...pecification

...t — ...he ...

a... pr... cove... custo... alignm... the setu...

3.3.1 Preli...

The following e... check:

1) Low pressure Hg... lamps are suitable).

2) Eyepiece which can b... exit slit (#1529).

3) Photomultiplier tube sen... wavelength region (e.g., R... housing (#1624E and #1424B...

4) Appropriate PM power supp... recorder.

Position the Hg lamp as close to the en... possible. Set S1 at 25μ, 10 mm high, S2 a... up the eyepiece to view S2, focus on the ... Refer to the performance test record include... manual and note the wavelength of the line w... wavelength error nearest the blaze angle of the g... being used. Scan slowly over the region of the line ... looking through the eyepiece. Always scan from ... to high wavelength and start at least 200A below t... line peak to remove backlash. When the line is ... observed through the eyepiece close S2 to 100μ, rescan the region, stopping where the line appears most intense. Observe the reading on the wavelength counter. If the value is more than 5A different from the value noted above, a major alignment check of the instrument may be necessary. If the error is less than 5A, set the wavelength counter to the specified value approaching it from at least 200A below the value ... adjust screw B on grating G1 until a maximum ... is observed.

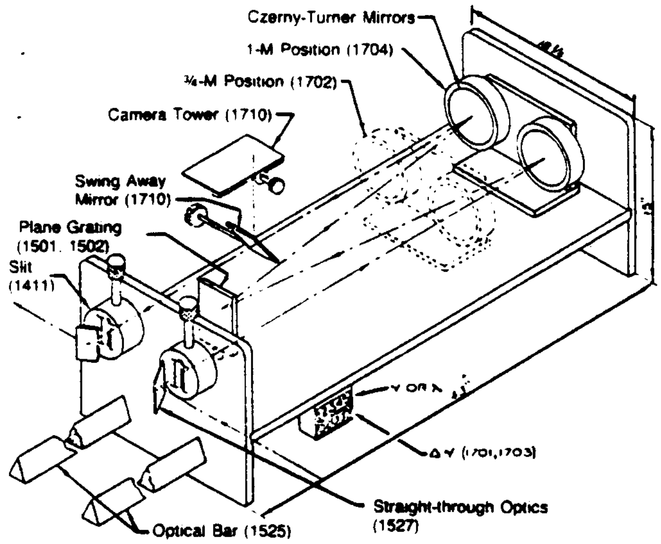


Figure 2
Optical Layout

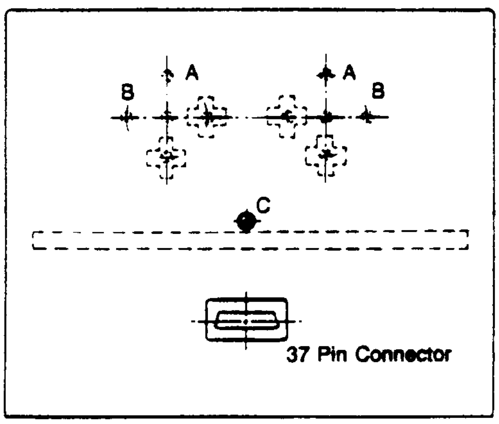


Figure 3
Spectrometer - Rear View

3.4 Optical Alignment of the 1702/1704 in the Field

3.4.1 Quick Alignment Check

All moderate misalignments can be corrected with adjustments of the grating mount (A and B, Figure 1). Changing the focal distance or positions of the mirrors (M1, M2) is especially likely to affect other aspects of the instrument's alignment, *and these components should not be touched until you are prepared to perform a realignment.* A SPEX Alignment Kit will be needed for the following steps.

Alignment Kit A consists of:

1 Laser assembly: a He Ne gas laser with mounting brackets.
1 Adapter ring for mounting the Hg pen lamp between the slit housing and the laser
1 Mirror target mask
1 Grating target fixture
1 Multipurpose slit target
2 ¼-20 x 1 inch socket head screws
2 ¼-20 x ¾ inch socket head screws

Alignment Kit B consists of:

1 Hg Pen-Ray lamp and transformer (1634 and 1635)
1 Phototube and housing (1P28, 1642B, 1424)
1 Eyepiece and mounting thumbscrews (1529)

Since photomultiplier tubes can be damaged by exposure to high levels of light, power to all photomultipliers should be turned off and the tubes removed from the instrument before beginning this alignment check.

Using Alignment Kit B, mount and align the laser according to steps 3.5.1 and 3.5.2. Check the alignment of the light path through the instrument by referring to steps 3.5.3 and 3.5.8. The light path can be observed by removing the top cover of the instrument.

Check parallelism of the slits by referring to step 3.5.6. For this check it will be necessary to install the Hg pen lamp in the adapter provided.

Check wavelength synchronization and accuracy by referring to step 3.3.1.

3.5 Complete Procedure for Factory Alignment

The following alignment instructions are carried out *at the factory by experienced technicians.* Do not attempt this procedure without first thoroughly reading and understanding these instructions. *A SPEX Alignment Kit B will be needed and familiarity with the principles and handling of optical systems will be absolutely necessary in order to accomplish the alignment.*

3.5.1 Initial Preparation of the Instrument

Referring to the internal bubble, level the instrument by adjusting the length of the legs. Only the center of the three rear legs should touch the table. Set both slits to 2 mm and set the height adjustment on the entrance slit to 2 mm.

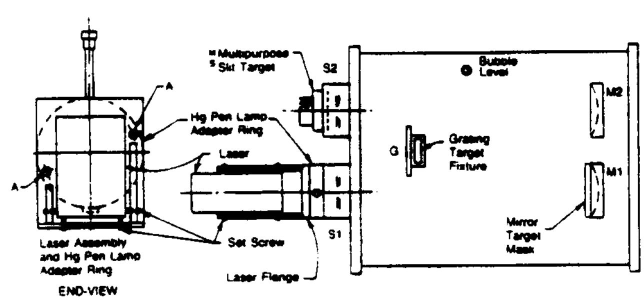


Figure 4
Layout for Factory Alignment

Mount the adapter ring (Figure 4) on the entrance slit using the two ¼-20 x 1 inch screws provided, locating the Hg pen lamp socket at the top. Mount the laser assembly (Figure 4) on the adapter ring, using the two

¼-20 x ¾ inch screws provided. Ignite the laser according to the manufacturer's instructions, and observe the cautions concerned with the operation of this laser as noted in the instruction manual.

CAUTION! *DO NOT LOOK DIRECTLY INTO THE LASER BEAM*

3.5.2 Alignment of the Laser Source

With the slit shutter closed to the center hartman, position the mirror target mask over the four screws of the first mirror. Loosen the four socket head screws on the laser assembly allowing the horizontal and vertical axis of the laser to be moved with respect to the slit. Adjust the position of the laser, side to side and up and down, until a spot of maximum intensity is observed on the mirror target mask, then retighten the four screws on the laser assembly. Adjust the shutter on the entrance slit to its fully open position. Aim the laser beam at the central hole in the mirror mask, by adjusting the tilt of the laser tube with the set screws provided (Figure 4). Retighten the socket head screws to maintain the alignment of the laser source.

