I.B. 495-100

SERVICE

MANUAL

HL-90

TRACING SYSTEMS

Manufactured and sold under one or more of the following patents:

Canada	U.S.A.	U.K.	Japan	France	Italy	Australia	Switzerland
917,773	3,704,372	1,292,507	756,804	2,066,165	916,825	450,468	531,395
930,795	3,727,120	1,384,253	844,232	2,213,543			
930,838	3,725,761	1,445,253		2,461,298			
950,553	3,860,862	2,008,343					
972,446	3,883,735	1,578,514					
1,005,540	4,197,453	2,054,198					
1,005,548	4,128,297						
1,077,755	4,160,158						
1,082,333	4,146,801						
	4,195,265						

and pending applications in Canada, U.S.A., U.K., Germany, Japan, and Italy.

SEPTEMBER 1997

Manual Number I.B. 495-100
Rev. G

Read, Understand and Follow These
IMPORTANT SAFETY INSTRUCTIONS
Before Operation Or Service

1. Please read ALL these instructions before operating the equipment.

2. Do not locate this equipment where moisture could cause a shock hazard.

3. Operate this equipment only using the type of power source specified. The equipment must be grounded by using a properly installed 3-wire cable that is terminated either by a 3-pin grounding type power plug, or by connection to a properly grounded distribution box. It is hazardous to defeat the purpose of this grounding.

4. Locate the power cord where it cannot be walked on. Be sure that nothing heavy enough to deform or damage the cord is allowed to rest on it.

5. In general, extension cords should not be used. Where their use cannot be avoided, be sure that the cord is rated to carry the required current, and that the current capacity of the power outlet is not exceeded.

6. Do not attempt to service this product yourself, as opening or removing covers may expose you to dangerous voltage points or other risks. Refer all servicing to qualified personnel.

7. Unplug this product from the power source and refer servicing to qualified service personnel, under these conditions:

   a. When the power cord is damaged or frayed.
   b. If the product has been exposed to rain, water, or other liquid.
   c. If the product does not operate normally when the operating instructions are followed. Adjust only those controls that are covered by the operating instructions, since improper adjustment of other controls may result in damage and will often require extensive work by a qualified technician to restore the product to normal operation.
   d. If the unit has been damaged.
   e. If the product exhibits a distinct change in performance, indicating a need for service.

8. This equipment should not be used for purposes, other than its intended and designed use.

IMPORTANT SERVICING INFORMATION

CAUTION

The subassemblies listed by serial number on the reverse on the test tracing, shipped with each equipment, comprise a complete system. To avoid the need for realignment after installation, ensure that the serial numbers os listed are kept together as one system.

Every effort has been made to ensure that this service manual contains the latest product information. Changes may be made from time to time, however, to improve product performance. CHECK THE BACK OF THE MANUAL for coloured Technical Bulletins of Errata Sheets that describe these changes. If it is noted that a component value in the equipment differs from that shown in the corresponding schematic diagram, record the actual value in this manual so that the same value can be used for replacement, if required, when servicing that particular assembly.

ESD PRECAUTIONS

Proper Electrostatic Discharge (ESD) procedures must be followed at all times when servicing one of these products. Wear a properly grounded wrist strap when handling any circuit card. All circuit cards and assemblies must be handled in electrostatic protective containers when in transit or when handled by non-grounded personnel.

WARNING

VOLTAGES EMPLOYED IN THE EQUIPMENT ARE SUFFICIENTLY HIGH TO ENDANGER HUMAN LIFE. THIS EQUIPMENT SHOULD BE SERVICED BY QUALIFIED SERVICE TECHNICIANS.

To avoid damage to this equipment, turn the unit OFF and remove AC input source power to the equipment before disconnecting cables or removing circuit cards.

File No.
LR27781

The equipment described in this manual is manufactured to CSA-approved standards.

Any changes made to this equipment may void CSA approval.

The equipment described in this manual meets the requirements of the low voltage directive 73/23/EEC and EMC requirements of 89/336/EEC.

Any changes made to this equipment may void this compliance.

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ABOUT THIS MANUAL

This service manual consists of six standard Chapters for all HL-90 products, followed by a custom Parts List and where applicable, an Addendum, as follows:

Chapter 1: GENERAL DESCRIPTION. Describes the principle of operation of the Linatrol HL-90 Co-ordinate Drive Tracing System, including specifications.

Chapter 2: DETAILED DESCRIPTION. Provides functional and circuit descriptions of the Tracing System assemblies and subassemblies.

Chapter 3: INSTALLATION. Covers the mechanical and electrical installation procedures and the motor checkout procedure.

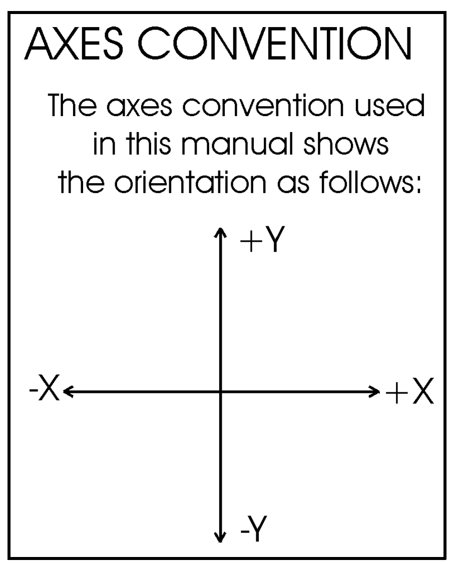
Chapter 4: OPERATING INSTRUCTIONS. The HL-90 Front Panel controls are described and operating instructions are given for the two tracing modes (PLASMA and OXY-FUEL) and the Stripping mode.

Chapter 5: OPERATING FEATURES. This section covers the special features of the HL-90 system, Lead Tracing, Kerf compensation and Pattern Tracing capabilities.

Chapter 6: ALIGNMENT & TROUBLE-SHOOTING. This section covers all essential maintenance procedures, operating and speed adjustments, power supply checks and line frequency change procedures.

Supplement: PARTS LIST. This is a complete listing, on an assembly basis, of replaceable parts for the particular HL-90 model you have selected. The information found in this section will be of value when ordering either spares or replacement parts.

Addendum: Where applicable, this manual contains an Addendum covering any differences from the standard configuration.



GENERAL DESCRIPTION 1

INTRODUCTION

The HL-90 Linatrol Co-ordinate Drive Tracing System automatically controls the motion of a cutting tool by following a line or silhouette pattern. It is intended for use on small cutting machines.

System features include automatic line acquisition, tool off-pattern interlock and a four-position direction switch for manual operation. The system consists of a Tracing Unit containing:

- the Scanner
- the Electronics and Controls
- two Drive Units.

A view of the HL-90 Drive Tracing System is shown in Figure 1-1.

PRINCIPLE OF OPERATION

The scanner is an opto-electronic device using a circular scan system to trace either line or silhouette patterns.

The scan motor is a synchronous ac motor, operating at 1800 rpm on a 60 Hz primary power supply (or 1500 rpm on a 50 Hz supply). Attached to the motor shaft is a mirror and magnet assembly. The magnet associated with a fixed coil generates a sinusoidal reference signal. The mirror reflects an image of the fixed photo-sensor through a focussing lens on to the pattern surface. The mirror is inclined at a small angle with reference to the optical axis and the image of the photo-sensor therefore traces a circular path about the pattern line.

The photo-sensor signal is obtained when the image of the sensor crosses the pattern line. It is processed along with the sine reference signal on the Tracing Circuit card to produce two vector signals that describe the direction of tracer motion required to follow the pattern line. These signals are amplified and supplied to the two Drive Units, thereby producing machine motion along the pattern line.

The controls which are wired directly to the Tracing Circuit card provide for speed adjustment, tracing or stripping operations and a four-direction manual traversing control. A green LED indicates pattern acquisition when illuminated.

The radius of the scanned circular path is known as the lead. A general purpose 3 mm lead is fitted on most models as standard equipment. Other leads are available, to suit specific requirements and operating conditions.

SPECIFICATIONS

POWER	! 100 Vac +10%/-15%, 50/60 Hz, or ! 115 Vac +10%/-15%, 50/60 Hz, or ! 230 Vac +10%/-15%, 50/60 Hz, Selectable by internal connections to the transformer, factory preset to the voltage specified by the customer.
TRACING SPEED	! 100 mm/min to 3000 mm/min; this depends on the options used with the system and the machine characteristics.
PATTERNS	! Line width or silhouette (0.5 mm, minimum); refer to Chapter 5.
LEAD	! Standard: 3 mm, fixed; other leads are available upon request.
FOCUS	! A 6-mm depth of field allows variations in tracing table height of ±3 mm, while still maintaining tracing accuracy.
ENVIRONMENT	! Operating temperature from 0EC to +50EC. ! Storage temperature from -18EC to +65EC. ! Humidity to 95% RH (non-condensing). ! It is recommended that this equipment be used in controlled indoor environment. ! Meets requirements for IP54 protection.

Table 1-1 HL-90 Specifications

WARNING

The Linatrol equipment is designed to operate from a three-wire, grounded power source.

Failure to provide the correct power source and grounding connections, as detailed in the installation instructions, may result in conditions hazardous to the operator and/or service personnel.

OPTIONS

These options are available for use with the HL-90 Linatrol Co-ordinate Drive Tracing System:

1. Increased power for high-speed applications, up to 3000 mm/min.

2. Corner enhancement to improve low speed operation.

3. Command mark actuated corner slowdown to reduce speed and allow the system to negotiate sharp corners while travelling at high speed.

4. CNC interface.

Figure 1-1 HL-90 Drive Tracing System

DETAILED DESCRIPTION 2

TRACER UNIT SUB-ASSEMBLY

The Tracer Unit Subassembly consists of the following components:

- Chassis-mounted transformer T1
- Power switch S5
- Primary fuse F1
- Cutting oxygen solenoid connector J5
- X-drive connector J6 and Y-drive connector J7 (as well as connector J9 or P9 for CNC interfacing, if fitted for CNC operation)
- Chassis Board circuit card assembly (CCA).

The unit is equipped with a latching power relay K3, which de-energizes, should input power fail. The unit must be reset before operation can resume.

Chassis Board

ASSEMBLY	SCHEMATIC
3916D27G01	3924D55
3916D27G02	3924D71

The Chassis Board CCA is mounted in the Tracer Unit Subassembly, on the back wall of the enclosure. The card is connected to other parts of the HL-90 by means of 'Fast On' terminals and connectors. The transformer secondary input to the card is via connector J12, pins 1 and 2.

The transformer output is rectified by rectifier bridge CR1 and filtered by capacitor C1 to produce +20 Vdc, and by capacitor C2 to produce -20 Vdc. Voltage regulator U1 is used to produce a regulated +12 Vdc source for the flood lamps and indicator light. If the unit is fitted for CNC operation (via connector J8), capacitors C3 and C6 are installed for stability.

On the 3916D27G01 card, transistor Q1 is used to turn on the flood lights; relay K2 performs the same function on the 3916D27G02 card.

Solid-state relay K1 is used to switch on the cutting oxygen solenoid. Capacitor C3 is used as a phase-shift capacitor for powering the scanner motor.

Test points and connectors provided on the Chassis Board are listed in Tables 2-1 and 2-2 respectively.

Test Points
+20V
-20V
+12V
GND

Table 2-1 Chassis Board Test Points

Connector	Connecting To
J3	Scanner Assembly
J8	CNC Option
J12	Transformer Secondary
J13	Tracing Circuit CCA

Table 2-2 Chassis Board Connectors

'Fast On' connection points E4 to E18 (refer to Figure 6-5) make it possible to configure the unit to operate from different input voltages and to provide different voltages to operate the cutting oxygen solenoid; E3 is ground.

Cable Assembly 415B905H01 is required to connect J13 on the Chassis Board CCA to J1 on the Tracing Circuit CCA. The cable should be installed as shown in Figure 2-1. Ensure that there are no twists in the cable and that pin 1 of J13 connects to pin 1 of J1. The cable connectors have a black dot on each end. These dots should be adjacent to a black mark on the mating connectors on the Chassis Board and the Tracer Circuit when the cable is correctly installed.

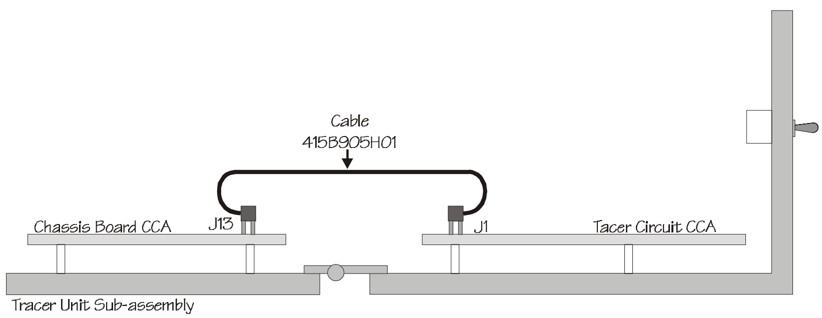


Figure 2-1 Cable Assembly 415B905H01 Installed

Power Supplies

When the appropriate transformer is fitted, the HL-90 system will operate from any of the single phase grounded AC power sources listed in Table 2-3.

LINE VOLTAGE	LINE FREQUENCY
230	50 Hz or 60 Hz
115	50 Hz or 60 Hz
100	50 Hz or 60 Hz

Table 2-3 Primary Power Requirements

Line frequency is factory selected to order. Adjustments necessary when changing from operation at one frequency to operation at another are detailed in Chapter 6, Alignment & Troubleshooting.

Power is supplied through primary fuse F1 and POWER ON/OFF switch S5 to the primary of transformer T1. The scanner motor power is supplied from the 115V winding on the primary of T1. The cutting oxygen solenoid power is supplied through solid state relay K1 on the Chassis Board CCA. The voltage to the solenoid can be either 24 Vac, 100 Vac, 115 Vac or 220 Vac, depending on the application.

PLUS AND MINUS 20 VDC SUPPLIES

The output from the secondary of T1, leads 4 (green) and 6 (green), is rectified by bridge rectifier CR1; the positive side of the bridge is filtered by C1 and the negative side by C2, to provide +20 Vdc and -20 Vdc outputs. The centre tapped secondary of T1, lead 5 (white and green), connects to chassis ground. Table 2-4 shows the dc voltage distribution.

VOLTAGE	USED FOR
+20 Volts	Tracer Unit Subassembly: +12V Regulated Supply (U1) to flood and spot lamps in the Lighting & Sensing Assembly. Tracing Circuit Assembly: U8, U22, and +12V Regulated Supply (U26).
-20 Volts	Tracing Circuit Assembly: U8, U22, and -12V Regulated Supply (U27).

Table 2-4 DC Voltage Distribution

The +20 Vdc output is supplied to regulator U26 on the Tracing Circuit CCA via J1-5, to a CNC (if fitted) via J8-3, and to regulator U1 on the Chassis Board CCA. The +12 Vdc output of U1 is fed via J3-1 to the series-parallel combination of flood lamps (DS1, DS2) and spot lamp (DS3) in the Lighting And Sensing Assembly. It is returned to chassis ground (E2) from the parallel DS1, DS2 lamps via J3-2 and FET light switch Q1 (or relay K2). Q1 is switched ON and OFF (or K2 is operated) from the Tracing Circuit Assembly via J2-1 and J3-3. Spot lamp DS3 is returned to chassis ground via J3-4.

The -20 Vdc output is supplied to regulator U27 on the Tracing Circuit CCA via J1-6. The +20 Vdc and-20 Vdc outputs go to U8 and U22 on the Circuit Board Assembly and to the collectors of their associated transistors Q3, Q4, Q5 and Q6.

REGULATED PLUS AND MINUS 12 VDC SUPPLIES

Regulated outputs, U26-3 and U27-3 provide +12 Vdc and -12 Vdc to the remaining integrated circuits and associated components on the Tracing Circuit CCA. The +12 Vdc and -12 Vdc supply voltages can be measured at test points TP1 and TP2 respectively.

SCANNER ASSEMBLY

The scanner assembly generates signals which, when processed, drive motors that enable a machine to accurately follow a pattern. A circular scan device is used to detect the pattern and generate a sine-wave reference signal.

The scanner rotates at 1800 rpm when operated with a 60 Hz power supply and at 1500 rpm when a 50 Hz supply is used. The scanner includes a magnet which rotates between AC generator coils to generate a sine-wave reference signal. The output of the generator coils appears between P2-3 (GND) and P2-6; connecting to the tracing circuits at J2-3 and J2-6, respectively.

Flood lamps illuminate the pattern to be traced. A lens is used to focus an image of the pattern line, in the plane of photo-sensor Q1, via a mirror mounted at the lower end of the scanner. When the scanner intercepts a black pattern line, the mirror reflects an image of the fixed photo-sensor on to the pattern line. While the image of the sensor covers the line, a reduced light condition exists and the sensor output current decreases. When the image of the sensor moves off the line, as a result of the circular scan motion, the current is restored to its original value. The sensor output is therefore a series of pulses at a repetition rate of twice the scanner rpm.

When tracing a line pattern, two pulses are produced, one corresponding to the forward direction of the scan, the other to the trailing side of the scan. The latter pulse is referred to as the `back scan' signal. When tracing a silhouette pattern, only one pulse per revolution is produced, the duration of which is approximately one half of the scan time.

The flood lamps which are mounted on the underside of the Tracer Unit illuminate a broad area. To effectively locate the Tracer at any point on the pattern (e.g. at a required starting point), a spot light illuminates a small area centred on the optical axis of the scanner. The appropriate light source is turned on automatically when the desired operating mode is selected on the STRIP/TRACE/START switch.

