



REFERENCE  
ONLY

AEROTECH  
BIPOLAR CHOPPER  
STEPPING MOTOR TRANSLATOR  
8007  
INSTRUCTION MANUAL FOR  
MODEL NUMBER  
D630-1058

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MODEL 8007

Stepping Motor Driver

## 1.0 DESCRIPTION

### 1.1 General

The Aerotech Model 8007 (80 volt, 7 amp/phase) is a bipolar chopper designed to drive 1000 oz-in stepping motors to 5000 steps/second. The unit contains a dual input front end with slew and step capability, sequencing logic for incorporating limit sensing, a power supply, and pulse width modulated motor current switching bridges. This compact state-of-the-art unit is destined to become the benchmark of the industry.

Total CMOS logic operating at 5 or 12 volts provides excellent noise immunity. The bipolar chopper drive, operating from 80 volts commands rapid motor response for high stepping rates and generates one-third more motor torque than an equivalent unipolar translator. Regenerative current from the motor returns to the power supply, dramatically increasing efficiency. No additional resistors or components are required for operation; simply add 115 or 230 VAC, direction and clock or slew and step commands, and the motor.

### 1.2 Front End

The front end incorporates an internal oscillator and a single pulse debounce latch to generate a local clock for the sequencer. There is also a local direction input. Either these local clock and direction signals or another clock-direction pair, called remote clock and direction, can be selected for routing to the sequencer by applying the appropriate logic level to the "LCL/REM" input at J2-16. The front end also has limits logic circuitry that can accept

signals from a limit switch assembly. Once a limit switch is closed, clock signals driving the motor further into the limit are inhibited, but changing direction removes the inhibit from the clock signal so that the motor can move back from the limit.

### 1.3 Sequencer

The sequencing logic is capable of operation in the two-phase-on, one-phase-on, or half-step sequence, selection is accomplished by logic commands. The adjustable output current can be reduced (to approximately 60% of the set value) by a logic command, permitting reduced power levels when desired.

### 1.4 Power Supply

The fused, isolated, internal power supply operates from 115 or 230 VAC and provides all necessary operating voltages in addition to regulated +5 VDC and unregulated +80 VDC for external use.

## 2.0 SPECIFICATIONS

### 2.1 Maximum Ratings

Peak Output Voltage	80 Volts
Continuous Output Current	7.5 amps/phase
Operating Temperature	0 to 50° C
Storage Temperature	-30 to +80° C
AC Line Voltage	125/250 VAC depending on transformer connections

### 2.2 Mechanical Characteristics

Weight	14 3/4 lbs.
Dimensions	6.2" wide x 9.37" long x 6" high (7.5" long w/o fan)
Mounting Dimensions	5 1/2" x 3 5/8"
Mounting Screws	1/4-20, 3/8" maximum depth into baseplate

### 2.3 Electrical Characteristics

Input Power	100-125 VAC, 200-250 VAC; 50-60 Hz
Switching Frequency, constant	5K Hz
External Supply Availability	
+80 VDC at J1-1 ( $z = 250\Omega$ )	.14 amp
+80 VDC at TB1-4	1 amp
+ 5 VDC Regulated	.05 amp
Internal Clock Frequency	100 - 1000 steps/sec.
Input Clock Frequency	0 to 20K steps/sec.
Input Impedance: Clock, Full/ Half, one/two, step, slew, LCL/Rem, Direction, LO I and Limits	0.1 M

Electrical Characteristics (cont'd)

Input Signal Levels	0 to +5v or +12v, depending on logic power setup
Minimum Clock Pulse Width	
(Clock occurs on positive going edge)	2 us
Minimum Time for Clcok at 0 level	2 us
Minimum Time between Clock Leading Edge and DIR transition	<u>+600</u> n-sec
Minimum Load Inductance	1 mh

## 3.0 INSTALLATION AND OPERATION

### 3.1 Control Hookup Considerations

The 8007 Stepping Motor Drive can be operated in local mode from switches or in remote mode from external Clock and Direction. It has an internal clock generator to operate manually at start/stop speeds with only a few external switches. For automated or high speed use, the 8007 can be run from external clock and direction inputs. Accordingly the inputs required for using the 8007 by itself are grouped on J2, and the inputs required for use with external clock and direction are grouped on J1. It is also possible to switch from one mode to another via the Local/Remote Control Line on J2-16.