3.5.3 Alignment of the Optics

Remove the grating G_1 from the backing plate hook, tape its plastic cover on, and put it in a safe place. Mount the grating target in position on the grating shaft making sure the alignment pin is properly seated and that the base of the target is firmly seated on the base block of the backing plate assembly (see Figure 1). Scan to the low wavelength end (approximately 0A) and locate the grating target fixture parallel to the end plate of the spectrometer. Aim the laser beam at the target hole in the grating target fixture, adjusting the up and down motion of M_1 with hex nut A, and the sideways motion with hex nut B (Figure 3). Remove the grating target fixture and reinstall the grating in position G_1. Scan to 6328A (1200 gr/mm gratings).

With the mirror target mask in position on M_2, adjust the position of the grating G_1 to that the reflected laser beam is aimed at the central hold in the mirror target mask. The grating may be moved from side to side with screws B (Figure 1) and up and down with screw A (Figure 1). Remove the mirror target mask from M_2. The multipurpose slit target may be inserted directly into the exit slit from the outside, placing the end with the white plastic disk nearer the slit. Aim mirror M_2 at the central hole in the slit target in the same manner as M_1 was aimed. DO NOT LOOK DIRECTLY INTO THE LASER BEAM THROUGH THE ALIGNMENT DISK.

3.5.4 Rocking the Grating G_1

Open S_1 and S_2 to 1 mm and set shutter to 2 mm high. Scan the counter to approximately 12656A. This is the second order of the 6328A line of a He-Ne laser. Using the ADJUST control, scan slowly until this line is visible through the slit target and observe the vertical position of the beam on the target.

Adjust cam C (Figure 1) until the image is vertically centered in the target. Tighten the no-mar screw to prevent cam C from rotating. Scan the counter to 0A. Check the vertical centering on the exit slit target. If it is not centered, re-center with screw A on the grating and repeat the above until you are satisfied that the spectrometer is centered at high and low wavelengths. Perfection of this adjustment is most critical on an instrument with curved slits. Do not adjust cam C after this adjustment has been made.

3.5.5 Rough Visual Focus

Do not attempt to refocus unless photoelectric checks (Section 3.5.7) indicate out-of-focus condition. Mirrors have been focused in the factory and bolted tightly in position.

Close exit slit down to about 500 microns and the entrance slit to about 10 microns wide by 5 mm high. Remove the multipurpose slit target disc and place the focusing eyepiece over the slit. Turn off the laser source and insert the Hg pencil lamp into the hole provided. Find 5461A line (use the visible green line, not the wavelength counter reading which has not yet been calibrated). Locate the slotted focusing screw through hole C, Figure 3) at the back of the instrument. Loosen the two Allen head screws in front of mirrors M_1 and M_2. With the eyepiece focused on the slit jaws, have an assistant turn the focusing screw until the line is visually focused. It is a good practice to focus a number of times, always approaching the best focus while turning the screw in the clockwise direction.

3.5.6 Paralleling Slits

Adjust both slits S_1 and S_2 to 15 microns and open shutter of S_1 to 10 mm. Very slowly scan past 5461A line in both directions, observing the manner in which the illuminated area will move up or down as you scan across the line. If the slit is properly paralleled, then, scanning in the direction of increasing wavelength, the central portion of the slit will be illuminated first, with light spreading to both ends uniformly. The line will disappear first at the center, then evenly toward both ends. Loosen Allen screws around slit S_2, turn until slit is properly paralleled and retighten.

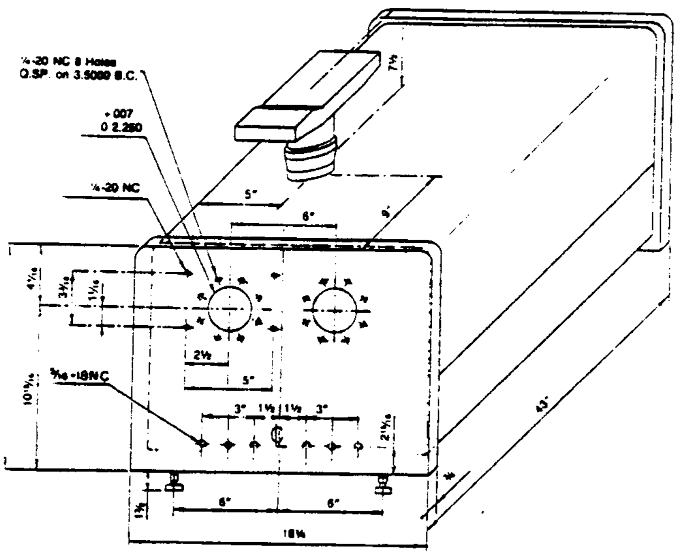
3.5.7 Photoelectric Focus

Readjust the entrance and exit slits to 6 microns width. Set the entrance slit to 2 mm height. Remove the eyepiece from the exit slit. Set up the instrument for photoelectric readout with a stripchart recorder. Refer to the Performance Test record and scan to the region of the spectrum indicated. Slowly scan this region. Observe the intensity of the lines, the depth of the valley between lines, and the half-width of the line. Adjust the focus slightly, turning the focusing screw through hold C behind mirrors in increments of ⅛ of a turn. Re-scan. Continue to focus and scan until the valley is deepest, relative to the line intensities and the halfwidth is at a minimum.

NOTE: It is advisable to pass through the best focus at least once, back off the focusing screw to eliminate backlash and approach the final value. It is also important to reverse the scan about 200A between trials, again to remove backlash, this time from the scanning systems.

3.5.8 Fine Optical Adjustment with the Laser

Remove the Pen-Ray lamp, turn off the power to the photomultiplier and remove it from the slit, and ignite the laser. Scan to 6328A reading on the wavelength counter and open S_1 and S_2 to 25μ. If necessary, repeat steps 3.5.2 and 3.5.3 to realign the laser and the mirrors.



SPEX INDUSTRIES INC.
1700 Series Spectrometer
Overall Dimensions 22073-B

3.5.9 Wavelength Setting (Grating G_1 Y-Axis) for 1200 gr/mm gratings

Turn off the laser and reinstall the Hg lamp. Place the eyepiece on S_2 and set S_1 and S_2 to 20 microns (S_1 at 2 mm high). Scan to the 5461A line, approaching the reading, as always, from at least 200A lower. When the green line appears most intense in S_2 observe the reading on the wavenumber counter. If it is less than 5 different from 5460.7 turn screw B of the grating mount (Figure 1) and repeak the line. Continue with these adjustments until the green line appears in S_2 at the proper wavelenght reading.

4 MAINTENANCE

4.1 Mechanical

Every year a drop or two of light machine oil can be placed on the leadscrew. Excess should be wiped off with a lint-free cloth or paper.

— — — — — — — — — — — — — — — — — — — —

All of the following suggestions are extreme measures included for information purposes. *PERFORM THEM ONLY AT YOUR OWN RISK.*

4.2 Optical

Before becoming too concerned about a small blemish visible on a grating, remember that it can only affect performance in proportion to its size. Even when new, a grating with the highest performance rarely looks cosmetically perfect.

Dust may be cleaned from gratings and mirrors with an air-bulb. Observing normal care and cleanliness for optical instruments should preclude any other maintenance. Should cleaning be required, however, the mirrors can be removed and washed in a dilute, mild detergent such as Lux dissolved in triple-distilled water, followed by rinsing with pure, triple distilled water. Test your solution for staining on a "sacrifice" front surface mirror as SPEX cannot be responsible for any damage.