CONTROL ASSEMBLY

The controls are mounted on the front surface of the Tracer unit enclosure, except the POWER ON/OFF switch which is mounted, together with fuse F1, on the left hand side.

The six front panel controls are:
- SPEED
- DIRECTION
- DRIVE (ON/OFF)
- MODE
- CUT OXY (MANUAL/OFF/AUTO).
- POWER

An ‘ON PATT’ (On Pattern) LED is provided to indicate when the tracer is following a pattern.

TRACING CIRCUIT ASSEMBLY

The following description applies to all groups of Tracing Circuit CCA 3925D27 used in systems with serial numbers of 10,000 and greater.

All signal processing circuits are located on this circuit card (refer to Chapter 7 for schematics). The sine generator output is used as a reference signal in the Sample And Hold circuits, and to generate timing signals that gate sample pulses through the control logic circuits. In the Tracing mode, sample pulses are derived from the sensor signal originating in the scanner; in the Stripping mode, the reference signal itself is used to originate the sample pulses. This ensures that the tracing speeds, under all modes of operation, are compatible.

Sensor Signal Processing

The sensor output goes to Buffer Amplifier U23A, via choke L1, and is ac-coupled to pre-amplifier U24B. The dc level of the pre-amplifier input is clamped by U23B so that U24B output is a series of positive pulses which correspond to the scanned crossings of the pattern line being traced. A peak detector circuit, U24A, measures the pre-amplifier output observed at TP5 and adjusted by gain control R21 until the output begins to limit (approximately 10.5 Vdc).

To eliminate the ‘back scan’ pulses, monostable U25 is triggered by the first pulse received upon acquisition of a pattern. The output of U25A is the Inhibit Pulse which is adjusted by R30 to 28 msec on a 60 Hz supply (on a 50 Hz supply the Inhibit Pulse is 34 msec). Since U25A is connected in a configuration which cannot be re-triggered, the duration of the inhibit pulse blocks the `back scan' signal, permitting the next forward pulse to trigger the Inhibit Pulse again.

As long as a pattern is being scanned, the Q output (TP6) of the Inhibit Pulse Generator is a train of pulses at a 30 Hz rate. Note that here, and in the following description, references to 30 Hz are in conjunction with a 60 Hz supply; a system using a 50 Hz supply has a corresponding reference of 25 Hz.

Monostable U20A, the On Pattern pulse generator, is timed to produce an output pulse with a duration of approximately five rotations of the scanner. Connected to be re-triggerable, the Q output is a continuous logic 1 (or high) as long as a pattern is being scanned. The output high from U20A drives the on pattern circuit, Q2 and DS1 (ON PATT); the Q output is used in mode-switching functions.

The output of U25A-6 is used to trigger the X-sample pulse at monostable U21B; the Y-sample pulse is generated by U21A. U20B-9 delays the Y-sample pulse from the X-sample pulse by 90E (8.33 msec for a 60 Hz supply; 10 msec for a 50 Hz supply).

The X-sample and Y-sample pulses are applied to Sample and Hold devices U11 (X-channel) and U18 (Y-channel) which produce the speed vector voltages necessary to follow the pattern.

Sine Reference Signal Processing

The Sine Generator output signal is a sinusoidal waveform, with peak negative voltage occurring as the scanner crosses the -Y axis of the machine. The signal is amplified by U13A with the gain adjusted by R41 to produce an output at TP3 of 15 volts peak-to-peak (5.3 Vrms).

A proportion of this signal is determined by the setting of the SPEED control potentiometer R40 and, if fitted, the LO/HI range switch or possible operation of the Slowdown circuit. This composite signal is sampled in the Sample and Hold circuits U11 and U18 to generate the speed signals that drive the X- and Y-Axis Drives, respectively.

For the Strip Mode implementation, amplifier U13B squares and inverts the sine wave reference signal. The positive-going edge of this signal is used to generate an approximate 90E delay (U5A). The negative-going edge of the 90E delay triggers U5B which produces a 6 µsec pulse used to sample the peak of the sine wave speed signal input to U14A.

The output of U14A is used in the Strip and Start modes as the X and Y speed vector voltages. The polarity of the voltages is determined by the setting of Direction Switch S1.

For Strip/Trace operation, analog switches U10A and U10B select either the manual-steer vector voltages or the trace-speed vector voltages for the Y and X channels respectively. The switch from Strip to Trace is made only if S2 is in the Start position and a pattern is detected. Should the pattern be ‘lost’, the Strip vector voltages are selected. Since S2 is in the Trace position, the voltages are zero and no motion takes place.

Analog switches U26A and U26B connect the sampling capacitor of the X-channel Sample and Hold IC, to the vector speed signal output in the Strip or Start mode. This ensures that when the switch to the trace-speed vector signal occurs, the speed vector at that instant is the same as the strip-speed vector voltage.

Drive Amplifier Circuits

This description applies to the X channel; the Y channel is identical (with the exception of component identities).

Analog switch U10A selects either the Strip speed signal voltage or the Trace speed signal voltage. This signal, or one from a CNC at J15-6, is the input to the servo-amplifier.

The servo-amplifier consists of operational amplifier U8 and a driver stage consisting of transistors Q3 and Q4. Potentiometer R50 is used to adjust the servo-amplifier offset to zero. Motor speed for a given speed signal input is adjusted by R65 which determines the scale factor of the tacho feedback summed with the speed input signal.

Capacitor C40, resistor R49 and the network consisting of R53 and C28 determine the amplifier frequency response characteristics and ensure amplifier stability.

The current output of U8 is limited by the value of R59. The output to the motor is provided by Q3 and Q4. Motor drive current is limited by CR34 and CR35 for positive output voltages, and by CR36 and CR37 for negative output voltages. When Q3 conducts, the maximum supplied current occurs when the voltage drop across CR34 and CR35 equals the base-emitter drop in Q3 and the voltage drop across R67. Any further increase in the voltage across R67 biases Q3 to reduce the current flow. Current limiting when Q4 conducts is achieved in a similar manner. Current limit is set to a nominal value of 1.5 amperes for G04 and G06 circuit cards, and to 1.0 ampere for G01 circuit cards.

Connections to the Drive Motor and Tachometer are made through X_M and X_T fast-on connectors. Motor return current and tachometer ground connections are made at the E2 (chassis ground) terminal.

Cutting Oxygen Solenoid

Cutting oxygen solenoid control is provided by means of a solid-state relay, located on the Chassis Board CCA. This relay is controlled by transistor Q1 which is turned ON when:

1. The Cut Oxygen selector (S3) is set to MAN, or

2. The Cut Oxygen selector (S3) is set to AUTO, and the pattern is being traced, or

3. The Cut Oxygen selector (S3) is set to AUTO, and the STRIP/TRACE/ START switch (S2) is in the START position.

On-Pattern Light

The ON Pattern light (DS1) illuminates when a pattern is acquired. The light is controlled by transistor Q2.

Indicator/Flood Lights

The selection of Indicator light or Flood light is controlled by the signal at J2-1. A logic 0 at J2-1 in STRIP mode selects the Indicator light. Selection of TRACE or START results in a logic 1 at J2-1, turning ON the Flood lights.

Circuit Card Connectors

The connectors for the circuit card functions are listed in Table 2-5.

CONNECTOR	FUNCTION
J1	Input power and cutting oxygen control
J2	Tracing signals
J10	Torch Height Control Enable or On Pattern
J14	Connections to tracer control
J15	CNC Connection
J16	Connection to tracer control

Table 2-5 Circuit Card Connectors

OPTIONS

The four optional circuits available with the system are:

- Low Speed Corner Enhancement - Tracing Circuit CCA 3925D27G04 or G06.
- High Speed operation - Tracing Circuit CCA 3925D27G04 or G06.
- Corner Slowdown - Tracing Circuit CCA 3925D27G06.
- CNC Interface - can be supplied with all Tracing Circuit CCA, 3925D27G01, G04 or G06.

The part number of the standard Tracing Circuit CCA (without any options) is 3925D27G01.

Low Speed Corner Enhancement

These circuits introduce a delay in the Tracer response to changes in direction of travel. The path followed by the Tracer can be made to more accurately reproduce small radii pattern corners by selecting the delay required to compensate for lead-induced under-cutting of corners. Ideally, Tracer response should be inversely proportional to the speed at which the Tracer is travelling.

In this system the delay is in the form of three fixed increments over the Low Speed range of 0 to 600 mm/min (0 to 24 IPM). Speeds from 0 to 230 mm/min (0 to 9 IPM) require the longest delay, while a lesser delay is required at speeds from 230 to 500 mm/min (9 to 20 IPM). The shortest delay is used at speeds from 500 to 600 mm/min (20 to 24 IPM).

Response variation is achieved by increasing/decreasing the capacitance of the sampling capacitor used in the Sample and Hold circuit. As a sample pulse is applied to U14-8, the X-axis Sample and Hold IC, capacitor C15 is charged to the voltage level at U14-3.

These sample pulses are too short to completely charge C15 during a single sample pulse. The source that supplies the charge current has a finite output impedance and therefore there is an exponential charging rate of C15, with an RC time constant during each sample pulse period.

This system is designed so that maximum speed on the Low range is 600 mm/min, regardless of the maximum speed on the High range. A ratio can be determined that will relate maximum speeds of these ranges. The maximum speed in the High range can be set at any value between 1000 and 3000 mm/min, depending on the application. The Low range speed adjustment (R122) should be set to the peak-to-peak sine wave voltage measured at TP12, corresponding to the High/Low ratio. Adjustment of this potentiometer defines the High/Low ratio.

The root-mean-square (rms) voltage, at maximum speed, is 5.3V (15V peak-to-peak) and the amplitude of this signal, measured at the wiper of R40 (Speed Control), is monitored at TP12. For a system with a 3000 mm/min maximum speed, R122 should be adjusted such that, when the speed control is set to Low range maximum, TP12 indicates 1.03 Vrms (3.0 Vp-p).

The calculation is:

$$V_{TP12} = 5.3\ V_{rms} \times \frac{600\ \text{mm/min}}{3000\ \text{mm/min}}$$

$$= 1.06\ V_{rms}$$

$$= 3.0\ V_{p\text{-}p}$$

Tracer speed setting must be determined in order to allow switching extra capacitors in/out of the Sample and Hold circuit. This is accomplished by means of a circuit consisting of U28 (two halves of which form a rectifier and filter) and U32. The sine wave at U32-1 is rectified so that the output, observed at TP13, is positive only and filtered by the combination of R98 and C64, C65 to remove ripple. The output, observed at TP13, is a DC voltage proportional to the amplitude of the sine wave, the gain of which can be adjusted at R86, part of the U32 circuit. The gain adjustment is set so that at maximum speed on the Low range and the voltage at TP13 is 5.0 Vdc.

The filtering circuit uses a long time constant so the voltage, measured at TP13, lags changes in speed control setting by several seconds. The two halves of U29 form comparators for the voltage observed at TP13 and a fixed reference voltage, taken from divider network R89, R90 and R91. The resistance values used in this network have been chosen so that the comparators will switch at speeds of 230 and 500 mm/min.

When the voltage observed at TP13 is less than the reference voltage input, the comparator output will be approximately 5 Vdc (considered to be a logic 1 level). A logic 0 will be generated by the comparators when the voltage at TP13 is greater than the reference voltage.

The outputs from these comparators are used to drive analog switches U30 and U31. The action of these two switches will cause extra capacitors to be brought into, or taken out of the Sample and Hold circuit. The extra capacitors are connected in parallel with C14 and C15 respectively, for X and Y channels.

Setting the HI/LO switch to the low speed range connects capacitors C98 and C101 in parallel with C14 and C15, respectively.

When the speed control is set between 500 and 600 mm/min, capacitors C73 through C77 are connected, through R105 and the action of analog switch U30, to X1. This charges capacitors (C73 to C77) to the voltage level found on capacitors C14 and C98. This eliminates transients in speed output when capacitors C73 and C74 are switched into the circuit in parallel with C14 and C98. At speeds of less than 230 mm/min, capacitors C75, C76 and C77 are also switched in parallel with C14 and C98.

Adjusting the voltage at TP13 higher than 5.0 Vdc, with the speed control at maximum on the low speed range, lowers the switching points at which the time constant of the Sample and Hold circuit is charged. For example, if the voltage at TP13 is set to 6.0 Vdc, switching occurs at 430 mm/min and at 190 mm/min, resulting in less overshoot on corners, at speeds of between 430 to 500 mm/min and 190 to 230 mm/min.

High Speed Operation

Increased machine stability, sometimes required in systems operating at high speeds is accomplished by the two shunts fitted between terminals 1-4 and 2-3 of both W1 and W2. Connecting one of these shunts between terminals 1-2 on W1 and W2 will increase machine stability. When further stability is required; connect the other shunt between terminals 3-4 of W1 and W2. Increasing machine stability may produce additional corner overshoot which can be reduced or eliminated through the use of the Corner Slowdown Option.

Since High Speed operation usually involves the use of a Plasma system, additional filtering to improve immunity to Plasma noise is provided by L1 on the Tracing Circuit card.

Corner Slowdown Circuit

The slowdown circuit operates by detecting the presence of command marks, or an edge pattern such as that shown in Figure 2-2. When a command mark is detected the tracer is made to slow down to a speed adjustable to any rate above 1/3 of maximum speed. The slowdown feature is enabled when:

- The circuit is enabled, and
- While in pattern acquisition mode.
- A Command Mark is being scanned.

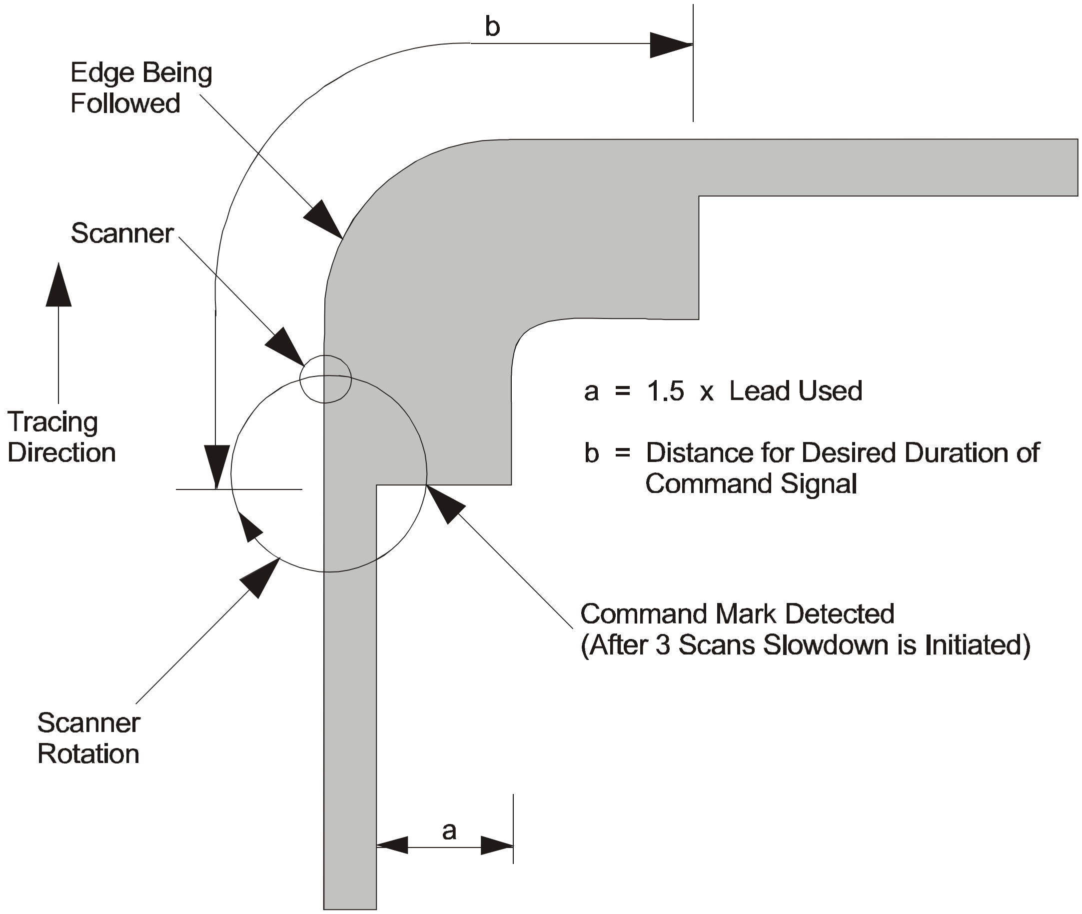


Figure 2-2 Command Mark for Corner Slowdown

The signal from the scanner (from U23-1) is amplified by U33. Signal gain is adjusted by R114 so that when the scanner is over an edge pattern (Command Mark), the signal at TP14 is saturated (full amplitude) for the duration of the signal from the Command Mark.

The signal at TP15 is the peak detected signal, suitable for monitoring with a dc voltmeter. R114 is adjusted clockwise (CW) until further adjustment causes little increase in voltage reading at TP15. Using an oscilloscope to view the waveforms at TP14 is the preferred method of gain adjustment.

When the signal from U21-6 (scan signal, delayed by 90 electrical degrees) is applied at U35-2 and the logic 1 generated by the scanning of a Command Mark is applied at U35-1, the condition of U35-9 is governed by the state of U35-8.

The signals on U34-1 and U34-15 are at logic 0, as a result of this counter being reset. A logic 1 clock signal is applied to U34-3 causing the counter to increment to 1. The output of U34-1 becomes a logic 1. On the next scan of the Command Mark the counter is incremented to 2 and the outputs of U34-1 and U34-15 are reset to logic 0 and 1, respectively. As a third scan of the Command Mark is completed, the counter increments to 3 and the U34-1 output is set to logic 0; the output state of U34-15 does not change. As the three count is reached, U35-8 is set to logic 0, inhibiting the clocking signal to the counter.