#### 3.1.1 Input Electrical Characteristics

Most inputs to the module are standard CMOS inputs with 100K input pull-up resistors to the logic supply (+V). Leaving an input open is equivalent to putting a "1" level on the input. Grounding the input is equivalent to a "0" level. One input on J2-1, One/Two phase on, has a 100 K input pull-down resistor to ground. Leaving this input open is equivalent to putting an "0" level on that input, and a logic "1" level or V+ is needed for an input high state. J1-3 & 4, Remote Clock/Direction, respectively, have neither pull up or down, and the unit should not be turned on in the remote mode with these terminals open.

#### 3.1.2 Local/Remote Mode

The Local/Remote Mode is the key to flexibility of the 8007. When a logic "1" is present at J2-16 (LCL/REM), the signal from the local clock generator is routed to the sequencer which generates the sequence of drive signals for each winding of the motor. Also the DIR (direction)



input at J2-11 is routed to the sequencer. When a logic "0" is present at J2-16, the signals from the internal clock generator and J2-11 (DIR) are ignored, while the signals on J1-3 (Remote Clock) and J1-4 (Remote Direction) are the ones that are routed to the sequencer. If the unit is to be run only from remote clock and direction inputs, insert a jumper between points 1 and 2.

### 3.1.3 Local Mode Operation

If the 8007 is to be operated by itself, it should be placed in Local Mode by letting J2-16 go high. This will allow the local direction input and the local clock generator to input to the sequencer. The local clock generator consists of two parts; one is a single step debounce latch requiring two inputs. These inputs, called NO (normally open) on J2-12 and NC (normally closed) on J2-4, are meant to be connected to the normally open and normally closed contacts of an SPDT momentary action pushbutton. The moving contact of the pushbutton should be connected to ground (J2-13). Pressing and releasing the pushbutton will send just one clock pulse to the sequencer and the motor will advance one step. The other part of the local clock generator is the slew oscillator. The slew oscillator has one input at J2-5. Grounding this input will turn this oscillator on and a constant frequency pulse train will be sent to the sequencer. Also, in local mode, the DIR input at J2-11 is routed to the sequencer.

### 3.1.4 Remote Mode Operation

If the unit is to be operated in the remote mode, either J2-16 should be grounded or a jumper should be inserted at points 1 and 2.

When this is done, the local clock generator is isolated from the rest of the unit and the local direction input J2-11 is ignored. Instead J1-3 Remote Clock, and J1-4 Remote Direction, are patched to the sequencer. The inputs on J2 other than the step inputs, slew, and direction are still effective.

The Remote input jack J1 has been designed to interface completely to Aerotech clock and direction generating modules, such as the 5KR high speed ramper, or the Parallel Incremental Stepping Motor card. The 8007 sends +80V at  $Z = 250$  ohm and ground to these modules for module power on J1-1 and J1-2, respectively. J1-5 is an input for the  $\overline{\text{Reset}}$  signal that is routed to the accessory readout (see sect. 3.1.6 for further description of the readout connections). J1-6 is LO/ $\overline{\text{HI}}$  I. (see sect. 3.1.7). It is on this jack since it is usually generated in the same equipment that generates the clock and direction signals.

### 3.1.5 Limits

The 8007 can restrict the range of travel of the load the motor is driving. The Limit circuitry prevents the motor from advancing beyond a point sensed by an external limit switch or external limit sensing logic.

The limits logic circuit of the 8007 has two inputs; CW  $\overline{\text{LMT}}$  and CCW  $\overline{\text{LMT}}$  (clockwise limit lo and counterclockwise limit lo) on TB1-13 and 14 respectively. These inputs are meant to be connected to normally open switches that close to ground when a limit is reached, but logic signals can also be used ("0" = limit reached). Since a logic "1" on the DIR input to the sequencer is taken to mean clockwise rotation of the motor, CW  $\overline{\text{LMT}}$  input is effective when the DIR input to the sequencer is a "1".