Fingerprints *may* be removable from gratings or mirrors provided action is taken within a few minutes of the accident. In a very short time acids on the skin will have attacked the aluminizing and caused irreparable damage. Touch the fingerprint lightly with a pressure-sensitive tape and immediately draw it away in a direction toward the edge of the optic. The procedure may be repeated several times with fresh pieces of tape.

4.3 Counter Illuminator

In order to extend the life of the bulbs which illuminate the counter, two 3-volt lamps are placed in series across 5V dc. (See wiring diagram)

To replace bulbs, remove the side panel. The pilot lamps are mounted in a tube with two end thrust springs. Push the tube against one of the springs and remove it to replace the pilot lamps. Do not put the tube in place without light bulbs, as shorting may occur.

Power for counter illumination is through the connector in the rear of the spectrometer.

5 TECHNICAL NOTES AND APPLICABLE EQUATIONS

5.1 Fundamental grating equation applied to Czerny-Turner mount

$$m\lambda = d(\sin\alpha + \sin\beta)$$ where

m = order
λ = wavelength
d = grating spacing
α = angle of incidence
β = angle of diffraction

For convenience in the 1700 series instruments, this can be expressed as

$m\lambda = d\,(2 \sin \alpha \cos \beta)$ where

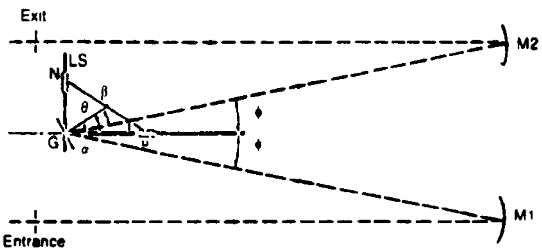
$\phi = 6°51'30''$ and $\cos \phi = 0.9928$ (¾-meter focal length)

$\phi = 4°54'$ and $\cos f = 0.9964$ (1-meter focal length)

θ = grating rotation measured from zero, its position at the direct image

$\alpha = \theta + \phi$

$\beta = \theta - \phi$



G = Grating N = Nut LS = Leadscrew B = Slide M1 & M2 = Mirrors

In the Spex sine drive, Nut N moves along leadscrew S while grating G is turned by an arm bisecting BN. B slides along a precision rod held at right angles to the leadscrew and maintains long-term precision of wavelength drive.

5.2 Theoretical Resolving Power

$$R_T = \frac{\lambda}{\Delta\lambda} = \frac{\nu}{\Delta\nu} = 2 \sin \theta \cos \phi \frac{W}{\lambda} = mN$$

λ = wavelength
ν = wavenumber
N = total number of grating grooves
W = width of grating ruling
m = order of diffraction

These equivalent expressions all yield numbers which are wavelength dependent. It can be seen that the resolution expresses as $\Delta\nu$ gives a figure independent of the wavelength or frequency observed.

5.3 Factors Influencing Resolution

Source - Since resolution is a linear function of grating width (i.e., optical path different) it is clear that if the source irradiates less than the full width of the grating, resolution will suffer. This dictates that the source or condensing lens must fully illuminate the collimating mirror. This can usually be checked visually by opening the spectrometer or, in the case of energy outside the visible spectrum, by making certain that throughput is reduced by slightly obstructing the edges of the collimating mirror.

Slit Width - The function of the slit seems to be one of the most misunderstood parts of the spectrometer. A good habit to cultivate is that of thinking in terms of spectral bandpass rather than mechanical slit-width. The bandpass is a function of the reciprocal linear dispersion which depends on the wavelength, the grating constant, the focal length of the instrument and the spectral order. Some typical values of reciprocal linear dispersion for this series of instruments are:

¾ Meter Focal Length

1200 grooves/mm

Order 1		Order 2	
1907A	11.A/mm		
4282	11.0	2141A	5.5A/mm
6328	10.7	3164	5.4
8273	10.2	4237	5.1
1.06μ	9.3	5300	4.7
1.26μ	8.1	6300	4.1
1.43μ	6.7	7150	3.3
1.55μ	5.0	7750	2.5

Grating
600 grooves/mm

Order 1		Order 2
3940A	22.2A/mm	Same as
8564	22.0	
1.26	21.4	1200 gr/mm
1.65	20.4	
2.12	18.6	grating in
2.52	16.2	
2.86	13.3	Order 1
3.10	10.0	

1 Meter Focal Length

Grating
1200 grooves/mm

Order 1		Order 2	
1970A	8.3A/mm		
4282	8.3	2141A	4.1A/mm
6328	8.0	3164	4.0
8273	7.7	4237	3.8
1.06μ	7.0	5300	3.5
1.26μ	6.1	6300	3.0
1.43μ	5.0	7150	2.5
1.55μ	3.8	7750	1.9

Grating
600 grooves/mm

Order 1		Order 2
3940A	16.7A/mm	Same as
8564	16.5	
1.26μ	16.1	1200 gr/mm
1.65μ	15.3	
2.12μ	14.0	grating in
2.52μ	12.2	
2.86μ	10.0	Order 1
3.10μ	7.5	

Thus, in the ¾ meter focal length instrument, at 6328A a 20-micron wide slit used with a grating of 1200 gr/mm in Order 2 will have a bandpass of 0.08A. The same slit used with a grating of 600 gr/mm in Order 1 would have a bandpass of 0.44A. Quite obviously the instrumental resolution would be 5 times better in the first case than in the second.

Slit Height - Increasing the height of straight slits reduces the instrumental resolution. This results from the well-known slight curvature of the spectra in the exit plane. In an exaggerated sense the infinitude of monochromatic spectral lines look like this ((((((. It can be seen that the top and bottom of each line overhang the center of the adjoining line. As the height of the slits is increased the ends of the exit slit begin to pass portions of adjoining wave-lengths. The effect on resolution is analogous to increasing the slit width. For this reason the height of straight slits should be limited when maximum resolution is required. On the other hand, curved slits permit full instrumental resolution even at 50 mm of slit height. Their use, however, is warranted only if *all* the following conditions are met:
1) Photoelectric detection is employed,
2) Insufficient flux is reaching the detector for good signal-to-noise ratio, and
3) The source is so large that the spectrometer continues to see more and more flux as the slit height is increased.

Recommended Minimum Entrance

Slit Length	Resolution	Slit
2 mm	0.1A	10µ
5 mm	0.1A	10µ
10 mm	0.15A	15µ
20 mm	0.2A	20µ
50 mm	0.4A	40µ

5.4 Factors Influencing Throughput

Source - Maximum throughput will be attained whenever the source subtends at least as large as a solid angle at the slit as does the collimating mirror in the spectrometer. When the source is too small, or cannot be brought close enough to the entrance slit, the relay optics must meet the same criterion.

In a monochromator with equal entrance and exit slits, measured monochromatic light source intensity is approximately 4/10 of the total integrated flux.

For maximum throughput the exit slit should be at least twice the entrance slit.

Detector - The radical difference between photographic and photoelectric detection must be borne in mind. Once the source has been properly placed the irradiance in the photographic image is solely a function of the f-number of the spectrometer and no optical shenanigans can increase the flux per unit area. Photoelectric detectors, however, integrate energy over the entire irradiated area and as a consequence the total flux can be increased simply be increasing the slit height or width. In most cases this will increase flux at the detector as a quadratic function.