The logic 0 at U36-3 causes the output, measured at TP16, to become a logic 1 which will open the switches in analog gate U38. Opening these switches inserts R120 in series with the speed control, resulting in a drop in the Tracer speed.

As the Tracer moves off a Command Mark and on to a line portion of the pattern, the first scan of the line portion results in a logic 0, 90 electrical degrees after the leading edge of the scan pulse, at TP14. This produces a logic 1 at U36-12 which, together with the logic 1 of the 90 degree delayed pulse, produces a logic 0 at U35-3. Since U35-4 and U35-5 were previously a logic 1, a logic 0 at U35-3 results in a logic 1 at U35-6, resetting counter U34.

As U34 is reset to zero, U36-3 becomes a logic 1 causing the switches in U38 to close and short-out the slowdown resistor, R120. With R120 effectively taken out of the circuit, normal speed is resumed and the 3-input NAND gate is enabled by the output at U35-9. The active NAND gate output enables the counter so that clocking can occur when a Command Mark is again scanned.

Circuits are included to ensure that the Command Mark feature does not function when the speed range switch is in the LO position, slowdown is disabled, or the STRIP mode is selected. The selection of LO Speed or Slowdown Disabled results in a logic 0 at U35-4, which causes a logic 1 at U35-6 to reset the counter.

Selection of the STRIP mode produces a logic 0 at U35-5 which results in resetting the counter, inhibiting slowdown.

Setting the mode switch to START when the high range is selected, enables the Slowdown feature, causing a logic 1 at U35-11, 12 and 13. This results in a logic 0 at TP16, causing Slowdown to result.

As a means of enabling/disabling the automatic height control of a Plasma system, an output is produced. This is available at connector J10, on the circuit card. Relay K2 operates contacts that are connected to J10. The relay is energized whenever slowdown is in effect, either through sensing of a Command Mark, in the START mode, or when the tracer is stationary in the TRACE mode. When the HL-90 is used in conjunction with a Picopath CNC, moving shunt W7 accross pins 3 & 4 makes it possible to 'Teach Trace' and tracing automatically stops when the pattern has been traced.

CNC Interface Circuits

The HL-90 can be supplied, or retro-fitted, with an interface cable that will enable it to operate with a CNC. The CNC Interface Cable Harness Assembly, suitable for use with various versions of the Picopath CNC, can be installed by simple plug-in connections to the Tracing Circuit CCA (3925D27G01, G04, or G06) and to the Chassis Board Assembly (3916D27G01 or G02). No soldering or unsoldering is required. Installation instructions provided with this optional purchase provide all the information required.

Alternatively, a CNC Interface Harness Assembly (6D21182G01) can be installed by a plug-in connection to the Tracing Circuit CCA and Chassis Board Assembly to permit operation with a Picopath or Hybrid D11 CNC.

12V ENCODER OPTION

When the HL-90 System is supplied (or retrofitted) with a CNC Interface, drive units incorporating optical incremental encoders can be supplied.

Contact Northrop Grumman-Canada, Ltd. for further information.

INSTALLATION 3

GENERAL

Three units make up the standard HL-90 system:

! a Tracer Unit, and
! two Drive Units.

Unpack the units carefully and visually inspect for transit damage. Verify that the parts supplied match the parts ordered.

NOTE

To avoid the need to re-align the system after installation, ensure that serial numbers of the sub-assemblies match those listed on the back of the test tracing, shipped with each system.

MECHANICAL INSTALLATION

General

In most applications the Tracer Unit is mounted above the tracing table on the Torch Carriage, which moves with the cutting torches in both axes. Accurate tracing is obtained by ensuring that the Tracer Unit is level and at the correct height, with reference to the scribed line (HEIGHT SET MARK) on the Scanner Assembly.

One Drive Unit is mounted so that it will drive the machine in the X-axis (Transverse axis) and the second Drive Unit is mounted to drive the machine in the Y-axis (Longitudinal axis).

Tracer Unit

Three holes, slotted vertically, enable the unit to be bolted securely to its mount, while permitting some adjustment of the head height and levelling.

The instructions required to install the HL-90 Tracer Unit are:

1. Insert one screw into the lower mounting hole, on the mounting plate, located on the machine.

2. Rest the Tracer Unit on this screw and then put the remaining screws through the slotted holes on the Tracer and into the machine mounting plate.

3. Adjust the height of the Tracer Unit so that the set mark on the head is set 38 mm (1-1/2 inches) above the pattern table. Tighten all mounting screws securely.

4. Check the height at several places on the tracing table to ensure that height variations do not exceed 3 mm from minimum to maximum. Variations in excess of 3 mm will result in an out of focus condition, which can result in unreliable operation.

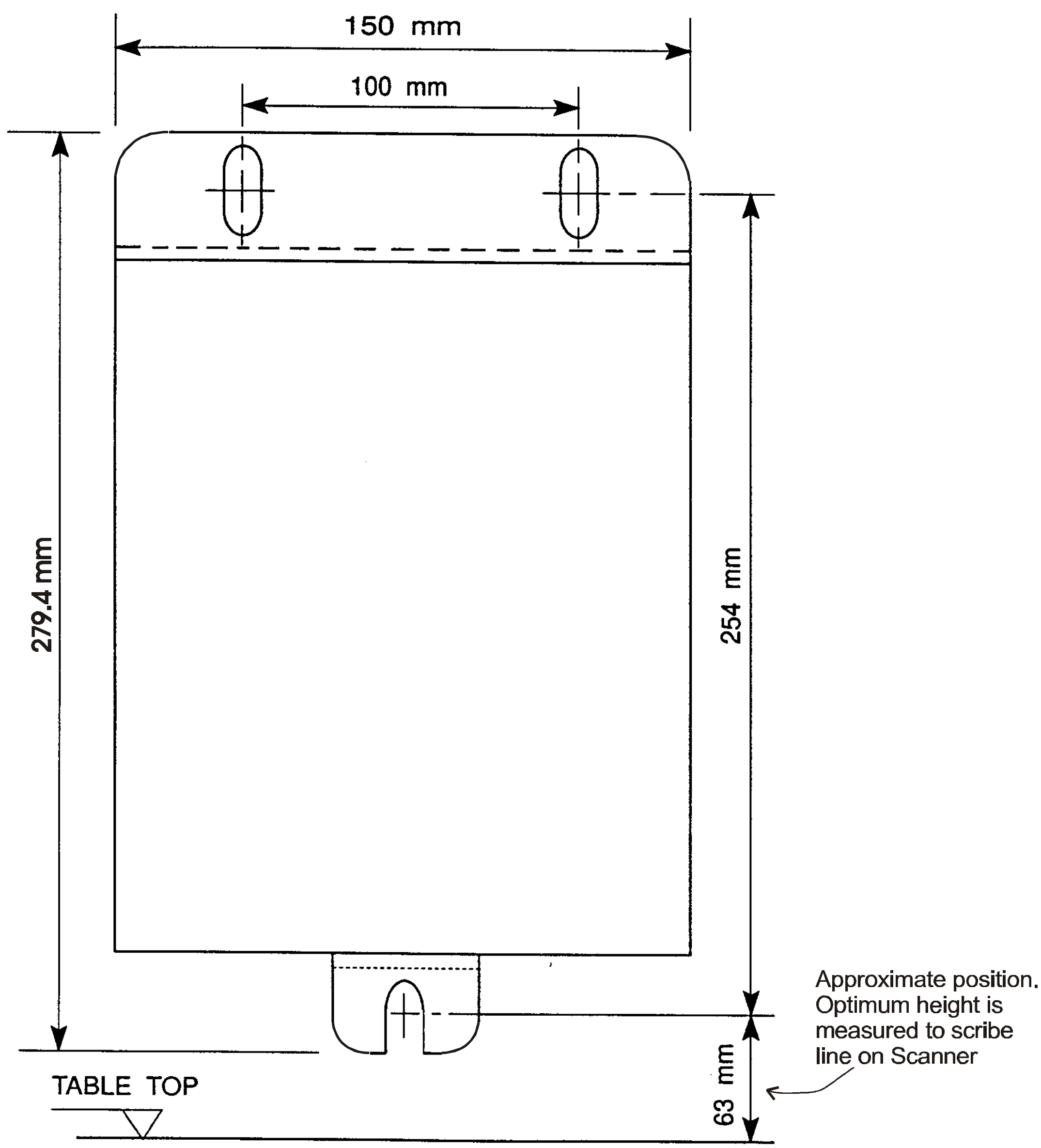


Figure 3-1 Tracer Unit Installation

Drive Units

GENERAL

Before installing drives, make sure the machine moves freely and that the machine rails, in both axes, are clean and free of obstructions.

Mount the gearbox with the pivot point on the pitch line (see Figure 3-2).

Mount the gearbox so that pressure on the output shaft is toward the centre of the gearbox.

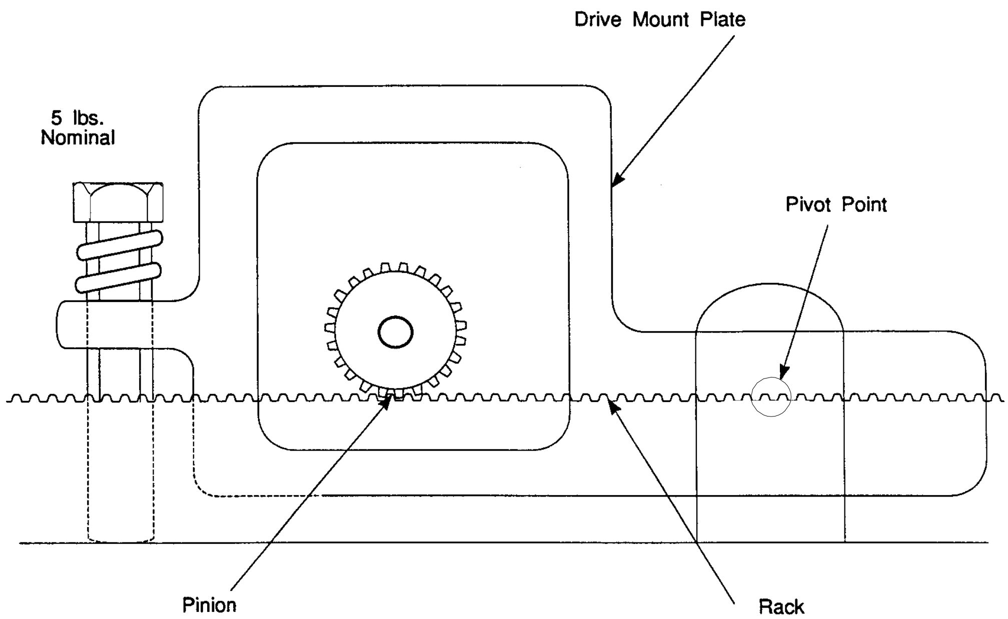


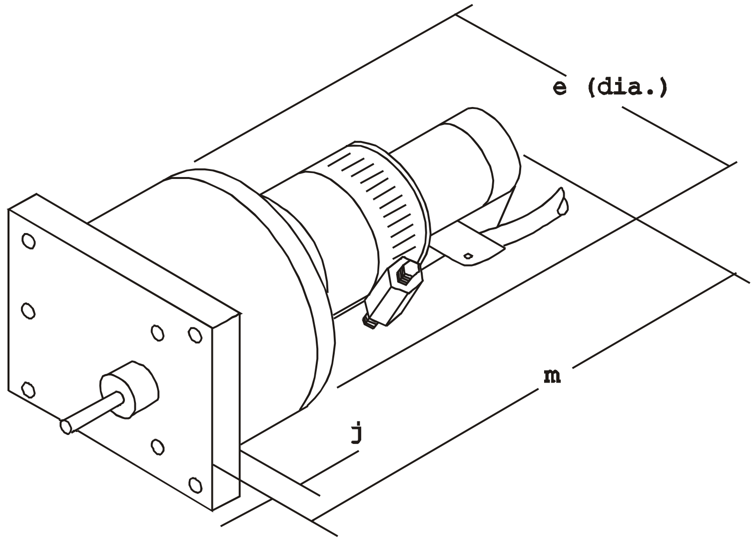
Figure 3-2 Typical Gearbox Mounitng

NOTE

The Drive Units can be interchanged to either the X or Y axis without causing damage. Once a unit is selected though, it must be identified for future reference.

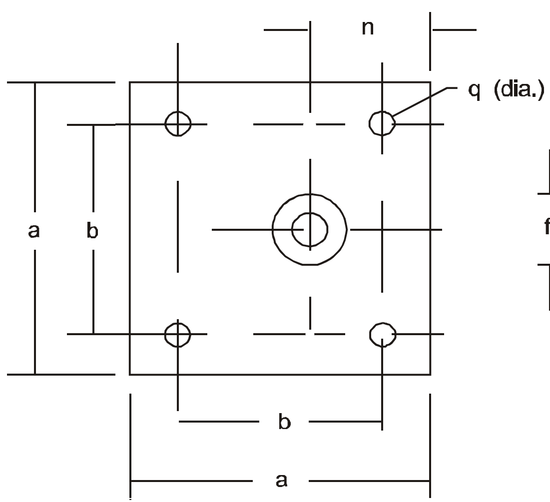
Use only the minimum pressure required to keep the rack and pinion meshed (2.5 kg/5 lb, nominal), to reduce the sideload on the gearbox output shaft.

The pinion size used should be the smallest possible, to produce minimum free motion at the machine (backlash). This will also produce the maximum thrust at the machine. The recommended range is 12mm (0.5 inch) to 18mm (0.7 inch) diameter.

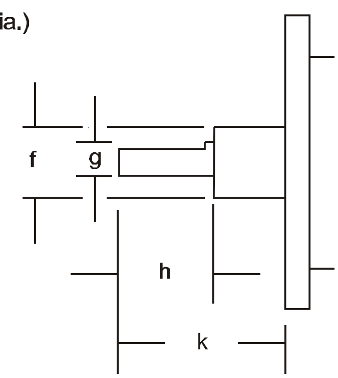


NOTES:

1. "m" IS MAXIMUM DIMENSION. SOME ASSEMBLIES ARE SHORTER
2. SOME DRIVES ARE SUPPLIED WITH THE PINION. REFER TO THE PARTS LIST SUPPLEMENT AT THE BACK OF THIS MANUAL



MOUNTING DETAILS



SHAFT DETAILS

DIMENSION		
	inches	mm
a	3.38	86
b	2.75	70
e	3.0Φ	76Φ
f	0.708Φ	18Φ
g	0.315Φ	8.0Φ
h	0.8	20
j	0.25	6.4
k	1.3	33.0
m	5.75	146
n	0.785	19.9
p	1.4	35.6
q	0.25Φ	6.4Φ

Figure 3-3 Typical Drive Assembly

ELECTRICAL INSTALLATION

WARNING

The equipment described in this manual is designed to operate from a three-wire, grounded power source.

Failure to provide the correct power source and grounding connections, as detailed in these instructions, may result in conditions hazardous to the operator and/or service personnel.

The supplier of the cutting machine must install an approved Emergency Off switch which must be readily accessible and is to remove power from the HL-90 when the switch is operated.

Tracer Unit

Electrical installation of the Tracer Unit involves connecting the input power and three cables to the connectors on top of the unit, as illustrated in Figure 3-4.

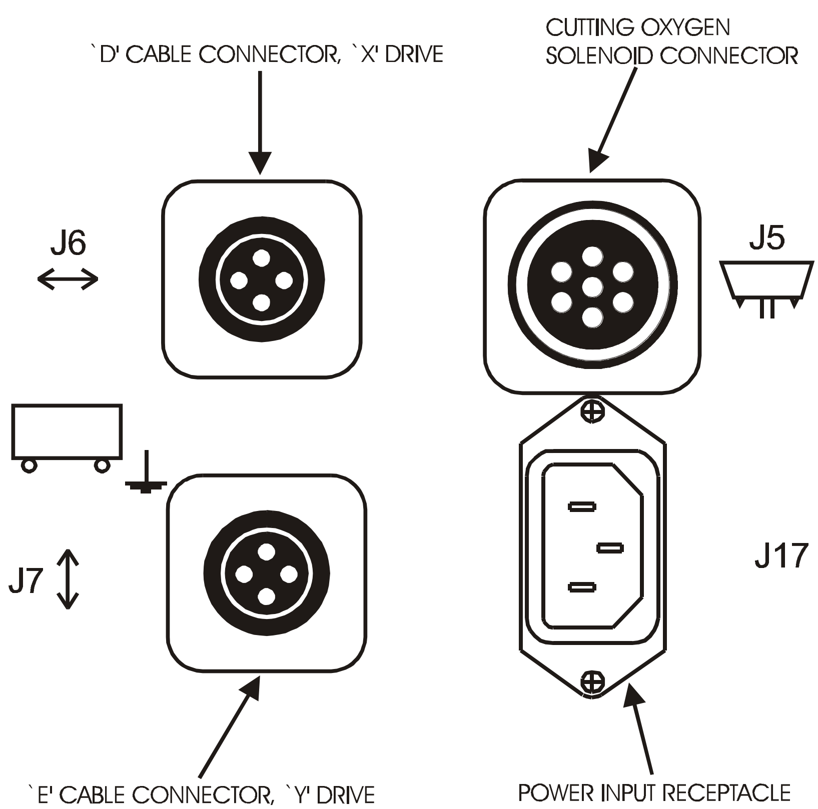


Figure 3-4 Tracer Unit Electrical Connectors

These connections include:

1. The Cutting OxygenSolenoid cable mates with connector J5, located just behind the power input receptacle. J5 is a seven-pin connector with the following pin assignments:

J5 PIN NUMBER	SIGNAL NAME	COMMENTS
1	Line	
4	Neutral	
2	Ground	Long pin supplied in connector kit must be used for this location
3	Not Used	
5	Height Control	Only used if Corner Slowdown is fitted
6	Height Control	
7	Height Control	
NOTES - Contacts 5 and 7 from the Height Control Relay K2 are *closed* to disable height control; contacts 6 and 7 are *open* to enable height control.		