When a limit input is said to be effective, it means that a "Lo" level on it will cause the clock input to the sequencer to be interrupted. If the DIR signal to the sequencer changes while the clock is interrupted by one of the limit inputs, that change will make the limit input no longer effective, and the clock signal to the sequencer will no longer be interrupted.

For example: The DIR input is a "1" and the motor is turning clockwise. The CW  $\overline{\text{LMT}}$  limit switch is activated and CW  $\overline{\text{LMT}}$  goes lo, interrupting the clock and stopping the motor. The operator changes directions, the CW  $\overline{\text{LMT}}$  input is now no longer effective, and the clock input is no longer interrupted. The motor begins to turn counter-clockwise and the CW limit switch now opens. Once the CW limit switch opens it is then again possible to operate the motor in the clockwise direction.

If limits are not needed, the inputs can be left open.

### 3.1.6 Readout

If it is desired to know the number of steps the motor has moved from a reference point, an external readout can be used.

J2 of the 8007 contains three signal outputs that can be sent to the external readout. They are  $\overline{\text{Reset}}$  on J2-7, Clock on J2-8, and DIR on J2-9. Clock and DIR are the signals that go to the sequencer, whatever mode the unit is in. The  $\overline{\text{Reset}}$  signal is not used by the 8007. It can be brought in from a switch or other piece of equipment on J2-2 or J1-5. If there is no connection on either of these points J2-7 will go to a "1".

### 3.1.7 LO/HI Current

The 8007 has an adjustment called "current adjust" (see Section 3.3.1) this sets the current through the windings of the motor. This

current would flow while the motor is not stepping, causing heat and wasting energy. To reduce the current flowing through the motor, an input has been provided called LO/ $\overline{\text{HI}}$  current on J1-6. When J1-6 is a "0" the current through the motor is constrained to the level set by the "current adjust". When J1-6 is a "1" the motor current is reduced to approximately 50% of its set value. Since leaving this input open puts a "1" on the input, this input should be grounded if this feature is not to be used. The Aerotech 5KR, 10D, and PI Cards have a signal output called CZ' designed to attach to this input which will reduce the motor current about 20 m.s. after the motor stops stepping.

#### 3.1.8 Sequencer Inputs

J2 also has full/ $\overline{\text{half}}$  step control on J2-6 and one/ $\overline{\text{two}}$  phase-on control at J2-1. They go directly to the sequencer and affect the sequence of the individual windings on commands. A logic "1" on J2-6 causes the motor shaft to turn through a  $1.8^\circ$  step angle with each clock pulse. If a logic "0" is present at J2-6, the motor moves through a  $0.9^\circ$  step angle with each clock pulse. Leaving J2-6 open causes a logic "1" to be present and full step operation will occur.

The other sequencer input on J2-1, one/ $\overline{\text{two}}$  phase-on, only has an effect in full-step mode. In the full-step mode, there are two windings of the motor on at any instant. However, a stepping motor can be operated in full step mode with only one winding on at any instant. This reduces current consumption, but it also reduces motor torque, and makes the motor more susceptible to drop-out. A "1" on J2-1 causes the unit to operate in one-phase-on mode. No connection causes a "0" to be present and the unit will run in two-phase-on mode.

### 3.1.9 Aerotech Front Panel Switch Assembly

The Aerotech Front Panel Switch Assembly C690-1057 is a useful accessory for the 8007 when it is used in the local mode. Its use greatly simplifies the wiring of the switches for local mode operation. S1 (Momentary action) connects correctly to the step NO and NC inputs. S2 (alternate action) connects to the DIR input. S3 (Momentary action) connects to the slew input. S4 (momentary action) connects to the reset input. S5 (alternate action) switches the outputs of the switch assembly between two output jacks for X-Y systems. S6 (alternate action) provides the switching function needed for the LCL/REM Command. S7 is meant to be used with other Aerotech equipment. S8 (alternate action) connects to the full/half step input. All these connections (except LCL/REM) between the switch assembly and the 8007 are made at one time with a 16 conductor ribbon cable and two press-on DIP plugs. The 8007 input "one/two phase-on" is not connected to the switch assembly but most users will leave this input unconnected. All switches are mounted on a common frame and the assembly requires one rectangular cutout and two screw holes for panel mounting.