Slits and Grating - When using photoelectric detection the careful choice of combinations of slit widths and grating orders can often pay large dividends in throughput. For instance, by going from the first to the second order of the grating the dispersion is doubled (usually at a price of about 10-15% loss in efficiency); this doubled dispersion permits the slits to be set twice as wide (for the same resolution) and the throughput increases quadratically. Changing to a grating with a smaller ruling constant (more grooves/mm) provides the same gains without the loss of grating efficiency which results from the use of higher orders.

Grating - Two cautions are worth keeping in mind once one has a grating of good efficiency. One is that the grating is most efficient at its "blaze" wavelength and that the efficiency falls faster toward shorter wavelengths than toward longer wavelenghts. A rule of thumb, for a grating with a blaze at λ, is that the efficiency will fall about 50% of maximum at $2\lambda/3$ and 2λ. The second caution concerns overlapping orders of diffraction which become increasingly troublesome as one works at longer wavelengths. At any position of the grating rotation the wavelength at the exit slit is uniquely determined by the geometry of the optical system. Unfortunately, the rules of diffraction allow not only the wavelength, λ, to appear at the slit, but also wavelengths, λ/n, where n is an integer. These wavelengths are referred to as higher orders of diffraction. Unless the detector is blind to the unwanted orders or is made blind by filtering, it will respond to wavelengths other than those of interest. For instance, a photomultiplier with an S-1 photochathode being used with a grating rotated to bring wavelengths at 1 micron to the exit slit will also receive and respond to energy at 5000A.

Other photocathodes are sensitive to ultravoilet when being used in the visible; in such cases a glass lens or the glass bulb of the photomultiplier itself, may serve as a filter since soda-lime glass cuts off at approximately 3000A.

5.5 Reduction of Scattered Light

At low grating angles, below approximately 4.5° problems of rediffracted light exist in "in plane" spectrometers (i.e. Littrow, Czerny-Turner, Ebert). Care should be exercised in choice of grating and/or appropriate filtering of the light source when highest spectra purity is required.

See References:

C.M. Pechina, Appl. Opt. *6, 1029* (1967)
J. Mitteldorf, D. Landon, Appl. Opt. *7, 1431* (1968)

6.1 Mini-step Driver (MSD) with typical options (See Section 6.2)

Pin #	CONTROL INPUT (25-pin female)	MONO OUTPUT (37-pin female)
1		Motor Phase 1
2		" " 2
3		" " 3
4		" " 4
5		
6		
7		
8		
9	SHUTTER OPEN (neg. true)	+24V/RET
10	FORWARD	
11	STEP	
12	LIMIT SWITCH LOW (pos. true when open)	
13	" " HIGH " " " "	
14		
15		
16		
17		+5 Vdc (to counter lights etc.)
18		LOW LIM
19		
20		1/RET
21	RET	2/RET
22	SHUTTER OPEN RET	3/RET
23	FORWARD/RET	4/RET
24	STEP/RET	
25	LIMIT SWITCH LOW/RET	
26		
27		
28		
29		AC GND
30		
31		+24V SHUTTER SUPPLY
32		XH1 CLUTCH XACTIVE (+24V)
33		
34		
35		
36		GROUND (VAC/RET)
37		HIGH LIM

6.2 MSD Options

Each MSD driver has a set of 6 pairs of pins that define the way the driver interprets signals it receives from the controller unit (CD2, DATAMATE, etc.) or from the spectrometer itself. Each pair of pins is labelled appropriately on the circuit board and to enable a functin listed below, *a jumper must be placed across the specified pair only.*

6.2.1 STEP, STEP

When a jumper is connected across *one* of these pairs, MSD expectes a STEP signal from the controller unit (pin 11 on rear panel of CD2, DATAMATE, etc.) to take the following form:

STEP - A positive pulse for STEP
STEP - A negative pulse for STEP

6.2.2 DIRECT. OPTION

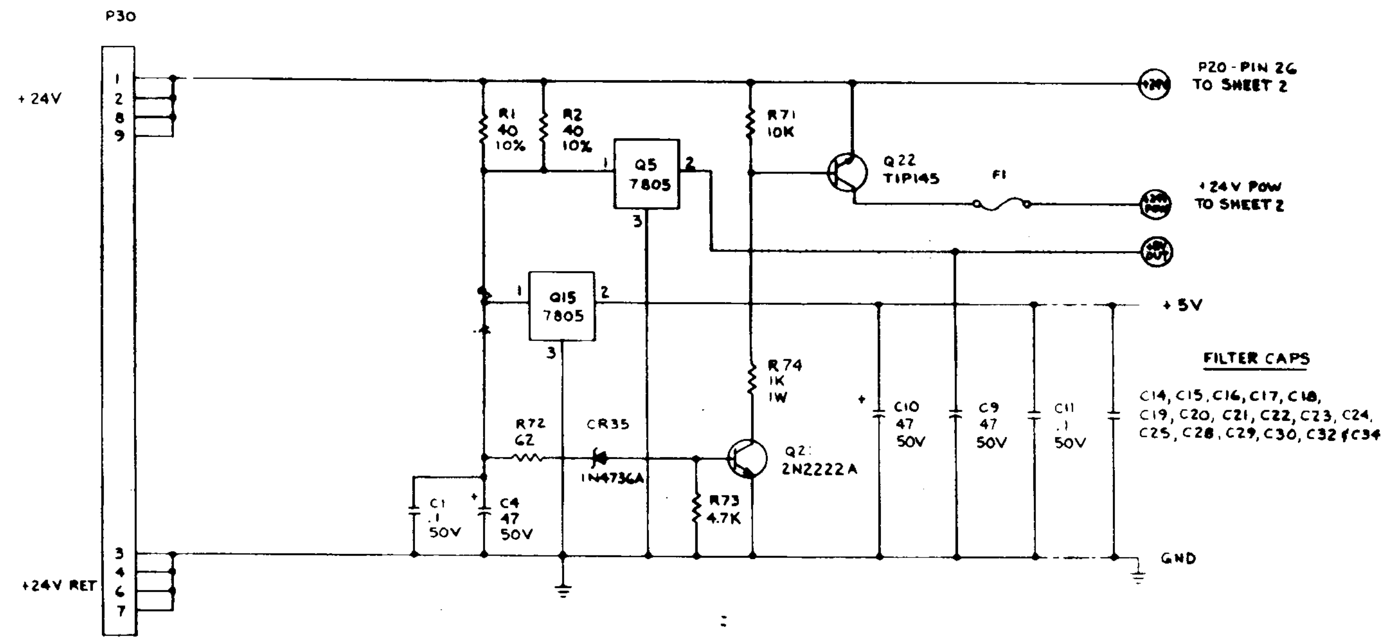
When a jumper is connected across *one* of these pairs of pins, the MSD expectes the FORWARD signal from the control unit (pin 10 on rear panel of CD2, DATAMATE, etc.) to take the following form:

A - FORWARD is High True (+5V)
B - FORWARD is Low True (0V)

6.2.3 SHUTTER OPTION

When a jumper is connected across *one* of these pairs, the MSD supplies current to the shutter when the control unit (pin 9 on rear panel of CD2, DATAMATE, etc.) gives the following signal:

A - current supplied to shutter when input is Low True (0V)
B - current supplied to shutter when input is High True (+5V)



WHEN USED WITH A 4 PHASE MOTOR,
DELETE LISTED ITEMS FROM PC BOARD.