2. The X-axis Drive Unit, via the 'D' cable, mates with the connector located to the left of the Cutting Oxygen Solenoid cable connector. The shield grounding terminal must be installed under one of the mounting screws of the connector.

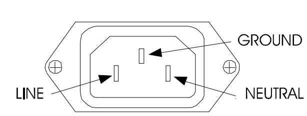
3. The Y-axis Drive Unit, via the 'E' cable, mates with the connector located to the left of the Power Input receptacle. The shield grounding terminal must be installed under one of the mounting screws of the connector.

4. The equipment must be operated from a three-wire, grounded power source. The power cable is connected in the equipment as follows:

   ! the BLACK wire is LINE,
   ! the WHITE wire is NEUTRAL, and
   ! the GREEN or GREEN/YELLOW wire is GROUND.

NOTE

Ensure that the power plug is connected to match that of the illustration at right.



5. The gearboxes of the Drive Unit must be connected via a low impedance path to the PE of machine installation. This is done by connecting a wire from the terminal screw marked ⏚ on the motor mounting plate of the gearbox to the machine frame. Ensure that the part of the machine frame used for this connection is connected to the PE of the installation. The resistance between the ground screw and the PE should be sufficiently low as to meet safety requirements.

Drive Units

If the direction of rotation of the drive motors results in machine motion which does not agree with the direction selected on the DIRECTION switch, follow the procedure outlined below. Do not change the orientation of the DIRECTION knob.

DIRECTION OF MOTOR ROTATION

Perform the following to reverse the rotation of either the X- or Y-axis motor.

1. Isolate the system from the AC supply.

CAUTION

When opening the Door Assembly, do not permit the door to open more than 90° or damage to the wiring may result.

2. Unlock the door for access to the interior of the Tracing Unit assembly.

3. Pull off the ‘fast-on’ type connection, identified as ‘XM’ on the top left corner of the circuit card, and exchange with the other X motor lead connected to the ground connection on the chassis of the unit; similarly, interchange the X tacho leads.

4. The motor drive wires are red and black; the tachometer wires are green and white.

MOTOR SPEED

For maximum machine speed, the recommended motor rpm is 2050 to 3000 (depending on pinion size and gearbox ratio).

Motor speeds of the X and Y motors are adjusted by R65 and R66, respectively, on the circuit card; clockwise (CW) rotation will increase motor speed.

OPERATING INSTRUCTIONS 4

GENERAL

The operating controls for this system are mounted on the hinged door of the tracing unit.

The control functions are described in Table 4-l. The equipment Operating Instructions follow this table.

Controls

The front panel controls (see Table 4-l) select these functions:

l. Machine SPEED.

2. Machine DIRECTION (4-way).

3. DRIVE (ON/OFF).

4. DRIVE Speed Range (HI/LO).

5. Mode (STRIP/TRACE/START).

6. CUT OXY (MAN/OFF/AUTO).

The POWER (ON/OFF) switch is located at the left side of the unit.

OPERATION

The tracer may be operated in either the Tracing mode, using a pattern, or the Stripping mode for manual cutting.

Tracing Mode (Oxy-Fuel)

1. Turn the POWER, DRIVE and CUT OXY off.
2. Fix a pattern on the tracing table.

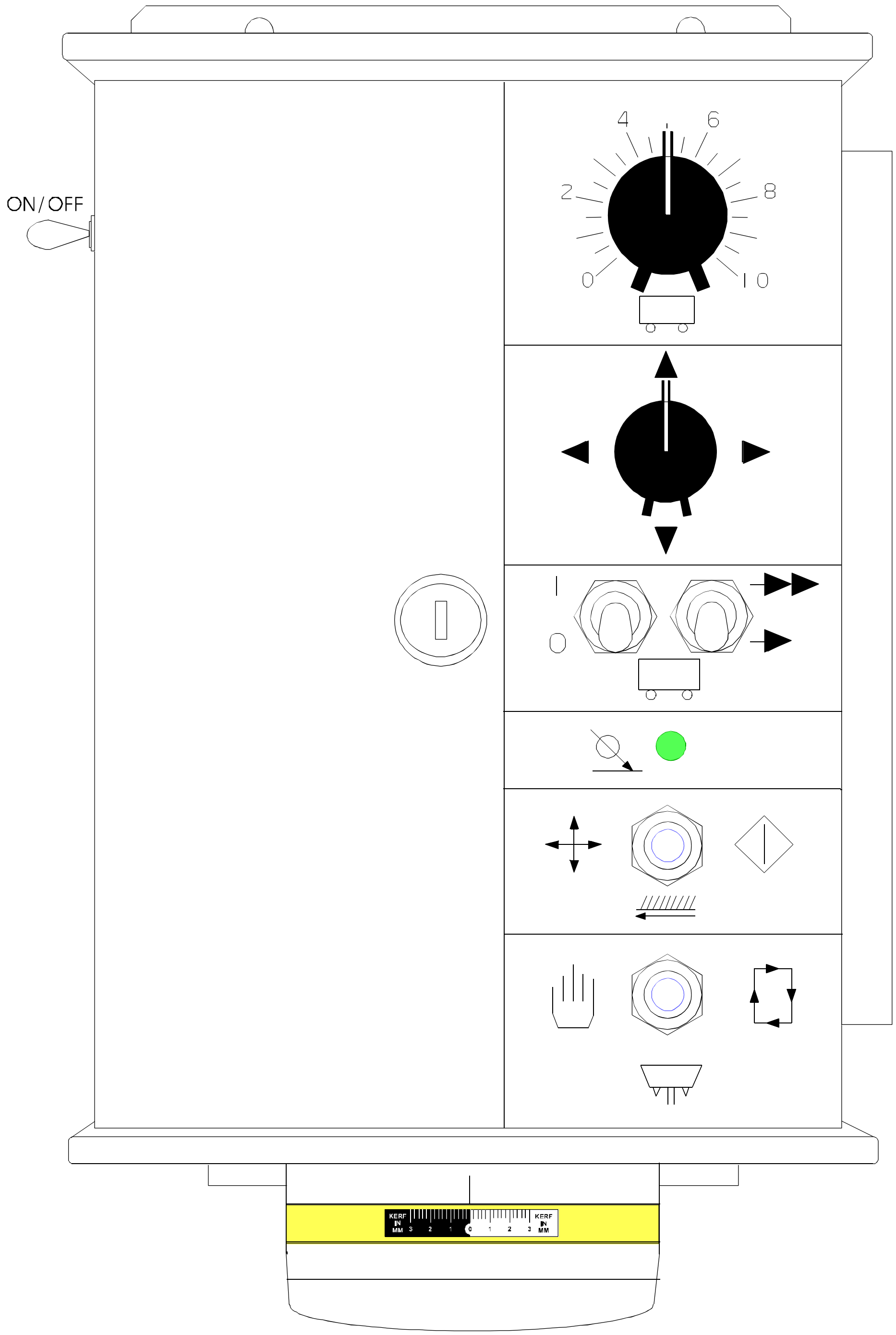


Figure 4-1 HL-90 Controls

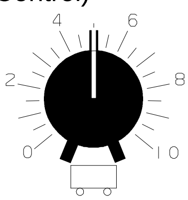
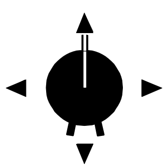
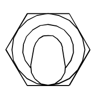
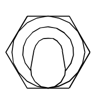
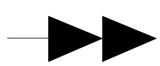
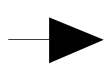
FUNCTION	SYMBOL/ SWITCH POSITION	DESCRIPTION
SPEED (Variable Control) 		Enables the speed of the tracer to be set from 0 to maximum.
DIRECTION (4-position rotary) 		Used for the stripping mode and to enter and leave a pattern in the tracing mode.
DRIVE (2-position toggle) 	|	Connects the speed signals to the input of the drive amplifiers.
	O	Removes the speed signals from the drive amplifiers.
		If installed, this switch selects the high speed range of from 0 to maximum.
		If installed, this switch selects the low speed range of from 0 to 600 mm/min.

Table 4-1 HL-90 Control Functions

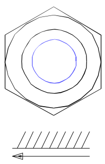
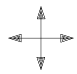
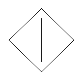
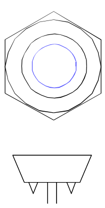
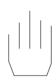
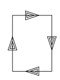
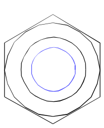
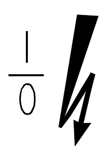
FUNCTION	SYMBOL/ SWITCH POSITION	DESCRIPTION
MODE (3-position toggle) 		Tracer moves in the direction set on the DIRECTION switch at the speed set on the SPEED dial.
	(Centre position)	The tracer will follow the pattern until the switch is moved to the STRIP position. The tracer will then move in the direction set on the DIRECTION switch and, with the CUT OXY switch set to AUTO, the cutting oxygen will automatically shut off.
		Momentary contact position. The tracer will travel in the direction set on the DIRECTION switch until a pattern is intercepted and the ON PATT light is lit. When the switch is released, it will return to the TRACE position.
CUT OXY (3-position toggle) 		Maintains the cutting oxygen while the tracer is off pattern for chain cutting, or in the STRIP mode.
	(Centre position)	Cutting oxygen is off.
		Cutting oxygen is on as long as the STRIP/TRACE/START switch is in the START position or the tracer is on pattern. If the tracer goes off pattern, the cutting oxygen will switch off.
POWER (3-position toggle) 		Momentary Up position - power is applied to the equipment.
		Mid position - normal operating position, power ON or OFF.
		Momentary Down position - shuts off power to the equipment.

Table 4-1 HL-90 Control Functions (Cont'd)

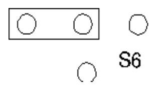
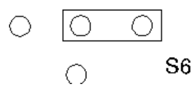
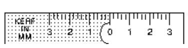
FUNCTION	SYMBOL/SWITCH POSITION	DESCRIPTION
SLOWDOWN ENABLED		The Corner Slowdown feature is enabled when the shunt is placed over the two left pins of S6 (located at centre left of the circuit card).
SLOWDOWN DISABLED		The Corner Slowdown feature is disabled when the shunt is placed over the two right pins of S6 (located at centre left of the circuit card).
KERF 		The kerf can be set over a range of 0 to 3 mm (1/8th inch). Before attempting kerf adjustment, LOOSEN the KERF LOCK SCREW and rotate the scanner assembly for the required amount; RE-TIGHTEN after the kerf adjustment is made. **NOTE** See chapter 5, page 1, for detailed information on kerf compensation.

Table 4-1 HL-90 Control Functions (Cont'd)

3. Move the POWER switch to the Up position. The floodlights will come on or the Position Indicator will light. Power should remain on when the switch is released to its mid position.

4. Set the MODE to STRIP and select the required speed range.

5. Turn the DRIVE to ON and steer the machine to the desired starting position, using the DIRECTION switch and SPEED control.

6. Turn the DRIVE to OFF and the MODE switch to TRACE when the desired position is reached.

7. Place the CUT OXY switch in the AUTO position (see Table 4-1, CUT OXY, for chain cutting).

8. Set the SPEED control to the desired cutting speed.

9. Set the DIRECTION control for the desired pattern entry direction.

10. Adjust the torches to preheat the plate.

11. When the plate is ready, set the DRIVE to ON and hold the MODE switch in the START position. Cutting oxygen will come on and the tracer will approach the pattern. When the pattern is acquired and the ON PATT light comes on, release the MODE switch.

12. Turn the DIRECTION switch so that at the end of the cut the tracer can be made to leave the pattern away from the work.

13. At the end of the cut, place the MODE switch to STRIP. The Tracer will leave the pattern and the cutting oxygen will automatically shut off.

14. Turn the DRIVE to OFF.

If the Tracer is equipped with the Low Speed Enhancement feature, or designed for High Speed operation, the HI range must be selected for speeds greater than 600 mm/min.

Tracing Mode (Plasma)

Operation depends on the type of Plasma Unit used and its interface to the Tracer.

Stripping Mode (Oxy-Fuel)

1. Turn POWER, DRIVE and OXY to OFF.

2. Turn the power ON.

3. Set the MODE to STRIP and select the required speed range.

4. Turn the DRIVE to ON and steer the machine to the desired starting position, using the DIRECTION switch and SPEED control.

5. Turn the DRIVE to OFF when the starting position is reached.

6. Set the SPEED control to the desired cutting speed.

7. Set the DIRECTION control to the desired cutting direction.

8. Adjust the torches to preheat the work.

9. When the work is ready, turn the CUT OXY switch to MAN.

10. Turn the DRIVE switch to ON.

11. When the cut is complete, turn the CUT OXY and DRIVE switches to OFF.

OPERATING FEATURES 5

LEAD

The mirror in the tracing head is tilted and off centre to enable it to scan a circular path. It therefore scans the pattern ahead of its position by a distance, or 'look-ahead', known as the lead. In the case of the HL-90, it is 3 mm (1/8th inch). Optional leads of 1 and 1.5 mm are available upon request.

KERF

To compensate for the width of cut, or kerf, adjustment is provided which is continuously variable between zero to 3 mm (with standard 3 mm Kerf-Lead modules). Kerf compensation is adjusted by turning the Scanner Assembly inside the Tracing Unit (see Figure 5-1). The Kerf Lock Screw must be loosened before making the adjustment.

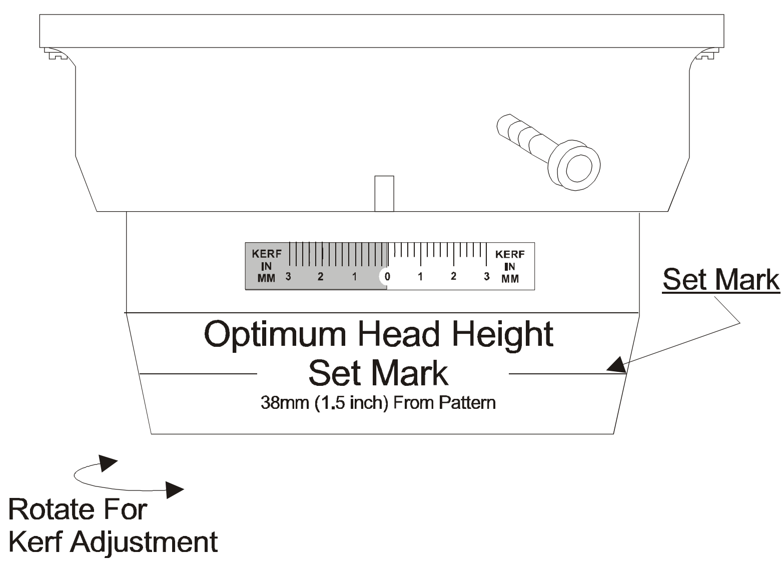


Figure 5-1 Kerf Offset Adjustment

To adjust for the required compensation the kerf width is set on the kerf scale. For example, if the kerf is 2.0 mm, the scale should be adjusted so that the black '2' (on the white section of the scale) is directly below the scribe mark. The tracer path is offset by half the kerf setting. When `0' on the scale is set below the scribe mark, there is no kerf compensation.

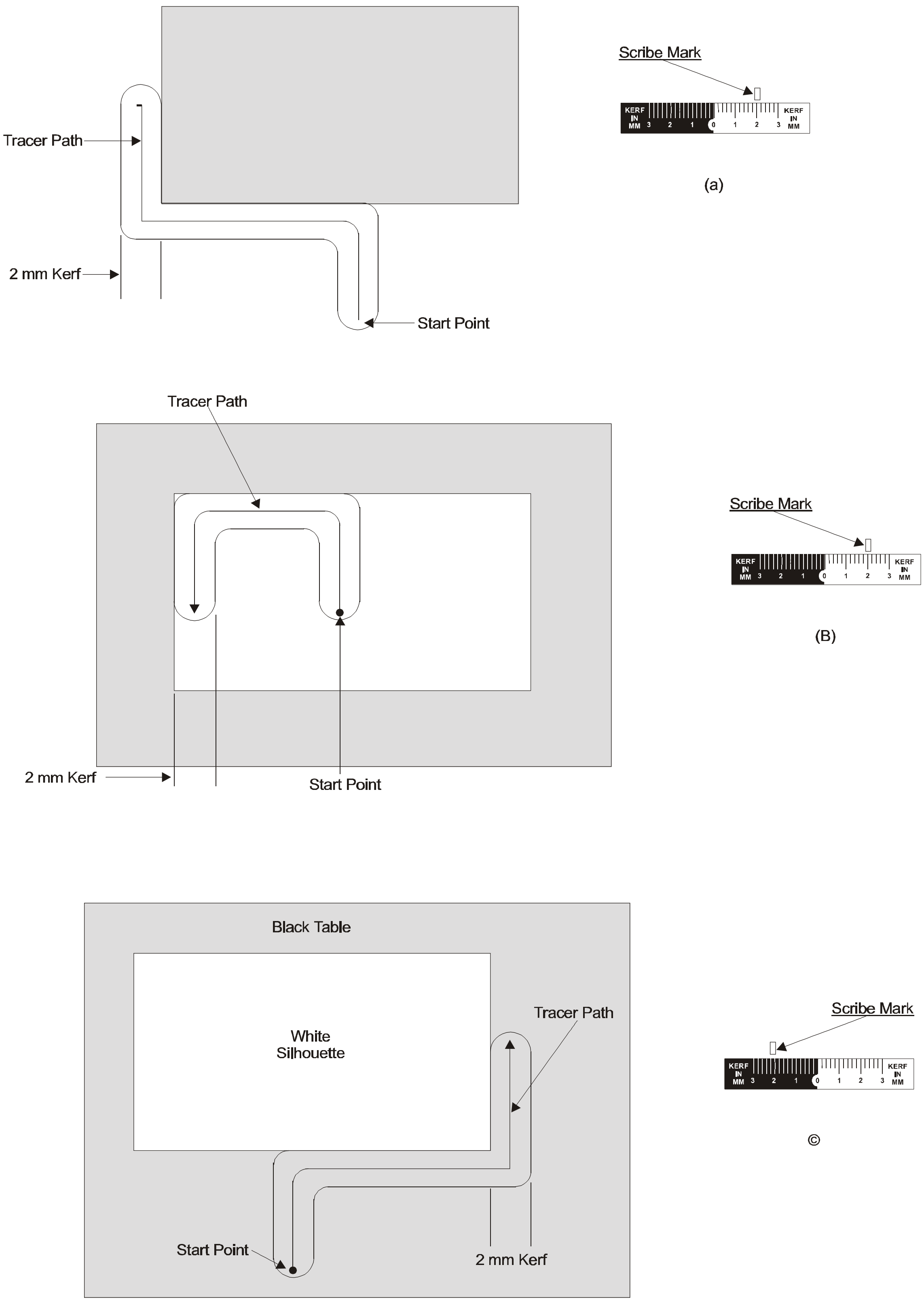


Figure 5-2 Determining Direction of Kerf Adjustment

PATTERNS

Patterns may be black lines or silhouettes drawn on white paper, or a cutout of white paper or card (referred to as a `white silhouette') laid on a black table top, as shown in Figure 5-2 (c).