### 3.2 Other Hookup Considerations

#### 3.2.1 5v/12v Logic Level Selection

The 8007 comes standard with a logic supply level of +5v, allowing it to interface with TTL logic levels. However, Logic operation at 12v is possible. To convert the 8007 to 12v logic, the printed circuit trace between jumper points 6 and 7 must be cut and a Jumper inserted between points 5 and 6. The second change involves R28. For 5 V operation, it has been changed to a jumper. (The jumper looks like a  $\frac{1}{4}$  W resistor but with only one black band around it). The jumper should be removed and a 12K-ohm resistor inserted in place of it.

### 3.2.2 Motor Connection

Connection terminals for the motor are on TBl-9 to TBl-12. Since the motor connection coding is not standardized, a timing diagram has been included in the appendix to aid in proper connection. Consult both this diagram and the motor spec sheet to determine correct terminal connection. The motor terminals shown on the schematic (D630-1058) are the correct terminal numbers for Sigma-20-4270D-series motors.

### 3.2.3 AC Power Input

Power requirement is less than 5 amp, 115v AC or 2.5 amp, 230 VAC. A 50/60 Hz source must be used for the fan. If a fan cooled unit is not required (discuss application with the factory), a 50 to 400 Hz source may be used. Line voltages may vary  $\pm 15\%$ . AC power is connected to TBl-1 and -2, figure 2: AC HI should be connected to TBl-1, the fused input. If operation from 230 VAC is desired see schematic.

### 3.2.4 Supplies Available for External Use

The 8007 furnishes power for external use. The logic supply at 20 ma is available at J2-14. TBl-6 furnishes +5v/12v at 30ma for supplying limit sensors. J1-1 is +80V. The +80V motor power supply passes through a 250 ohm, 5w resistor, and from there to J1-1. The resistor is in series with the 80v to drop this output level to near the nominal 40v required by other Aerotech equipment. +80V directly from the motor power supply is available at TBl-4. Up to 1A. can be drawn if the current drawn, plus motor current per phase, is less than 7.5A.

### 3.3 Adjustments

See PC Assembly drawing D690-1083 sheet 4 for location of signals

and adjustments.

### 3.3.1 Motor Current

Setting the motor current requires a 10A DC ammeter and a 10A rectifier bridge. Remove AC power and turn R16 full CW. With motor connected open any output line and connect the AC terminals of the bridge between the motor and the 8007. Connect the ammeter + and - leads to the + and - terminals of the rectifier bridge. Ground J1-6. Apply AC Power and step the motor at least two steps, either by two step commands (local mode) or two clock pulses (remote mode). While monitoring the connector, turn R16 until the desired high I command current is reached. Remove ground from J1-6. The current will decrease to the lo I command value. Remove AC Power, remove diode bridge, and reconnect the motor lead to the 8007.

### 3.3.2 Internal Clock Frequency

The Internal Clock Frequency can be adjusted by grounding J2-5 and observing the frequency at M 10-11. Adjustment is made at R7. If a step rate higher than the maximum attainable from adjusting R8 is desired, R8 can be removed and a lower value substituted.

### 3.3.3 Lo I Current Level Adjustment

Normally a LO I command reduces the current level by about 50%. If a different percentage reduction is desired, R17 can be changed to a different value. Set the Current limit as per Section 3.3.1, but maintain AC Power and leave the ammeter connected. Now remove the ground from J1-6 and observe the current. If this LO I current level is too high, insert a larger value resistor in place of R17; if too low, a smaller value. Remove A.C. power and replace fuse.