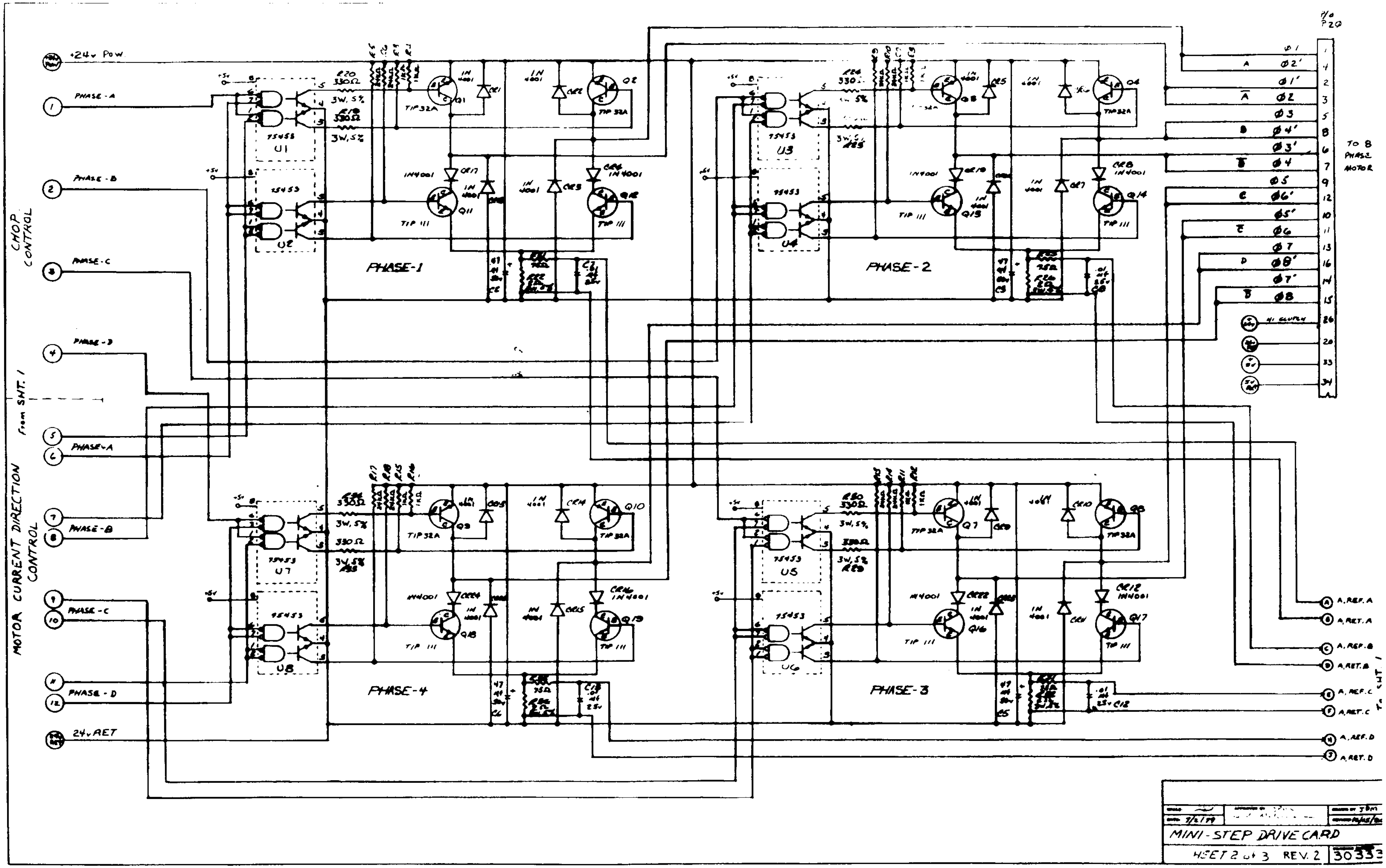
ITEM	DESCRIP.	SPD. NO.
R66, R62	150 Ω	90204
R11, R12, R15, R16 R60, R61	1K Ω	90319
R31, R36, R57, R63	75 Ω	90176
R13, R14, R17, R18	24K Ω	90480
R58 R64	100K Ω	90559
R29, R30, R33, R34	330 Ω	90834
R32, R36	2 Ω	90033
C17, C18, C27, C36	.01 uF	91070
C18, C19, C20, C21, C25	0.1 uF	91148
C5, C6	47 uF	91298
Q9, Q10, Q7, Q8	TIP32	92149
Q16, Q17, Q18, Q19	TIP111	92150
CR11, CR12, CR13, CR14, CR15, CR16, CR9, CR10, CR17, CR23, CR24, CR25	1N4001	92227
U14, U15	74LS74	95456
U5, U6, U7, U8	75453	95748

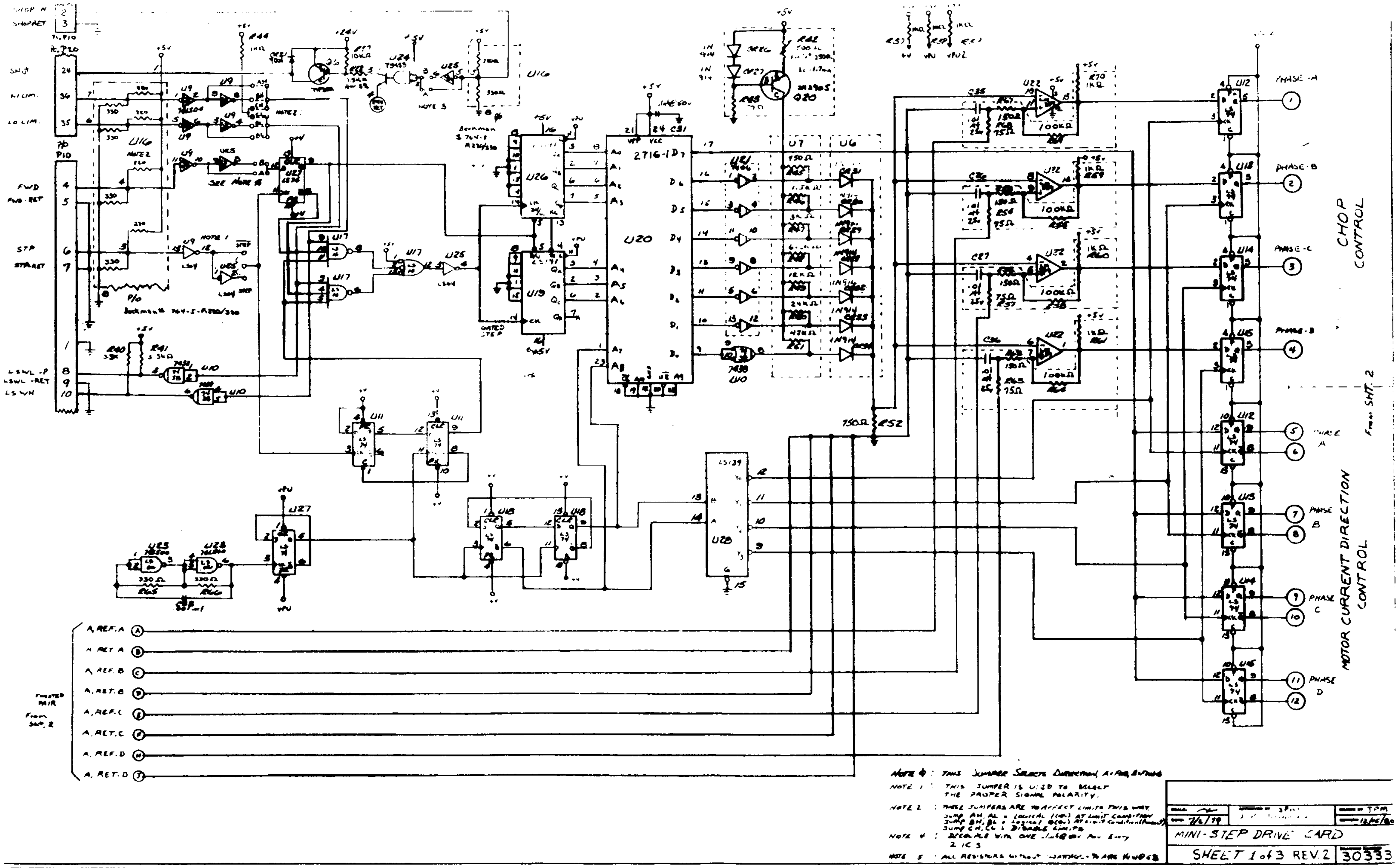
REPLACE R42 500Ω WITH BOURNS 3339P-1-102 POT. SET TO ~700Ω.
REPLACE R1 & R2 40Ω, 10W WITH 50Ω 10W.