The quality of the pattern has a considerable influence on the accuracy and reliability of the tracer. Patterns can be drawn so that material wastage is reduced and the efficiency of cutting operations improved. For accurate corner cuts, compensation for the lead/speed characteristics of the tracer may be made by adjusting the corners on the pattern.

Guidelines for Patterns

Factors, associated with patterns, that influence the tracing operation include:

1. Contrast between line and background.
2. Cleanliness of the pattern.
3. Width of the line in line-drawn patterns.
4. Type of material on which the patterns are drawn.
5. Type of material used to draw the patterns.

To produce patterns that provide the best results, the following guidelines are recommended.
Table 5-1 lists some of the materials used in producing patterns.

TYPE OF MATERIAL	REMARKS
COMMERCIAL PATTERN PAPER	Use India ink or firmly drawn pencil (H or HB). Ideal material for durability, dimensional stability and contrast.
BRISTOL BOARD (Buff or White)	Excellent contrast. Liable to absorb moisture.
ART BOARD (Buff or White)	Similar to Bristol board, but more durable. Thickness may require re-focussing.
HEAVYWEIGHT BOND PAPER	Similar to Bristol board. Generally most popular for 'one-off' patterns.
'MYLAR'	Excellent dimensional stability. Durable white backing sheet required. Tendency to curl requires a means to maintain uniform contact with backing sheet/tracing table to prevent an out-of-focus condition.
'DIAZO' TRANSPARENCIES	Reflect infra-red. Requires special lens on tracing unit. Easily scratched. Good dimensional stability.

Table 5-1 Pattern Materials

TYPE OF MATERIAL	REMARKS
PHOTOGRAPHIC NEGATIVES	Not recommended.
TRACING PAPER	White backing sheet required. Changes size with moisture (not recommended).
FELT PENS	Some felt-tipped pens reflect infra-red. May require a special lens on the tracing head.
'PLEXIGLASS'	If used as a protective cover (and to keep patterns flat), it is susceptible to pitting from cutting splatter. It should be used with caution.

Table 5-1 Pattern Materials (Cont'd)

1. The edge of the line should be drawn accurately, since it is the edge of the pattern that will be traced.

2. A red pen or pencil should be used for drawing construction lines or notes; the tracer will not detect red.

3. For optimum performance, lines should be drawn in black India ink, with a minimum width of 0.7 mm (1/32nd inch), on a white or buff background; however, 'H' or 'HB' grade pencil- drawn lines with a minimum width of 0.5 mm (1/64th inch) provide acceptable results.

4. If pencils are used, the lines should be dense and free from breaks. Repeatedly going over a line tends to polish the surface, causing it to behave like a mirror; this should be avoided.

5. Some materials appear black to the human eye but are seen differently by the tracer; these materials should be avoided (see Table 5-1).

6. Paper or card stock used for patterns should be of a type that is not affected by moisture. Some types readily absorb moisture and may, consequently, change size (see Table 5-1).

7. Patterns should be kept as clean as possible and free from grit marks or smudges, especially near the tracer's path.

8. The minimum distance between adjacent lines on the pattern should not be less than the lead, i.e. 3 mm (1/8th inch); see Figure 5-3.

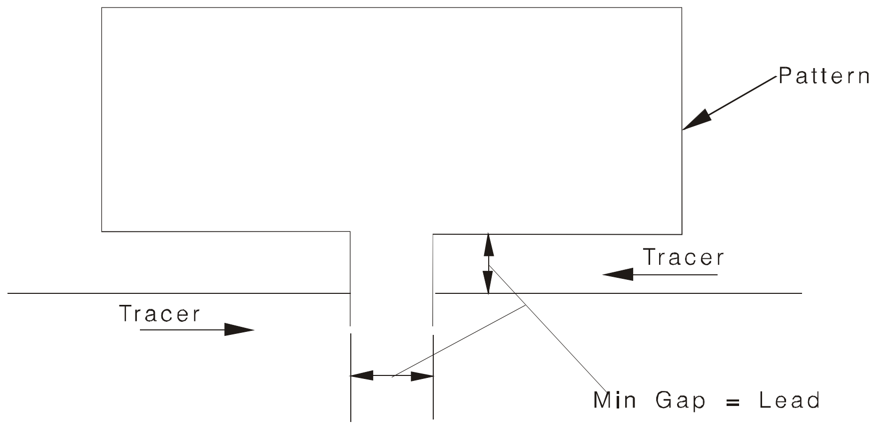


Figure 5-3 Minimum Line Separation

Corner Compensation

Tracing head lead may be compensated for on the pattern in applications that require accurate corner cuts at lower speeds.

Figures 5-4 (a) and 5-4 (b) illustrate the technique for outside and inside corners. The lead-speed correction factor is obtained on a trial and error basis since it is affected by the physical characteristics of the cutting machine. The lower the cutting speed the greater the correction factor. This is typically equal to the lead or scan radius used.

Low Contrast and Shopworn Patterns

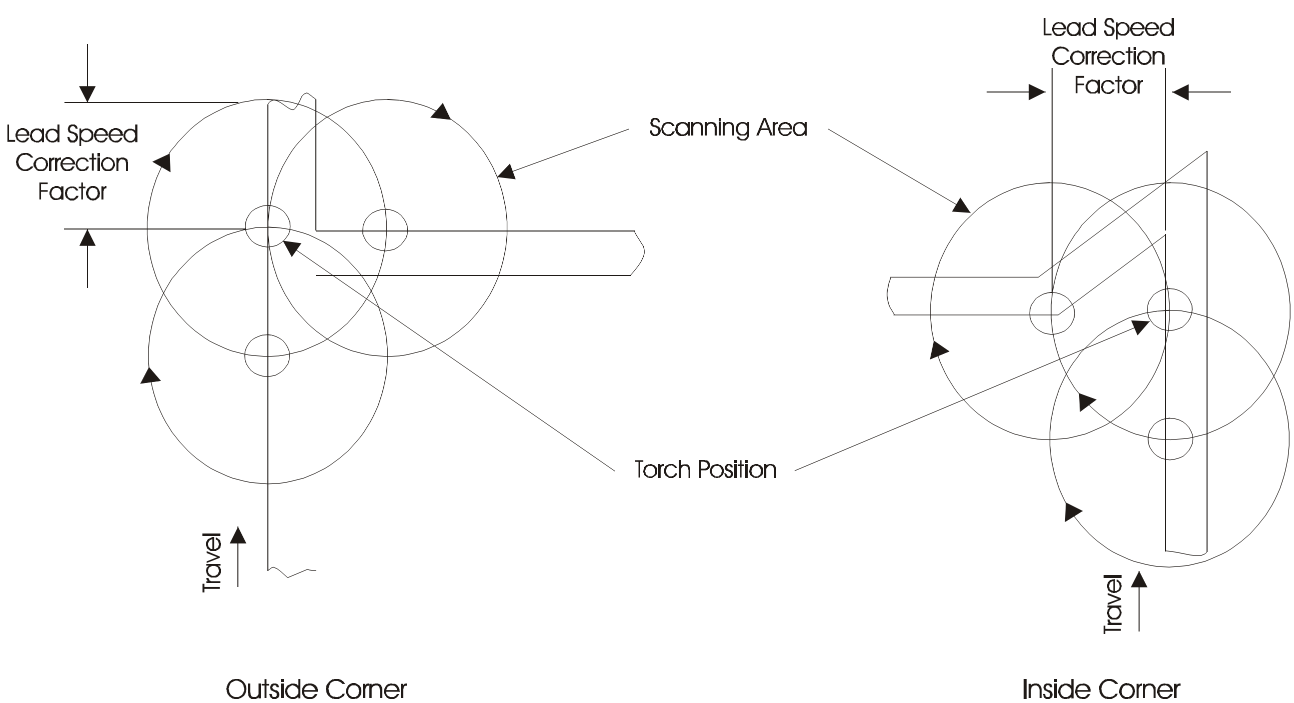


Figure 5-4 Corner Compensation

Adjustments may be made if lighter pencil-drawn patterns need to be traced (i.e. patterns that provide a lower contrast than firmly-drawn 'H' or 'HB' grade pencils). Refer to **Signal Level Set-Up** in Chapter 6, Alignment & Troubleshooting.

NOTE

An overall dirty pattern reduces the reflected light and hence, the signal output; dirty marks may generate false signals. It is important to maintain patterns in as clean a condition as possible.

Pattern Nesting

When cutting several parts from the same plate, it may be more economical and more efficient to group or nest them on one pattern.

Similar or dissimilar pieces may be nested together. Figure 5-5 shows simplified arrangements; more complex shapes may be treated in the same manner. Chain cutting of groups of unconnected patterns (e.g. white silhouettes) may be performed if the cutting oxygen is operated with the 'CUT OXY' switch (S3) set in the 'MAN' position.

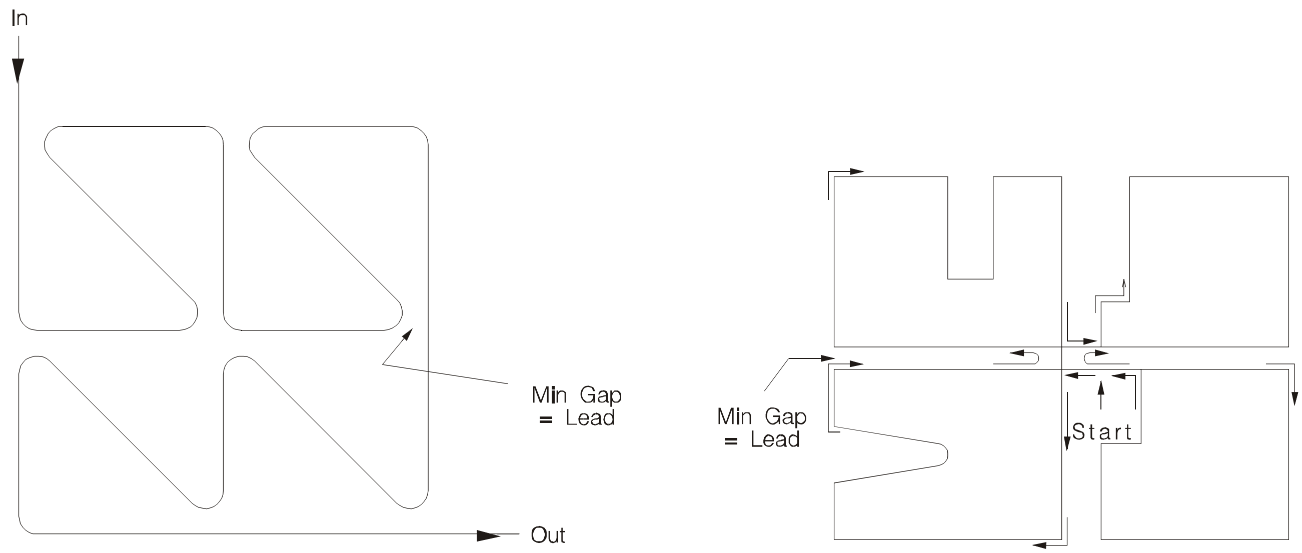


Figure 5-5 Pattern Nesting

Command Marks

Command marks are placed on a pattern to initiate the automatic corner slowdown operation. The use of command marks is only possible when the Corner Slowdown Option circuits are installed in the system.

Command marks are detected at 90E after line interception. When drawing Command marks, the dimensional information given in Figure 5-6 should be closely followed, noting these points:

1. When a Command mark is used, the leading edge of the mark should represent the desired point of slowdown and include allowances for 3 scan revolutions (120 msec for 50 Hz operation or 100 msec for 60 Hz operation) and machine-dependent deceleration time.

2. The width of the Command mark (dimension ‘a’ in Figure 5-6) should be at least 1½ times the lead used, without any gap between it and the pattern line.

3. There should be little or no difference in contrast between the Command marks and the pattern lines.

4. Kerf compensation cannot be adjusted at the scanner assembly when Command marks are used. Kerf allowances can be incorporated into the pattern.

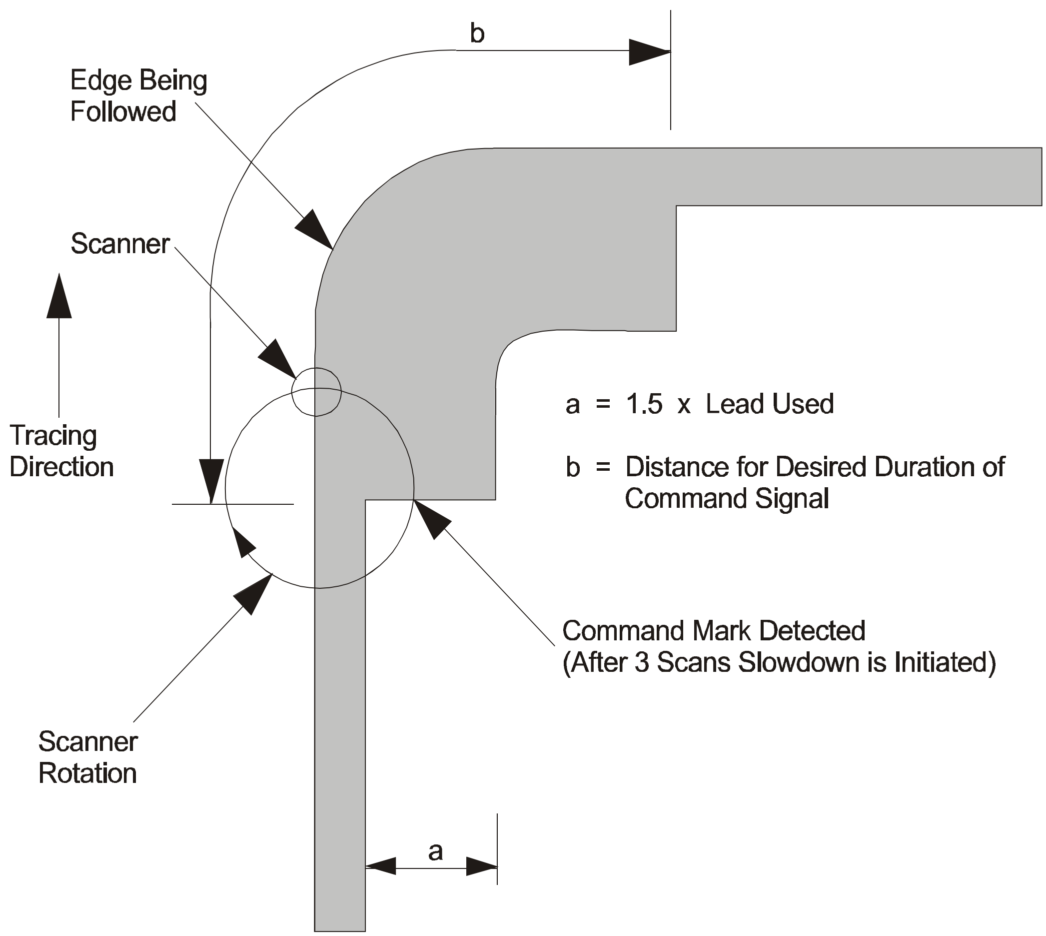


Figure 5-6 Command Mark for Corner Slowdown

ALIGNMENT & TROUBLESHOOTING 6

WARNING

Setting the Power Switch to OFF does not remove power from the equipment. Disconnect the power source from the unit before opening for servicing.

GENERAL

As an aid to performing alignment, the procedure has been subdivided into a logical sequence as follows:

! Power Supply Checks
! Signal Level Set-up
! Zero-Signal Offset Adjustments
! Linear Speed Adjustments
! Line Frequency Change
  P Converts from 50 to 60 Hz
  P Converts from 60 to 50 Hz
! Low Speed Range Adjustment
! High Speed Stability
! Slowdown Circuit Calibration
! Measuring and Recalibrating True Linear Speed

Where applicable, references have been made to troubleshooting information presented in Table 6-2. Examples of how these references will appear are `refer to Troubleshooting Guide, Step (number)'. In each case refer to Table 6-2.

Shielding the Scanner Assembly Photo-transistors

The cast aluminum housing of the installed Scanner Assembly is a lattice-structure type (see Figure 6-1) and the internal photo-transistor and lens can be seen through the open slots.