## W A R R A N T Y

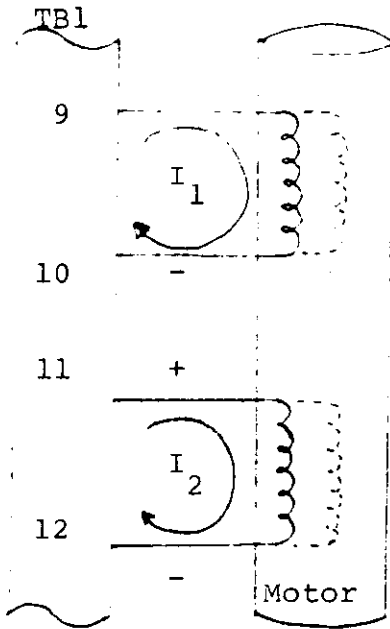
ALL SYSTEMS ARE WARRANTED FOR A PERIOD OF 12 MONTHS FROM THE DATE OF SHIPMENT. THIS WARRANTY COVERS DEFECTS IN WORKMANSHIP AND MATERIALS. A VOIDED WARRANTY IS CONSTITUTED BY PHYSICAL ABUSE, REMOVAL OF FACTORY APPLIED SERIAL NUMBERS, TAMPERING OR IMPROPER APPLICATION, OVER-STRESSING EQUIPMENT BEYOND ITS PUBLISHED SPECIFICATIONS, FAILURE TO COMPLY WITH RETURN PROCEDURES DESCRIBED IN THIS WARRANTY, AND ANY CHANGE OF OWNERSHIP FROM THE ORIGINAL PURCHASE.

IN THE EVENT A DEFECT OR A MALFUNCTION OCCURS IN YOUR EQUIPMENT, THE FACTORY MUST BE NOTIFIED PRIOR TO YOUR PREPAID SHIPMENT BACK TO THE FACTOR FOR REPAIR. A FULLY-DETAILED EXPLANATION OF YOUR DISCREPANCY MUST ACCOMPANY THE EQUIPMENT. THE CUSTOMER WILL BE NOTIFIED IF THE RETURNED ITEM OR SYSTEM IS NOT COVERED BY WARRANTY AND THE COST TO THE CUSTOMER FOR THE REPAIR.

THIS WARRANTY IS THE FULL EXTENT OF AEROTECH, INC., LIABILITY. AEROTECH IS NOT RESPONSIBLE FOR ANY TYPE OF PHYSICAL INJURY DUE TO PRODUCT USE OR FAILURE.