12-15-80 J.P. McNamara

MINI-STEP DRIVE CARD

SHEET 3 OF 3 REV. 2 30333

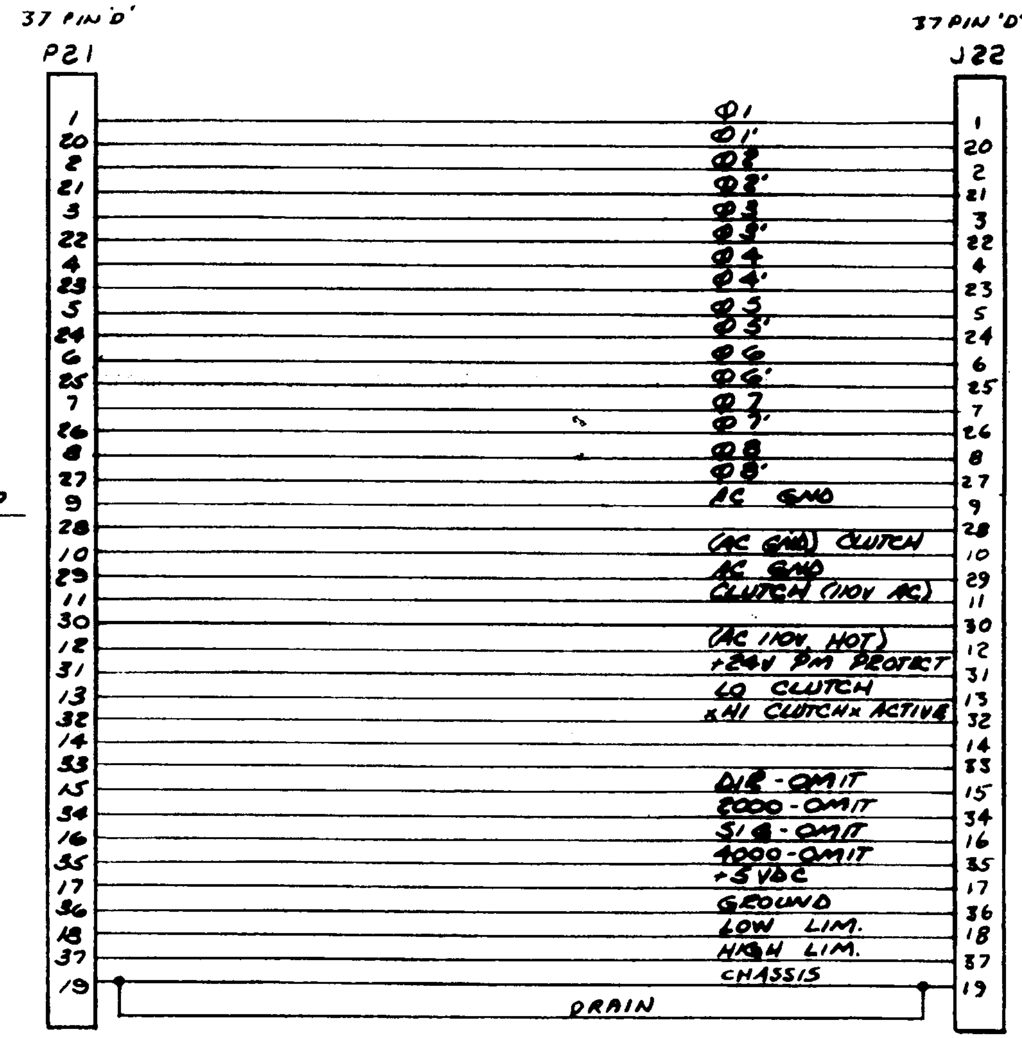

+24v POW.
PHASE - A
PHASE - B
PHASE - C
PHASE - D
CHOP CONTROL
from SHT. 1
PHASE - A
PHASE - B
PHASE - C
PHASE - D
MOTOR CURRENT DIRECTION CONTROL
24v RET
PHASE - 1
PHASE - 2
PHASE - 3
PHASE - 4
U1
U2
U3
U4
U5
U6
U7
U8
75453
TIP 32A
TIP 111
1N4001
3W, 5%
330Ω
TO 8 PHASE MOTOR
P20
A. REF. A
A. REF. B
A. REF. C
A. REF. D
MINI - STEP DRIVE CARD
SHEET 2 of 3 REV. 2
30333


CHOP CONTROL
MOTOR CURRENT DIRECTION CONTROL
From SHT. 2
PHASE-A
PHASE-B
PHASE-C
PHASE-D
2716-1
U20
LS139
NOTE 0 : THIS JUMPER SELECTS DIRECTION, AT POWER UP
NOTE 1 : THIS JUMPER IS USED TO SELECT THE PROPER SIGNAL POLARITY.
NOTE 2 : THESE JUMPERS ARE TO AFFECT LIMITS THIS WAY. JUMP AH, AL = LOGICAL 1(HI) AT LIMIT CONDITION. JUMP BH, BL = LOGICAL 0(LO) AT LIMIT CONDITION. JUMP CH, CL = DISABLE LIMITS
NOTE 4 : DECOUPLE WITH ONE .1µF PER EVERY 2 ICS
NOTE 5 : ALL RESISTORS WITHOUT WATTAGE ARE 1/4W
MINI-STEP DRIVE CARD
SHEET 1 of 3 REV. 2
30333

30341-A

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
[illegible]	A	[illegible]	JK		