It is necessary to shield the photo transistor from ambient light when the door of the Tracer Unit Assembly is opened for servicing. This can be done by wrapping a piece of paper around the scanner housing so that it is shielded from the ambient light (a piece of cloth will serve equally well).

Failure to follow this procedure may result in the sensor circuit producing false signals, making it impossible to calibrate the system properly or for the system to trace a pattern**.**

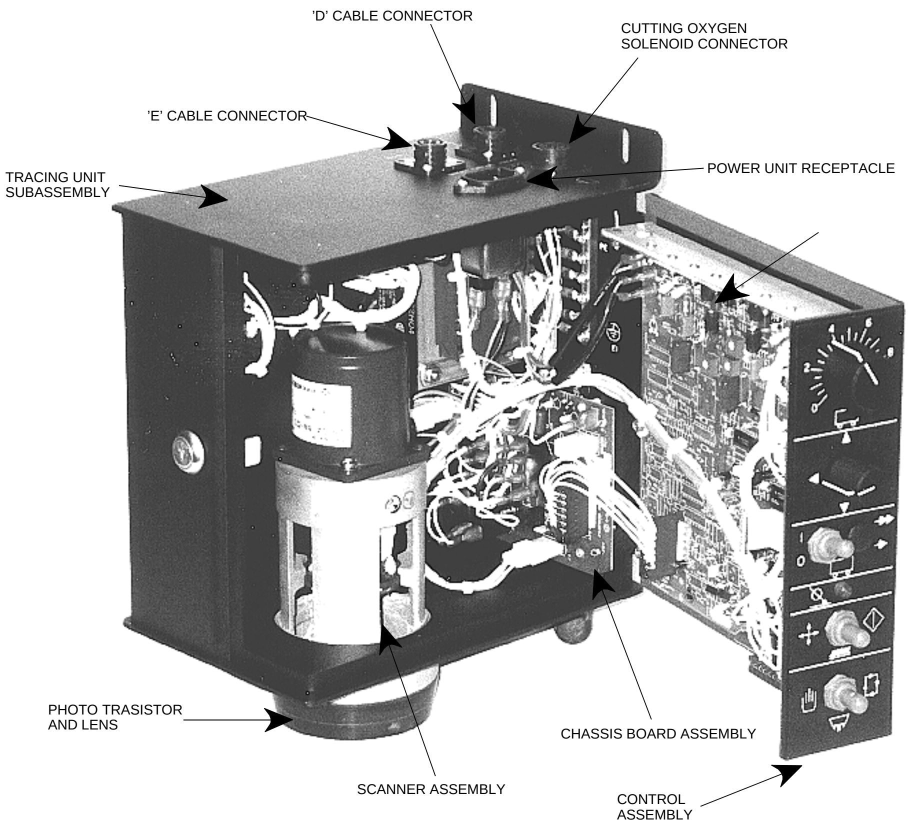


Figure 6-1 Tracer Unit Assembly, Opened View

Power Supply Checks

1. Switch the power ON. If the system does not respond, refer to Troubleshooting Guide, Step 1.

2. Set the DRIVE switch to ON, the SPEED control to 5 and the STRIP/TRACE/START switch to STRIP.

3. The following measurements must be made while the machine is moving. Refer to Troubleshooting Guide, Steps 2 and 3.

   (a) Chassis Board CCA measurements: +20 Vdc ±3V at the +20V TP (Test Point).
   -20 Vdc ±3V at the -20V TP.
   +12 Vdc ±0.6V at the +12V TP.

   (b) Tracing Circuit card measurements: +12 Vdc ±0.6V at TP1.
   -12 Vdc ±0.6V at TP2.

Signal Level Setup

1. Position a typical shop pattern under the Scanner Assembly.

2. Set the tracer controls to acquire the pattern and once the pattern is acquired, set the DRIVE switch to OFF. Refer to Troubleshooting Guide, Step 4.

   Observe the voltage at TP5 and adjust R21 on the circuit card CW until the output shows no further increase (between 9.5 and 11.5 Vdc). Turn R21 CCW until the voltage decreases by approximately 0.1V from the maximum reading, then turn it CW $1/10^{th}$ of a turn.

   Typical symptoms of decreasing signal level after the equipment has been in service for some time are erratic acquisition of a pattern or tracer reversal on pattern.

Zero-Signal Offset Adjustments

1. Measure the voltage at TP3 on the circuit card. Adjust R41 for 5.3 Vac ±0.1V on a digital voltmeter (15 Vp-p ±0.3V) and then switch the power OFF. Refer to Troubleshooting Guide, Step 5.

2. Disconnect the scanner motor connector P4/J4. Switch the power ON and measure the voltage at TP3 on the circuit card. Adjust R73 until the voltage level at TP3 reaches 0 Vdc ±5 mV.

3. Measure the voltage at terminal XM on the circuit card and adjust R50 for 0 Vdc ±50 mV. Measure the voltage at terminal YM on the circuit card and adjust R52 for 0 Vdc ±50 mV.

4. Switch the power OFF and re-connect the Scanner motor connector P4/J4. Switch the power ON.

Linear Speed Adjustments

1. Set the DRIVE switch to ON, select the HI drive range and set the SPEED control to 10 on dial.

2. Measure the actual speed of travel in the X axis and adjust R65 on the circuit card until the linear speed agrees with the specified maximum speed. Refer to Troubleshooting Guide, Steps 5, 6, 7 and 8.

3. Measure the actual speed of travel in the Y axis and adjust R66 on the circuit card until the linear speed agrees with the specified maximum speed. Refer to Troubleshooting Guide, Steps 9, 10, 11 and 12.

Line Frequency Change Adjustments

The Linatrol HL-90 equipment can operate on either 50 Hz or 60 Hz line frequencies. The following procedures must be followed when changing the frequency of operation.

CONVERTING FROM 50 Hz TO 60 Hz SUPPLY

1. Measure the voltage at TP3 on the circuit card using a digital voltmeter. Adjust R41 for 5.3 Vac ±0.1V (15 Vp-p ±0.3V).
2. With the Tracer Unit set to trace on Test Pattern 205P773 (located at the end of this manual), adjust R30 for a positive-going pulse of 28 msec ±1 msec duration at TP6 and R35 for a negative-going pulse of 8.33 msec ±0.15 msec duration at TP7 (an oscilloscope is required).

NOTE

Resistors R30 and R35 have been sealed with Glyptol cement. Break the seal to adjust and reseal after adjustment. Change the ‘50 Hz’ marking on the circuit card to read ‘60 Hz’.

3. Perform steps 3 and 4 from the Zero-Signal Offset Adjustment procedure.
4. Set the DRIVE switch to OFF.

CONVERTING FROM 60 Hz TO 50 Hz SUPPLY

1. Using a digital voltmeter, measure the voltage at TP3 on the circuit card. Adjust R41 for 5.3 Vac ±0.1V (15 Vp-p ±0.3V).
2. With the Tracer Unit set to trace on Test Pattern 205P773 (located at the end of this manual), adjust R30 for a positive-going pulse of 34 msec ±1 msec at TP6, and R35 for a negative-going pulse of 10.0 msec ±0.15 msec at TP7 (an oscilloscope is required).

NOTE

Resistors R30 and R35 have been sealed with Glyptol cement. Break the seal to adjust and reseal after adjustment. Change the ‘60 Hz’ marking on the circuit card to read ‘50 Hz’.

3. Perform steps 3 and 4 from the Zero-Signal Offset Adjustment procedure.
4. Set the DRIVE switch to the OFF position.

Low Speed Range Adjustment (Dual Range Equipment Only)

1. With the SPEED control set to 10 and the LO DRIVE RANGE selected, adjust R122 to obtain a linear speed of 600 mm/min (24 IPM).

2. If the Tracer is equipped with the Low Speed Enhancement circuit, adjust R86 for 5.0 Vdc ±0.1V at TP13, with the SPEED control set to 10 and the LO DRIVE RANGE selected. Wait several seconds for the voltage at TP13 to stabilize after adjusting R86.

3. Operation at high speeds on the low-speed range may result in excessive overshoot on sharp corners. If overshoot occurs, repeat step 2 above, setting the voltage at TP13 to 6.0 Vdc ±0.1V. Corner compensation can be increased by adjusting R86 until a 4.0 Vdc ±0.1V level is measured at TP13.

High Speed Stability (High Speed Systems Only)

1. If the machine exhibits instability during high speed operation, check that shunts are installed connecting pins 1 and 2 and connecting pins 3 and 4 of W1 and of W2. Ensure that the gearbox mounting and spring pressure do not permit free motion of the machine. If instability persists, the machine is not suitable for high speed operation.

2. If the machine exhibits excessive overshoot during high speed operation, remove the shunt connecting pins 1 and 2 of W1 and W2. If the machine becomes unstable, return the shunt connecting pins 1 and 2 to W1 and W2; otherwise proceed to step 3.

3. If the machine is stable and further reduction in overshoot is required, remove the shunt connecting pins 3 and 4 of W1 and of W2. Install a shunt connecting pins 1 and 2 of W1 and W2. If the machine becomes unstable, remove the shunt connecting pins 1 and 2 and place it across pins 3 and 4 of W1 and W2; otherwise proceed to step 4.

4. If the machine is stable and further reduction in overshoot is required, remove the shunt connecting pins 1 and 2 of W1 and W2. If the machine is unstable, install a shunt connecting pins 1 and 2 of W1 and W2.

Slowdown Circuit Calibration (If Command Mark Option Installed)

1. To enable the command circuit, install a shunt across the left/centre pins of Jumper S6 (below U36 on the Tracing Circuit CCA). Install the shunt across the centre/right pins to disable the circuit.

2. Using Pattern 206P969 (located at the end of this manual), operate the Tracer over a Command Mark and stop the Tracer.

3. Observe the signal at TP15 with a digital voltmeter and adjust R114 cw until the point at which an increase in R114 does not result in a change in the voltage at TP15. Or, using an oscilloscope, observe the signal at TP14 and adjust R114 to obtain a saturated signal for the duration of time that the Command Mark is scanned. Do not increase the gain settings past the point where the signal is clipped. Noise from dirt on patterns may cause improper operation of the circuit.

4. Verify correct operation of this circuit by tracing Pattern 206P969.

5. Using a typical pattern, adjust R120 to obtain a speed during slowdown operation which results in optimum corner tracing at the maximum operating speed,. Maximum counter-clockwise (ccw) adjustment results in a slowdown speed which is approximately 1/3 of the dial speed.

Measuring and Recalibrating True Linear Speed

The 0 to 10 calibration on the SPEED potentiometer should represent speeds from zero to the maximum rated speed of the machine. A setting of `5' will therefore represent 50% of maximum speed.

The following example is for a machine with a maximum speed of 1000 mm/min (40 IPM). To measure the actual speed:

1. Remove the cap from the SPEED control knob; it can be lifted out with your fingers.

2. Loosen the collet-locking nut and remove the knob on the control shaft.

3. Trace a test line, drawn in the X-axis direction, 500 mm long (see Figure 6-2).

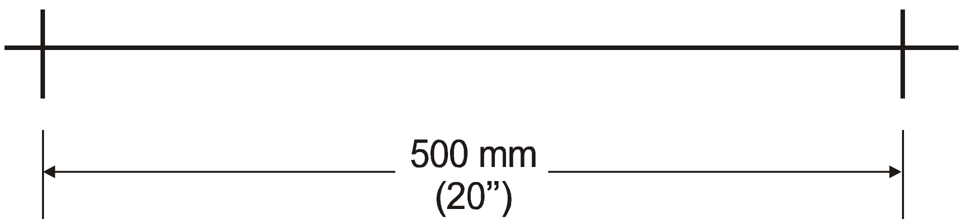


Figure 6-2 Speed Measurement Test Line

4. Starting from the fully CCW position, slowly rotate the control until the X drive begins to turn, then back the control off until the drive just stops.

5. Replace the knob on the control shaft to set the index mark over the scale `0' and tighten the nut.

6. Repeat step 4 and check that the drive stops at `0', readjust if necessary. Then reinsert the cap in the control knob.

7. Set the SPEED control to `10' and record the time taken to traverse the 500 mm test line. At 1000 mm per minute this should be 30 seconds.

8. While tracing the test line measure the output voltage at terminal XT on the circuit card.

9. Calculate the calibrated speed voltage (V_{CAL}) as follows, assuming the measured tacho voltage at terminal XT is 5 volts and the time taken to travel 500 mm is 27 seconds:

$$V_{CAL} = \frac{27 \text{ seconds}}{30 \text{ seconds}} \times 5 \text{ volts}$$

$$= 4.5 \text{ volts}$$

10. Retrace the test line and adjust R65 for a tacho output of 4.5 volts at terminal XT. Verify that the tracer takes 30 seconds to travel 500 mm.

The Y axis is calibrated in a similar manner, with the 500 mm test line drawn in the Y-axis direction. The Y-drive tacho output voltage is measured at terminal YT and adjusted by R66.

In this example, the machine was rated at 1000 mm (40 inches) per minute. If the machine is rated at 2000 mm (80 inches) per minute, the measured test line becomes 1000 mm (40 inches) long, and so forth.

Changing the Lead

The following instructions describe the steps required to replace a Standard (3 mm lead) Mirror & Magnet Assembly, part number 1904C26G01, with either a 1 mm lead Mirror & Magnet Assembly, 1904C26G02 (identified by the number `1' on the face of the assembly on which the mirror is located), or a 1.5 mm lead Mirror & Magnet Assembly, 1904C26G03 (identified by the number `1.5' on the face of the assembly on which the mirror is located).

If either the 1 mm lead mirror or the 1.5 mm lead mirror is used, both kerf and system tracing speed are affected.

- ! The use of kerf is not possible. If required it should be included in the pattern.
- ! The maximum tracing speed of the system is limited, as follows:

MIRROR	MAXIMUM TRACING SPEED
1 mm lead	1000 mm per minute
1.5 mm lead	1500 mm per minute

The Lead may be changed by the following procedure:

1. Switch the mains power OFF and disconnect the scanner motor connector J4/P4. This is a three-contact connector, one half of which is part of the scanner motor assembly.
2. Loosen the kerf locking screw and rotate the scanner assembly (as would be required to adjust the kerf) so that the two screws used to mount the scanner motor can be removed. A short screwdriver is required.
3. Remove the scanner motor and mirror & magnet assembly.
4. Remove the mirror & magnet assembly by undoing the two set screws that secure it to the motor shaft.
5. Install the new mirror & magnet assembly, positioning it on the shaft so that its end is located approximately 7.5 mm from the face of the boss on the motor end plate. Refer to Figure 6-3.

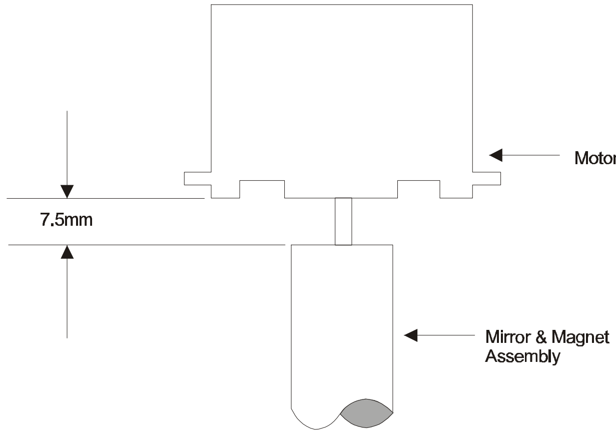


Figure 6-3 Mirror & Magnet Assembly

6. Replace the Motor Assembly and secure it in place using the four mounting screws removed in Step 2.

7. Reconnect connector J4/P4 and set the kerf scale to the zero position.

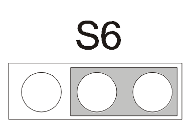
On systems using Tracing Circuit card part number 3925D27G04 or 3925D27G06, the Low Speed Corner Adjustment feature (which is intended to work with a 3 mm lead mirror) must be disabled when a 1 mm or 1.5 mm lead mirror is used.

To disable the Low Speed Enhancement circuit:

- Note the position of the adjustment screw on potentiometer R86 on the Tracing Circuit card. If a 3 mm lead mirror is reinstalled, R86 must be returned to this position.

- Adjust R86 to the maximum clockwise (cw) position.

The `Corner Slowdown' feature on systems using Tracing Circuit card 3925D27G06 must also be disabled. To do this place the two-pin shunt across the two right hand pins of three-pin header S6 which is located on the Tracing Circuit card.



For speeds up to 300 mm per minute, the LOW speed range can be used (`5' on the dial on the LOW speed range). For speeds greater than 300 mm per minute, use the HI speed range.

NOTE

When the Lead is changed, it may be necessary to re-zero the Kerf.
See ‘Re-Zeroing Kerf’ instructions.

Re-Zeroing Kerf

The procedure for checking and, if necessary, correcting calibration of the kerf is:

1. Attach a ball point pen (or similar scribing device) to the Tracer Unit to scribe a drawing next to the test pattern being traced.

2. Set the Kerf Control to zero.

3. Trace the 0.5 mm wide line inside the circle of Test Pattern 205P773. The path recorded by the pen will result in a single line. If necessary adjust the kerf. This is the new zero kerf position. Kerf should not be adjusted when a 1 mm or 1.5 mm lead mirror is used.

PERIODIC MAINTENANCE

General

Perform periodic maintenance (as described below) at three-month intervals, or more frequently where conditions require.

Component locations on the Lighting & Sensing Unit (part number 1904C30G01) and Lighting & Sensing Board (part number 415B803GO1) are shown in Figure 6-4. Component locations on the Chassis Board CCA (part numbers 3916D27G01 and 3916D27G02) are shown in Figure 6-5, and component locations on the appropriate Tracing Circuit cards (part numbers 3925D27G01, 3925D27G04 and 3925D27G06) are shown in Figures 6-6 through 6-8, respectively.