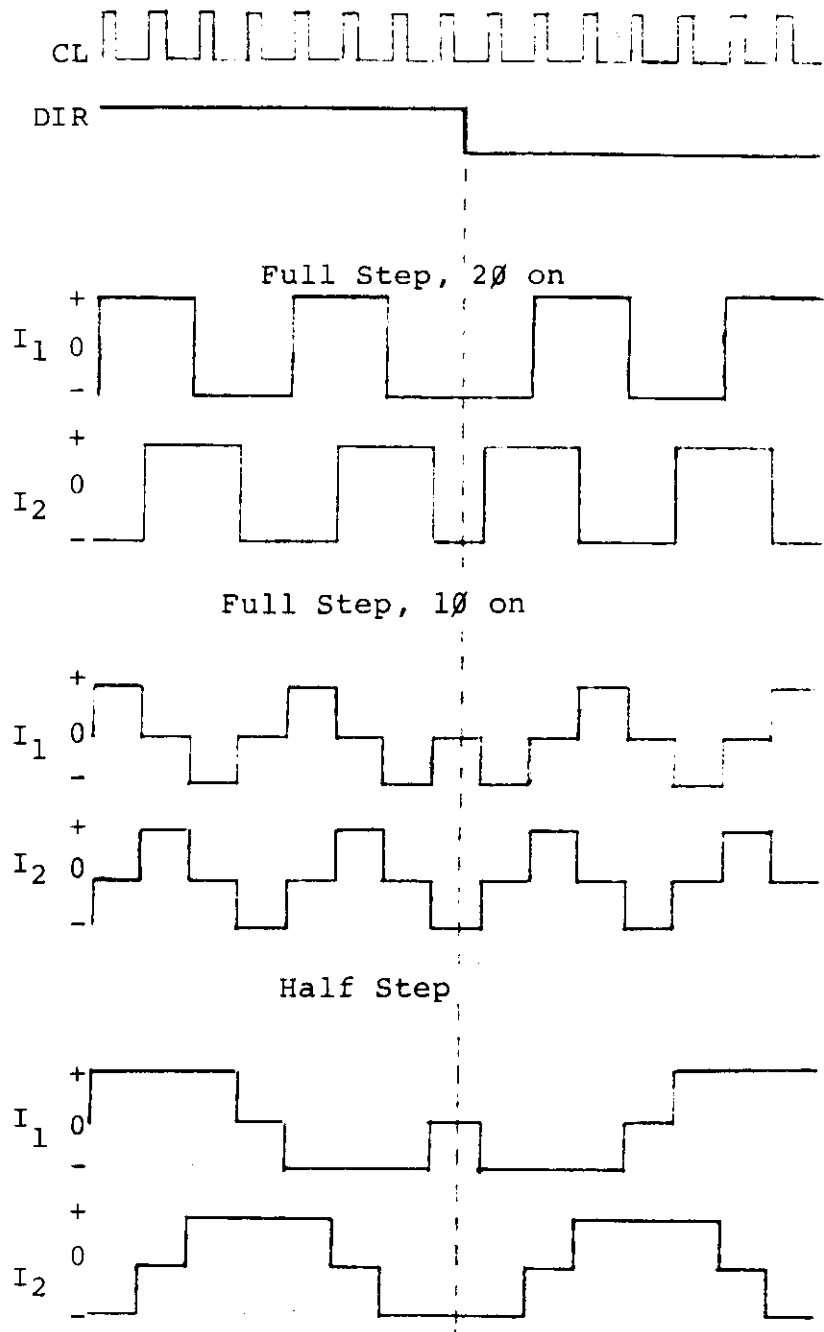


# Motor Connection and Current Phasing Diagram



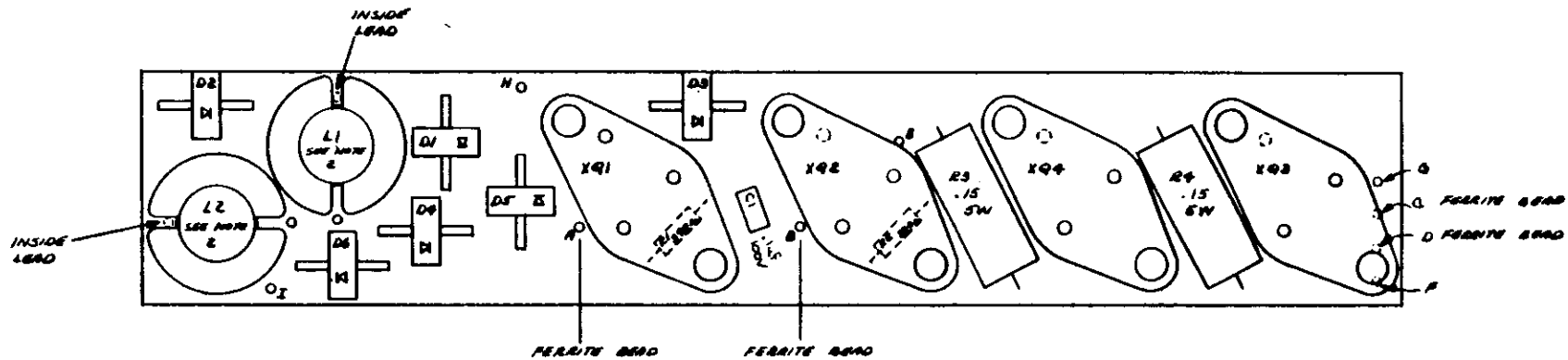
$I_1$  and  $I_2$  are positive when current flows as shown, negative when current flows in opposite direction.

## Current Phasing





REV.	DATE	DESCRIPTION	BY	CHKD.
A		ADDED C1 PER ECN00196		



NOTE 1) X91-X95 TRANSISTOR SOCKET (PROJECTS UNLIMITED P18884)  
 2) L1, L2 FOR MORE INFORMATION SEE DWG. 69081187  
 3) D1 THRU D6 = MR021

LEFT HEAT SINK

FERRITE BEAD {  
 G-VIO. — 22 GA. — 10"  
 C-BLK. — 22 GA. — 10"  
 D-GRAY — 22 GA. — 9 1/2"  
 F-WHITE/YELLOW- 16 GA. — 8"