MINI-STEP DRIVE

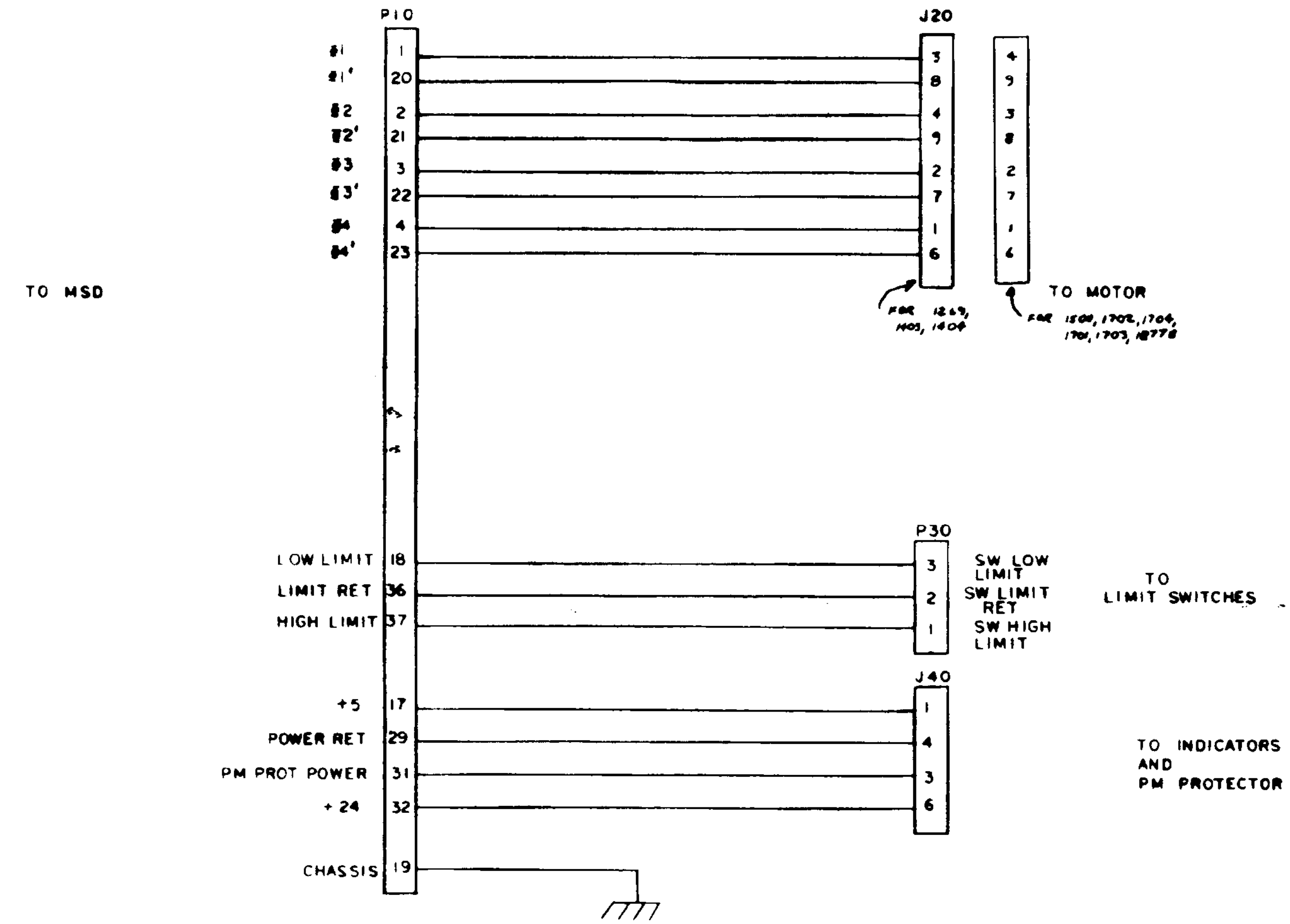


TOLERANCES (EXCEPT AS NOTED)	SPEX INDUSTRIES INC.		
DECIMAL ±		SCALE NONE	DRAWN BY N. TORCHIA / APPROVED BY J. P. McN[illegible]
FRACTIONAL ±	TITLE EXTERNAL CABLE (MS DRIVER → MONOC.)		
ANGULAR ±	DATE 1-31-80	DRAWING NUMBER 30341-A	

ASSEMBLY D30341

K+E ALBANENE ® 10 5485 ENGINEERS' STANDARD FORM

MADE IN U.S.A.



ASSEMBLY NO 831818

SPEX INDUSTRIES, INC.