Scanner Sub-assembly

1. Check the flood lamps and wipe them with a soft cloth on a regular basis.

2. Replace the lamps once a year. Darkened flood lamps give reduced light output which affects tracing performance.

3. Check and wipe the flood lamp reflector with a damp, clean, soft cloth.

Tracer Unit

1. Check if any relays or control switches are loose or worn.

2. Ensure that internal plugs and connectors are properly seated.

Drive Units

The motors are lubricated and sealed and do not require additional lubrication.

1. Check for excessive gear backlash and if necessary, replace the gearbox or drive unit.

2. Routine cleaning of the rails and wheel surfaces will prevent a buildup of slag which can lead to drag on the drives.

Replacing Flood Lamps

The flood lamps, located at the bottom of the Lighting & Sensing Unit in the Scanner Assembly are held in place by clips that are also the electrical contacts. See Figure 6-4.

To replace the flood lamps (DS1 and DS2):

1. Remove the Scanner Assembly or move the unit clear of the table.
2. Loosen the clip screws.
3. Rotate the clips and remove the lamps.
4. Install new lamps.
5. Position the clips and tighten the screws.
6. Replace the Scanner Assembly at the optimum height.
7. Rotate the flood lamps to eliminate shadow (if present) caused by a seam in the glass.

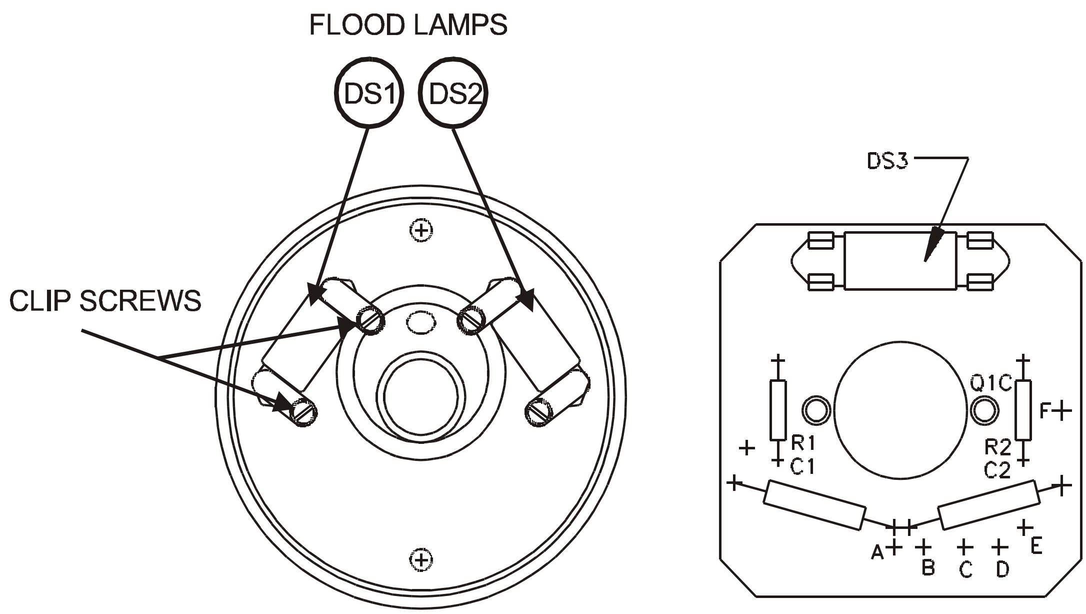


Figure 6-4 Flood Lamps and Spotlight

Replacing Indicator Lamps

The Lighting & Sensing Unit Assembly produces a small, well defined indicator spot that can be positioned in the centre of the scanned area.

All Lighting & Sensing Units, part number 1904C30G01, with Serial Number 2392 and up, are new assemblies. They contain a new Lighting & Sensing Board Assembly, part number 415B803G01. The new Lighting & Sensing Units replace older assemblies (with Serial Numbers below 2392).

The new circuit card assembly (CCA) 415B803G01 is identical to the previous version except for indicator lamp DS3, which is held in place by two clips instead of a socket mounted on two posts. The lamp now used for DS3 is the same type as those used for the flood lamps (see Table 6-1).

A metal mask with a narrow slit is used to obtain a small indicator spot. The mask is held in place by the two screws used to mount the CCA on the plastic moulding.

Figure 6-4 shows the location of components on Lighting & Sensing CCA 415B803G01.

To replace the indicator lamp (DS3):

1. Remove the two retaining screws from the Lighting & Sensing Unit Assembly.

2. Lower the unit while feeding the attached cable through the slot in the side of the Scanner Assembly. Cut the plastic cable-tie securing the cable to the Scanner Assembly and disconnect the motor ground connection by removing the motor mounting screw in one corner of the motor. Disconnect the Scanner-to-Chassis Board cable connectors, if necessary.

3. Pry the indicator lamp straight up from the clips using a small screwdriver to push one end of the lamp out of the clip. Remove the lamp; do not force the clips sideways.

   Install a new lamp by resting it on the clips and pushing straight down until the lamp snaps into place.

4. Replace the Lighting & Sensing Unit Assembly. Replace the motor ground connection and the mounting screw in one corner of the motor. Carefully feed the cable back through the slot in the side of the Scanner Assembly. Excess cabling inside the housing may block light and prevent tracing. Replace the two retaining screws used to mount the Lighting & Sensing Unit Assembly.

5. Check spotlight centering with the tracer positioned at the correct height above the pattern. Trace a pattern, with zero kerf, stopping the tracer while it is moving in the X and Y axes and noting the position of the indicator spot in relation to the pattern.

The position of the spot along the X axis can be altered by moving the slotted mask under the indicator lamp; two screws secure the mask. The position of the spot along the Y axis can be altered by rotating the indicator lamp between the clips. The lamp filament is offset from the centre.

Replace the plastic cable tie securing the cable to the Scanner Assembly and if necessary, the Scanner-to-Chassis Board cable.

Ordering Replacement Lamps

The part number and description of the flood lamps, DS1 and DS2, and the Spotlight, DS3, used on the Lighting & Sensing CCA, are given in Table 6-1.

CIRCUIT DESIGNATION	DESCRIPTION	PART NUMBER
DS1 and DS2	Flood Lamp, Stanley A3472C12V5W10X37	K7486A1L01
DS3	Spotlight, Stanley A3472C12V5W10X37	K7486A1L01

Table 6-1 Flood Lamps and Spotlight - Part Number and Description

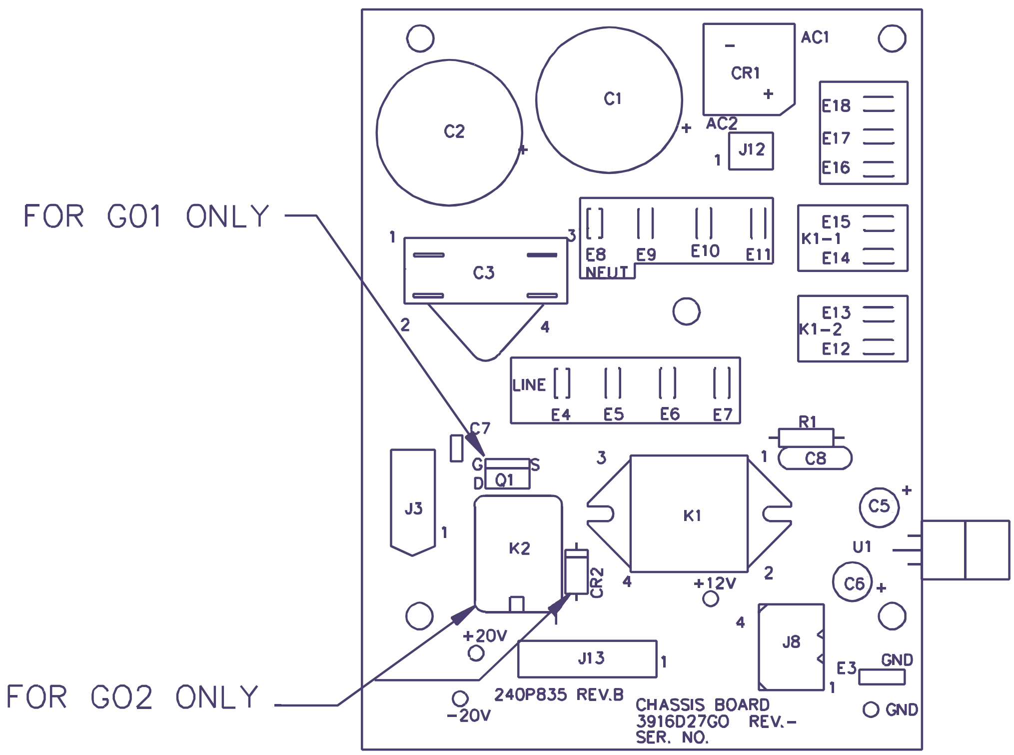


Figure 6-5 Component Location on the Chassis Board CCA

Troubleshooting Information

A step-by-step Troubleshooting Guide and Adjustment Procedures are included in Tables 6-2 and 6-3. The component layouts for the Tracing Circuit CCA's are shown in Figures 6-6, 6-7 and 6-8. A set of schematics is included in the attached parts supplement for this HL-90 configuration.

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
1-1	No response from the system; no motion or lights. The Scan Motor does not run.	Power Input Cable	Top of Tracer.	Check connection to correct mains supply.
1-2		F1, Mains Fuse.	Left side of Tracer Unit.	Check fuse; replace if defective.
1-3		S5, Mains Switch.	Left side of Tracer Unit.	Measure line voltage at the input to the switch; it should be within +10%, -15% of the ac input rating shown on the rating nameplate on the lower left side of the Tracer Unit. If the output of the switch is not the same, replace the switch. Latching power relay K3 must operate.
2-1	No response from the system except the Scan Motor runs.	T1 Power Transformer output.	P12 on the Chassis Board Assembly.	Measure the voltage between P12-1 and P12-2; it should be 30 Vac ±3V at nominal input. If high, recheck the mains voltage; if low, replace the transformer. If normal, check CR1; replace, if defective.
2-2		+20 Vdc Test Point.	Chassis Board Assembly.	Measure the voltage between the Test Point and GND; it should be +20 Vdc ±3V. If low, disconnect P1 from the CCA. If the voltage is now correct, the CCA is defective; repair or replace it. If the voltage remains low, U1 or the lamp circuit is defective; refer to Step 3 for fault finding. If the voltage is still low, check rectifier CR1 and capacitor C1 and replace the defective part.

Table 6-2 Troubleshooting Guide

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
2-3		-20 Vdc Test Point.	Chassis Board Assembly.	Measure the voltage between the Test Point and GND. It should be -20 Vdc ±3V. If low, disconnect P1 from the CCA. If the voltage is now correct, the CCA is defective. Repair or replace it. If the voltage is still low, check rectifier CR1 and capacitor C2 and replace the defective part.
2-4		TP1, +12 Vdc.	Circuit Card Assembly.	Measure the voltage at TP1. It should be +12 Vdc ±0.6V. Repair or replace the CCA, if defective.
		TP2, -12 Vdc.	Circuit Card Assembly.	Measure the voltage at TP2. It should be -12 Vdc ±0.6V. Repair or replace the CCA, if defective.
3-1	No lights; Tracer moves.	U1, Lamp Regulator.	U1 on the Chassis Board Assembly.	Measure the voltage at the +12V Test Point. It should be +12 Vdc ±0.6V. If the voltage is incorrect, disconnect P3 from the scanner assembly. If the voltage is still incorrect, replace U1. If the voltage is correct, the fault is in the scanner assembly.

Table 6-2 Troubleshooting Guide (Cont'd)

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
3-2		Flood Lights.	Bottom, Lighting & Sensing Assembly.	Check the flood lights DS1 and DS2 for continuity (J3-1 and J3-2). Replace if defective (see Figure 6-4).
3-3		Spot light.	Inside, Lighting & Sensing Assembly.	Check the spot light DS3 for continuity (J3-2 and J3-4). Replace if defective (see Figure 6-4).
3-4	Flood lights ON, very dim.	Flood Switch Circuit.	Q1 on the Chassis Board, or K2 on the Chassis Board.	Set the STRIP/TRACE/START switch (S2) to the trace position. Measure the voltage at J3-2; it should be 1.5 Vdc ±0.6V.
4-1	The ON PATT light does not come on, and the tracer does not follow a pattern.			a. Verify that the flood lights are ON. b. Verify that the lights and reflecting surfaces are clean. c. Check that the Head height is 38 mm from the reference line to the pattern. d. Verify that the pattern meets the requirements of the tracer (refer to Chapter 5).
4-2		TP5, Sensor Signal.	Circuit Card Assembly.	Measure the output signal on TP5. With the tracer over a pattern, the voltage should be 10.5 Vdc ±1.0V; if incorrect, readjust per Table 6-2, Step B. If adjustment does not correct the fault, check that:
4-3				a. The scan motor is running. b. The correct voltage is applied to the photo sensor; it should be +12 Vdc ±0.6V at P2-7 and -7 Vdc ±1.2V at P2-4.

Table 6-2 Troubleshooting Guide (Cont'd)

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
4-4		Photo Sensor Output.	P2-2.	Over a pattern, the output should be pulses, minimum 100 mV. An oscilloscope is required to make this measurement. The dc level at this point should be approximately 0 volts. If the voltage is close to either +12 Vdc or -7 Vdc, replace the photo sensor. If the photo sensor pulse is within spec., the circuit card is defective. Repair or replace it.
5-1	Machine will not drive in the X axis.			Set the STRIP/TRACE/START switch (S2) to STRIP, the speed control to maximum and the drive switch to the +X (right) direction.
5-2		TP10, +X Speed Signal.	Circuit Card Assembly.	Measure the speed signal; it should be +7.5 Vdc ±0.3V. If the voltage is out of spec., complete Step 6 in this guide. If no voltage is measured, recheck the power supplies, Step 2 in this guide. Proceed if the power supplies are OK.
5-3		TP3, Sine Ref. Signal.	Circuit Card Assembly.	Measure the sine signal. It should be 5.3 Vac ±0.2V. If the voltage is out of spec., complete Step 6 in this guide. If no voltage is measured, check the sine generator output from the scanner assembly at J2-6. If a voltage is not present, repair or replace the scanner assembly. If the signal at TP3 is OK, proceed.

Table 6-2 Troubleshooting Guide (Cont'd)

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
5-4		Terminal Xm Motor Output.	Circuit Card Assembly.	Measure the speed signal. It should be approximately 10 Vdc. If the output is approximately -3 Vdc, disconnect the motor leads. If the voltage is unchanged, repair or replace the circuit card assembly. If the voltage increases to approximately -20 Vdc, repair or replace the Drive Unit. If the output is zero volts, replace the circuit card.
5-5				Repeat Steps 5-1 to 5-5 with the direction switch in the -X (left) position; voltages at TP10 and Terminal Xm should be similar, but with positive polarity.
6-1	Machine drives in the X axis; the speed is controllable, but not at the set speed.			Set the STRIP/TRACE/START switch (S2) to STRIP, the speed control to maximum, the drive switch to ON and the direction switch to +X (right).
6-2		TP10, +X Speed Signal.	Circuit Card Assembly.	Measure the speed signal. It should be +7.5 Vdc ±0.15V. If the voltage is out of spec., recheck the power supplies, as in Step 2 of this guide. If the power supplies are OK, proceed.
6-3		TP3, Sine Ref. Signal.	Circuit Card Assembly.	Measure the speed signal. It should be 5.3 Vac ±0.1V. If the voltage is out of spec., complete Steps C1 and C2 in this guide.

Table 6-2 Troubleshooting Guide (Cont'd)

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
				If the voltage cannot be adjusted to within spec., check the sine generator output from the scanner assembly at J2-6; it should be approximately 3 Vac (0.5 to 5 Vac). If this voltage is out of spec., repair or replace the scanner assembly. If the voltage is OK, repair or replace the circuit card assembly.
6-4		Motor Speed, +X Direction.		If all voltages are OK, check the motor speed; refer to Linear Speed Adjustments, Steps 1 and 2. If the speed is still incorrect, proceed.
6-5		Terminal Xm Motor Output.	Circuit Card Assembly.	Measure the output voltage; it should be -5 Vdc to -8 Vdc.
6-6		Terminal Xt Tacho Output.		Measure the output voltage; it should be +4 Vdc to +6 Vdc. If this voltage is incorrect, the fault can be in either the CCA or the drive unit assembly. Interchange the X and Y motors by switching the Xm and Xt leads with the Ym and Yt leads; repeat Step 6-4. If the Y motor, driven by the X amplifier, runs at the correct speed, the X drive assembly is defective. If the fault transfers to the Y motor speed, the CCA is defective. Repair or replace the defective assembly.

Table 6-2 Troubleshooting Guide (Cont'd)

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
6-7		Motor Speed, -X Direction.		If the fault occurs only in the -X direction, repeat Steps 6-1 through 6-6 with the direction switch in the -X (left) direction. The voltage at TP10 should be +8.5 Vdc, Term Xm +5 Vdc to +8 Vdc, and Term Xt -4 Vdc to -6 Vdc.
7-1	Machine drives in the X axis but there is no speed control.			Set the STRIP/TRACE/START switch to STRIP, the direction switch to +X (right), the SPEED control to 0, the drive switch to OFF and the power switch to ON. If the drive motor immediately runs at high speed, the circuit card assembly is defective. Repair or replace. If the drive motor does not run, set the DRIVE switch to ON and increase the SPEED control setting to 1. If the motor runs at high speed and stops when the SPEED control is returned to zero, the fault is an open tacho. Replace the drive unit. If the motor continues to run at high speed, the drive unit is miswired, i.e. either motor leads or tacho leads are reversed. Refer to Chapter 4, Motor Rotation.
8-1	Machine drives in the X axis but the speed is irregular.			Set the STRIP/TRACE/START switch to STRIP, the direction switch to +X (right), the SPEED control to 0, the drive switch to OFF and the power switch to ON.