RIGHT HEAT SINK

FERRITE BEAD {  
 G-YELLOW — 22 GA. — 10"  
 C-BRN. — 22 GA. — 12 1/2"  
 D-BLUE — 22 GA. — 12 1/2"  
 F-WHT./YEL. — 16 GA. — 8"

L. H. SINK

E - BRN #16 GA. 5"  
 H - WHT/GRN #16 GA. 5"  
 B - WHT #22 GA. 10"  
 A - WHT/BLK #22 GA 12"  
 I - BRN #16 GA. 5" } FERRITE BEAD

R. H. SINK

E - BRN #16 GA. 10"  
 H - WHT/RED #16 GA. 13"  
 B - WHT/BLU #16 GA. 13"  
 A - WHT/BRN #16 GA. 13"  
 I - RED #16 GA. 12" } FERRITE BEAD

DIMENSIONS TOLERANCE UNLESS OTHERWISE SPECIFIED		
UNLESS OTHERWISE SPECIFIED		
FRAC TIONS	DECIMALS	ANGLES
3 TO 8 & 1/16	3 TO 2/100	3 TO 30'
9 AND UP & 1/32	3 TO 2/100	3 TO 30'
REV	PROBES	EXCEPT AS NOTED
DATE	BY	NOTES
DRAWN	BY	
CHECKED	BY	
DESIGN	BY	
ENGRG	BY	
PROD	BY	
S.A.	BY	
APPD	BY	

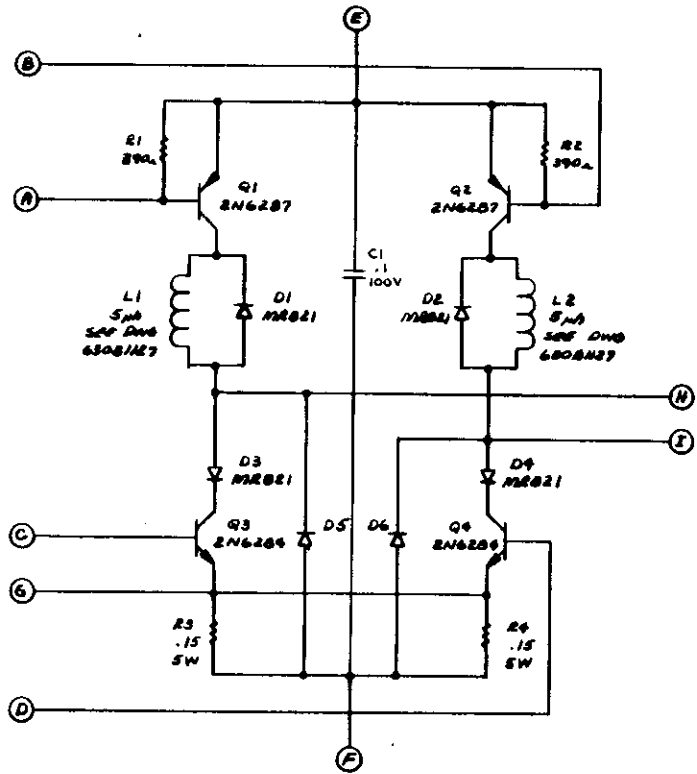
**AEROTECH, INC.**  
 101 East Street  
 Pittsburgh, Pa 15203 412 883 7430

**BIPOLAR CHOPPER  
 8007 HEAT SINK CARD  
 (ASSEMBLY)**

CODE IDENT. NO. **C**  
**690C1165**  
 SCALE 2:1 BY **5**

DRAWING 69-131-281187-1

REVISED	
NO.	DATE
A	ADDED C1 PER SCHEMATIC



MACHINING TOLERANCE UNLESS OTHERWISE SPECIFIED		 101 Soto Drive Pittsburgh, Pa 15220 412 682 7476	
TOLERANCES UNLESS OTHERWISE SPECIFIED			
DATE	DESIGNED BY	BIPOLAR CHOPPER 8007 HEAT SINK CARD (SCHEMATIC)	
DRAWN	CHECKED		
ISSUED	CODE IDENT. NO.	C	690C1165
PROG	SCALE	~	1 OF 5
APPD	BY		

DRAWING 44-131-28(17)

690C1165