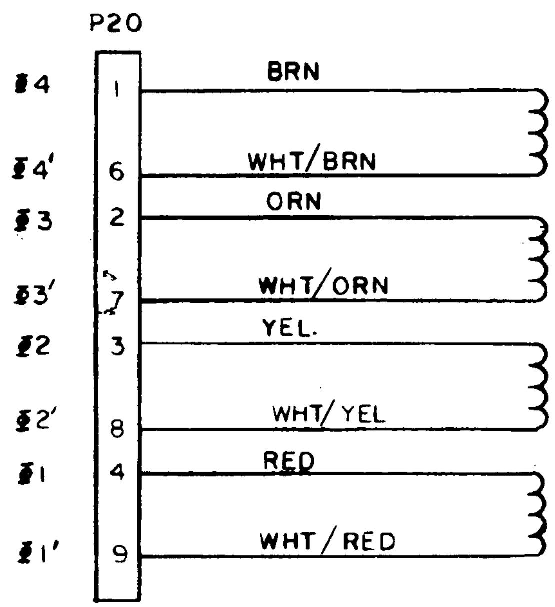
DRAWN BY DP

APPROVED BY DAK

TITLE MONOCHROMATOR INPUT CABLE (4 PHASE) SCHEMATIC

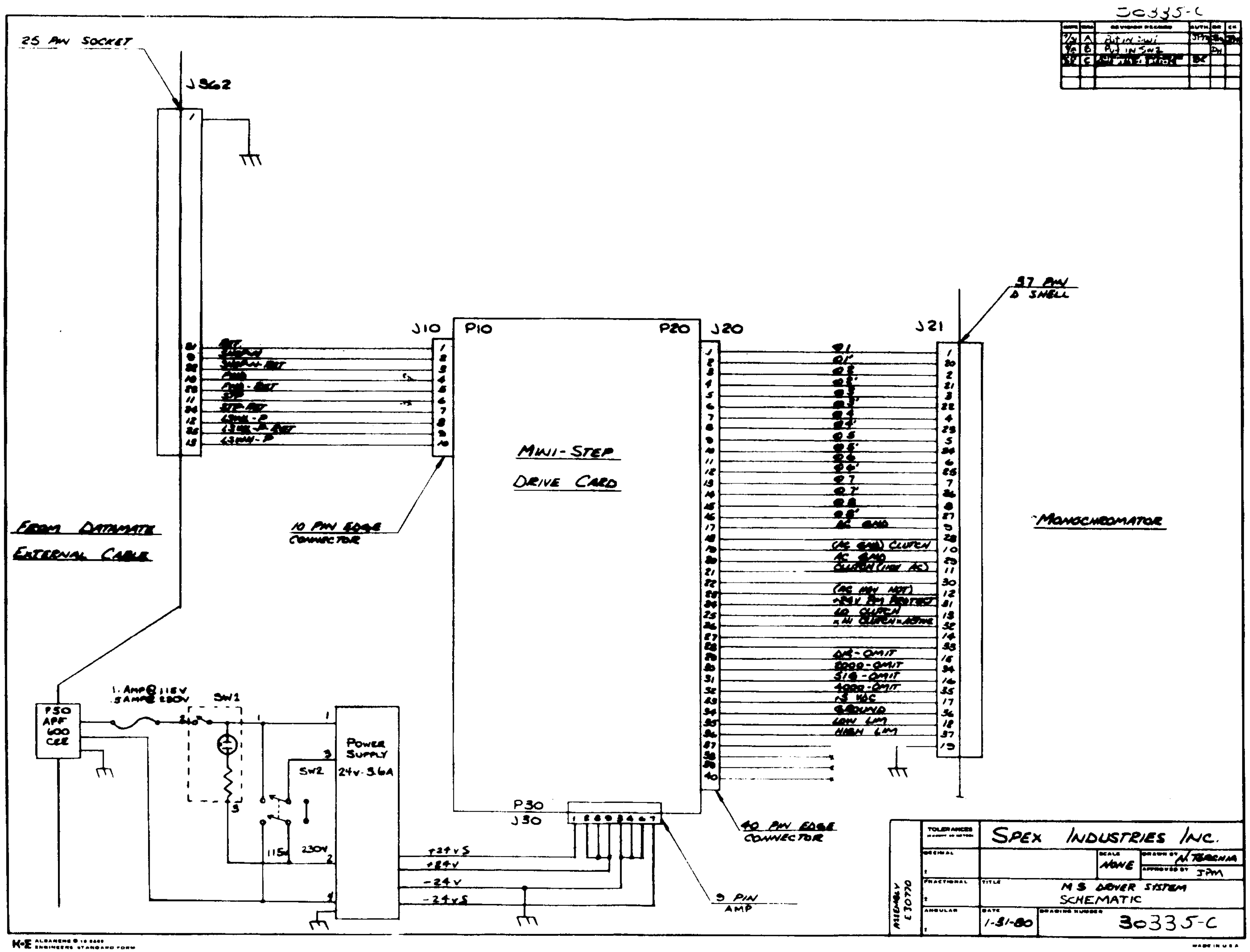
DATE 1-17-83

DRAWING NUMBER 31819



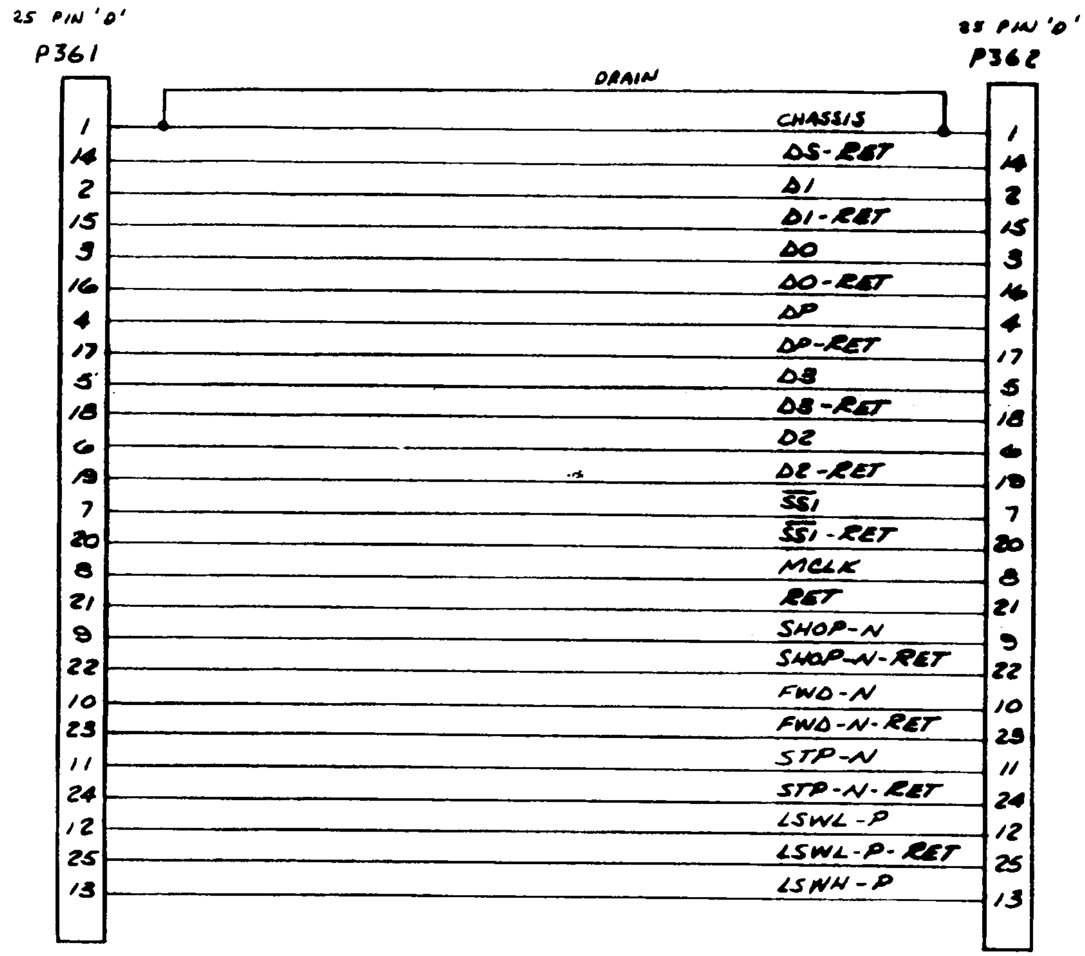
DATE	SYM	REVISION RECORD	AUTH. / DR. / CK.

ASSEMBLY NO. C31816	TOLERANCES (EXCEPT AS NOTED)	SPEX INDUSTRIES, INC.	
	DECIMAL ±	SCALE ~	DRAWN BY DP / APPROVED BY [illegible]
	FRACTIONAL ±	TITLE 4 PHASE MOTOR SCHEMATIC	
	ANGULAR ±	DATE 1-12-83	DRAWING NUMBER 31817


30335-C
25 PIN SOCKET
J362
J10
P10
P20
J20
J21
37 PIN D SHELL
MINI-STEP DRIVE CARD
MONOCHROMATOR
FROM DATAMATE EXTERNAL CABLE
10 PIN EDGE CONNECTOR
40 PIN EDGE CONNECTOR
9 PIN AMP
P30
J30
POWER SUPPLY 24V-3.6A
SW1
SW2
115V
230V
+24V
-24V
-24VS
1. AMP @ 115V
.5 AMP @ 230V
LOW LIM
HIGH LIM
GROUND
SPEX INDUSTRIES INC.
M S DRIVER SYSTEM SCHEMATIC
SCALE NONE
1-31-80
ASSEMBLY E30770

30340-11

DATE	SYM	REVISION RECORD	AUTH.	DR.	CK.
[illegible]	A	[illegible] ADDED DRAIN	DK		



ASSEMBLY 030340

TOLERANCES (EXCEPT AS NOTED)
DECIMAL ±
FRACTIONAL ±
ANGULAR ±

SPEX INDUSTRIES INC.

SCALE: NONE
DRAWN BY: N. TORCHIA
APPROVED BY: J. P. [illegible]

TITLE: DATAMATE → MS DRIVER EXTERNAL CABLE

DATE: 1-30-80
DRAWING NUMBER: 30340-A