Table 6-2 Troubleshooting Guide (Cont'd)

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
8-2		TP10, +X Speed Signal.	Circuit Card Assembly.	Monitor the voltage at TP10; it should be 3.75 Vdc ±0.15V and remain constant.
8-3		TP3, Sine Ref. Signal.	Circuit Card Assembly.	If the voltage varies, measure the sine reference; it should be 5.3 Vac ±0.2V and remain constant. If the reference voltage varies, repair or replace the scanner assembly. If the reference voltage is constant, repair or replace the circuit card assembly.
8-4		R68, Current Limit Resistor.	Circuit Card Assembly.	Measure the voltage across R68. With a resistance of 1.0 ohm, the meter reading in volts is equivalent to the motor current in amperes (R68 = 0.68 ohm in the high speed version, current = 1.4 times the voltage reading). The current is limited to a maximum of approximately 1 ampere (1.4 amperes for the high speed versions). Under normal operation, the motor should require less than 0.5 ampere and the voltage across R68 should be 0.5 Vdc, or less. If the voltage is high, i.e. 0.8 Vdc to 1.1 Vdc, a fault in either the drive unit or the machine wheels and bearings is indicated. Decouple the motor from the machine to determine the location of the fault. Repair or replace the faulty components.

Table 6-2 Troubleshooting Guide (Cont'd)

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
8-5		R67, Current Limit Resistor.	Circuit Card Assembly.	Repeat Step 8-4 with the direction switch in the -X (left) position and measure the voltage across R67.
9-1	Machine will not drive in the Y axis.			Perform Steps 5-1 to 5-5, but in the Y axis. Measure the Speed Signal at TP11, the Sine Reference at TP3 and the Motor Output at terminal Ym.
10-1	Machine drives in the Y axis; the speed is controllable, but not at the set speed.			Perform Steps 6-1 to 6-7, in the Y axis. Measure the Speed Signal at TP11, the Sine Reference at TP3, the Motor Output at terminal Ym and the Tacho Output at terminal Yt.
11-1	Machine drives in the Y axis but there is no speed control.			Perform Step 7-1, in the Y axis.
12-1	Machine drives in the Y axis but the speed is irregular.			Perform Steps 8-1 to 8-5, in the Y axis. Measure the Speed Signal at TP11, the Sine Reference at TP3, the +Y current limiting across R69 and the -Y current across R70.
13-1	Machine operates, but the flood lamps can not be turned off.	Power FET Q1, or Relay K2.	Located on the Chassis Board Assembly.	Replace Q1 or K2.

Table 6-2 Troubleshooting Guide (Cont'd)

STEP	FAULT SYMPTOM	CHECK	LOCATION	ACTION
13-2	Tracer will not slowdown over Command Marks.	Signal Gain TP14, TP15.	Circuit Card Assembly.	Adjust the Gain. Refer to Slowdown Circuit Calibration, Step 3.
		Signal at TP16.	Circuit Card Assembly.	The voltage must be +5V when the Tracer is over a Command Mark. If the voltage is not +5V, the circuit card is defective.
13-3	Corner Compensation is incorrect.	Signal at TP13.	Circuit Card Assembly.	The voltage at TP13 must be +5 Vdc when on the LO range and SPEED control at 1-. Adjust R86; refer to Low Speed Range Adjustment, Steps 1 through 3. If this voltage is correct, the circuit card is defective.

Table 6-2 Troubleshooting Guide (Cont'd)

TEST POINT	OUTPUT SIGNAL	TYPICAL VOLTAGES	ADJUSTMENT
TP1	+12V Supply	+12 Vdc ±0.6V	N/A
TP2	-12V Supply	-12 Vdc ±0.6V	N/A
TP3	Sine Output	15 Vp-p ±0.3V (5.3 Vac ±0.1V)	R41 (Gain), R73 (Offset)
TP4	Sensor Signal	0V to +12V pulse	R21
TP5	Scan Signal	10.0V ±0.5V	R21
TP6	Inhibit Pulse	0V to +12V pulse (27 or 34 msec)	R30
TP7	90E	+12V to 0V pulse (8 to 10 msec)	R35
U21B-10	Sample Pulse	0V to +12V pulse (5 to 7 µsec)	--
U21A-6	Sample Pulse	0V to +12V pulse (5 to 7 µsec)	--
TP10	`X' Speed	Between +7.5 Vdc and -7.5 Vdc	R40 R73 (Offset)
TP11	`Y' Speed	Between +7.5 Vdc and -7.5 Vdc	R40 R73 (Offset)
XM	`X' Drive	0 Vdc ±50 mV	R50 (Offset)
XT	`X' Tacho	Between +6 Vdc and -6 Vdc maximum	R65 (Speed)
YM	`Y' Drive	0 Vdc ±50 mV	R52 (Offset)
YT	`Y' Tacho	Between +6 Vdc and -6 Vdc maximum	R66 (Speed)
TP12	Speed	Between +7.5 Vdc and -7.5 Vdc	R40, R122, R120
TP13	Speed Ref.	0.0 to +5.0 Vdc	R86
TP14	Scan Signal	0V to +12V pulse	R114
TP15	Peak Detected Scan Signal	0V to +12V	R114
TP16	Slowdown Signal	+5V	

Table 6-3 Adjustments and Test Points on the Tracing Circuit CCA

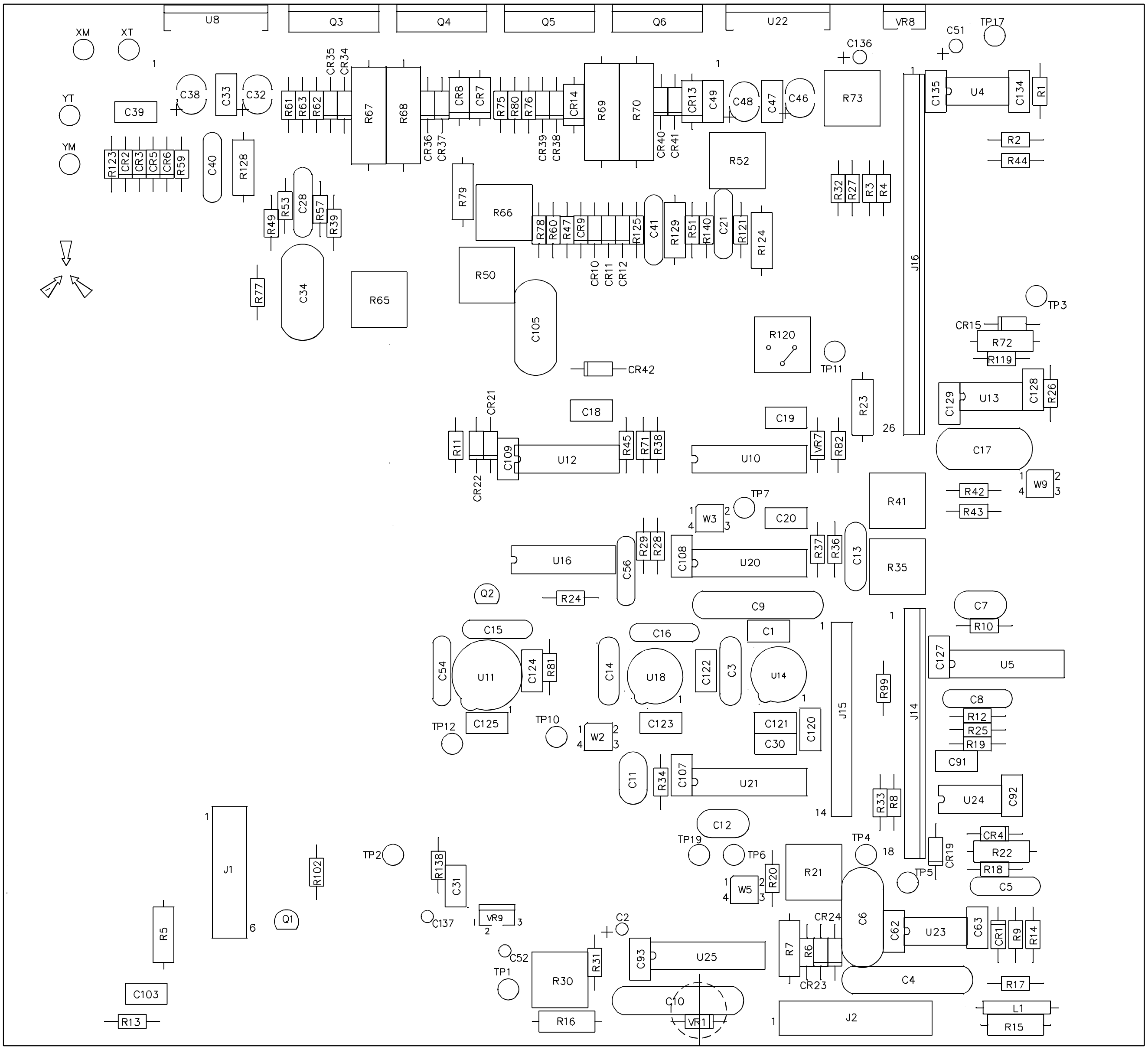


Figure 6-6 Component Location on Tracing Circuit CCA 3925D27G01

NOTE

Not all Tracing Circuit CCA illustrated in this chapter may be used in your system. Please refer to Parts List to determine which Component Location figure is applicable.

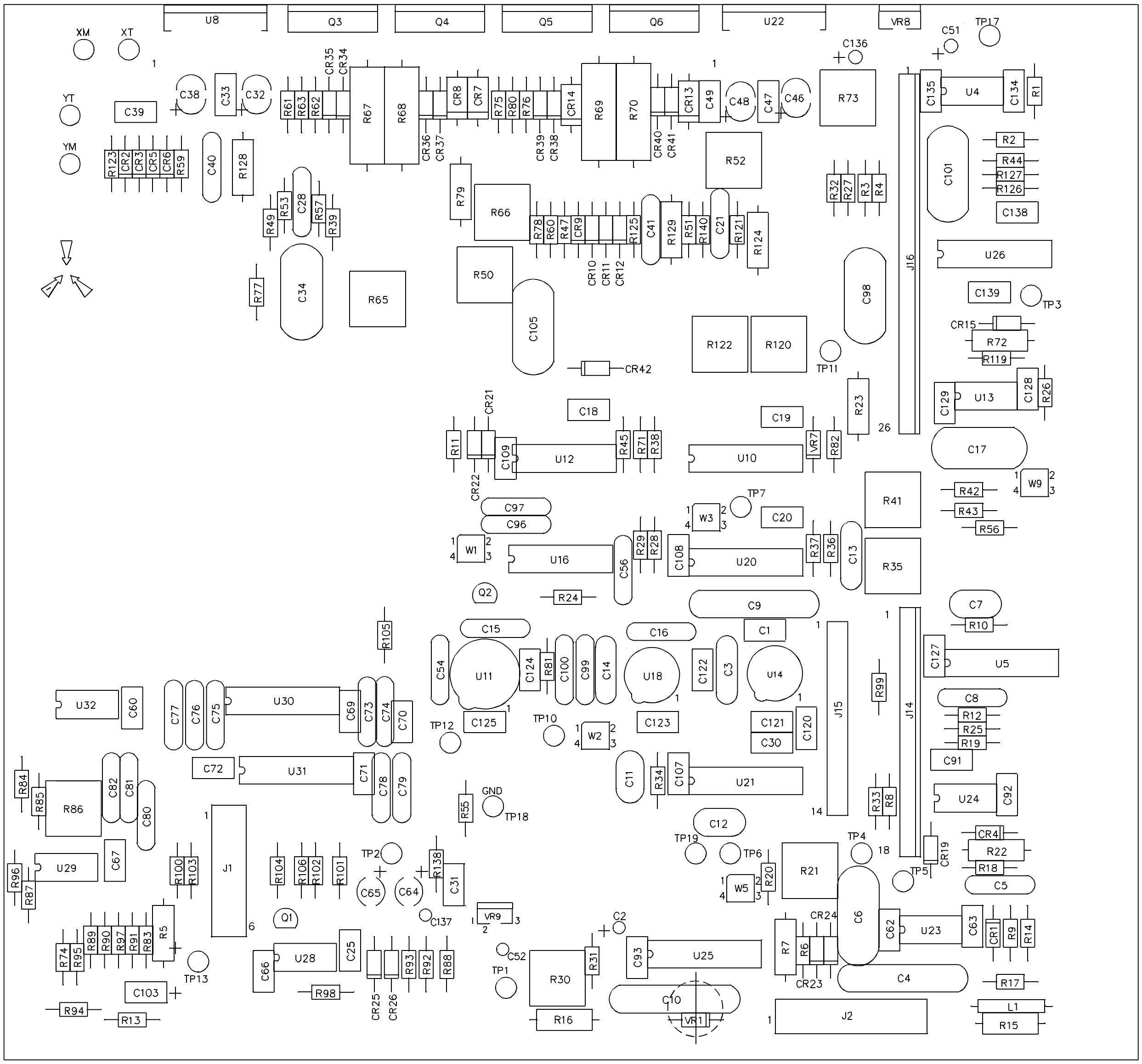


Figure 6-7 Component Location on Tracing Circuit CCA 3925D27G04

NOTE

Not all Tracing Circuit CCA illustrated in this chapter may be used in your system. Please refer to Parts List to determine which Component Location figure is applicable.

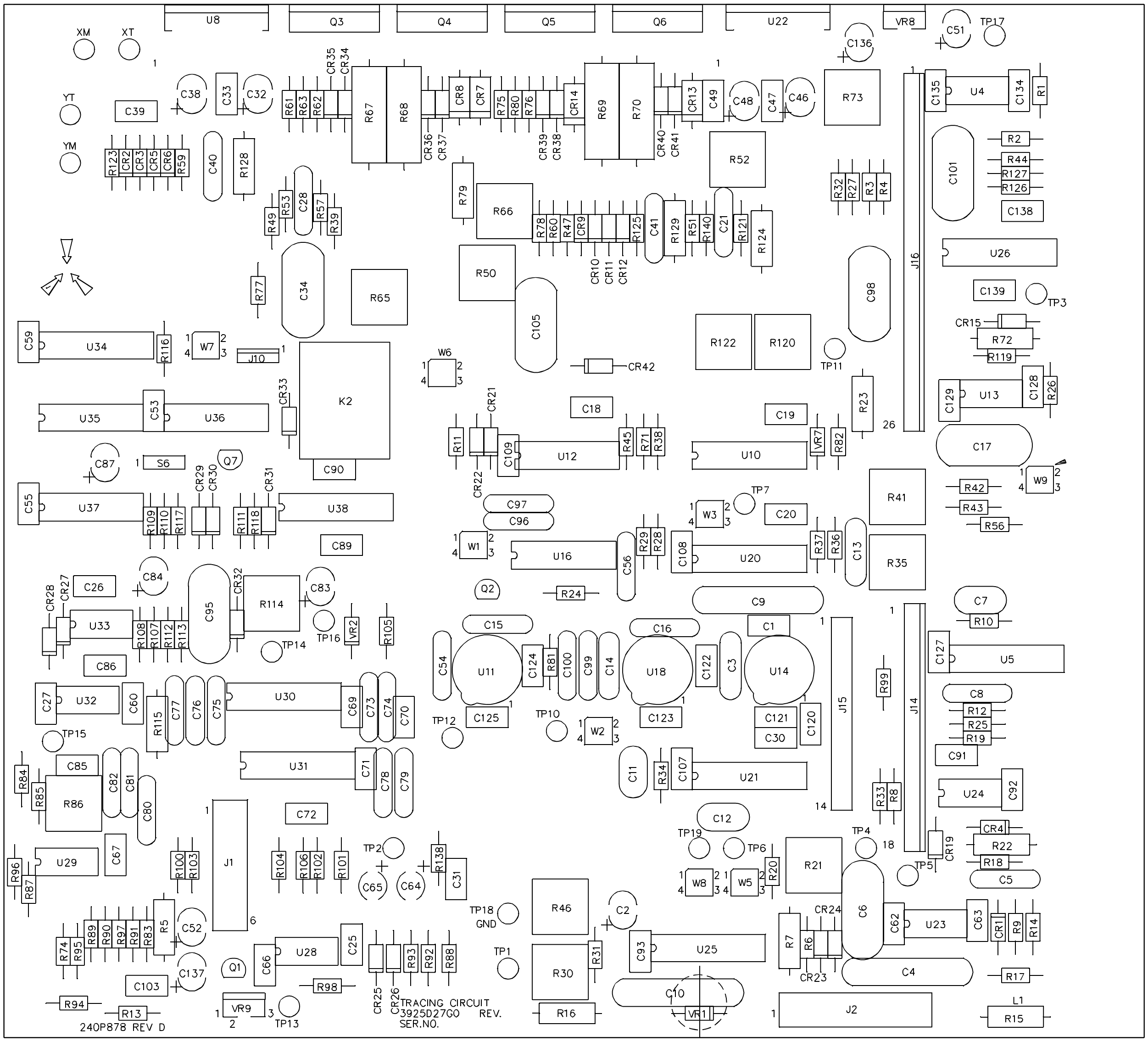


Figure 6-8 Component Location on Tracing Circuit CCA 3925D27G06

NOTE

Not all Tracing Circuit CCA illustrated in this chapter may be used in your system. Please refer to Parts List to determine which Component Location figure is applicable.