U S E R M A N U A L

Scanner Control Board
AE1000

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Printed in Germany

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Notice

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CONTENTS

1. WARRANTY

General Scanning GmbH (GSG) warrants this product to be free from defects in materials and workmanship. The warranty period is one year from the date of shipment. The laser lamp and all optical parts are not included in this warranty.
GSG will, at its option, repair or replace the product if GSG determines that it is defective within the warranty period and if it is returned, freight prepaid, to a service designated by GSG.

Under this warranty, GSG is not obliged to

- Repair damage resulting from attempts by personnel other
- than GSG representatives to repair, or service the product;
- Repair damage resulting from improper use or from connecting product to incompatible equipment;
- Furnish service if personnel other than GSG representatives have made modifications to the product.

There is no implied warranty of fitness for a particular purpose. GSG is not liable for consequential damages.

Customers assume all responsibility for maintaining a safe Class IV laser working environment and for certification of any system into which the laser system is assembled. OEM customers must assume all responsibility for CDRH certification.

2. INTRODUCTION

The AE1000 scanner control board contains all the circuitry required for operating General Scanning's closed loop galvanometric scanners. It includes a PID position controller and a closed loop temperature regulator. The AE1000 circuitry is designed for the optimal control and response of a General Scanning galvanometric scanner while maintaining low noise and good position stability. Both the scanner and the controller board are protected by additional circuitry from most fault conditions.

General Scanning welcomes customer feedback on its products - we would appreciate it if you would send your comments to us.

3. SPECIFICATION

Size	:	single euro size (100 mm x 160 mm) 30 mm high
Connector	:	VG connector, 64 pins
Pin Assignment	:	compatible to AE 850 with further pins used for additional features
Input Power	:	±15 to ±18 V/2 A (±18 V is recommended)
Input Power option for separate supply of control circuitry and output stage	:	±15 to ±18 V/1 A and max. ±30 V/2 A
Power Supply Noise and Ripple	:	100 mV p-p
Input Signal Voltage Range for non Differential Input	:	Input + : ±10 V Input - : open Input + : ±5 V (with Input - : GND) (Input - can be connected to GND by jumper) Input + : open or GND Input - : ±5 V (Using AE1000 together with the SSA 3001 rack, only Input + is accessible)
Input Signal Voltage Range for Differential Input	:	±5 V p-p
Input Impedance	:	Input + : 10 KΩ ±1 % Input - : 10 KΩ ±1 %
Position Signal	:	10 V p-p at full rated angle
Centering Range of PD Signal	:	±50 % of full angle
Gain Drift	:	< 0.01 %/°C typ.
Offset Drift	:	< 50 µrad/°C typ.
Position Noise	:	< 50 µV p-p 1 Hz to 10 kHz
AGC/Voltage Regulator Nominal Output Voltage	:	+11.5 V
Position Acknowledge Signal	:	TTL Signal indicating that the scanner has reached destination. Low signal level means scanner has settled. In the SSA, this signal is brought out instead of the velocity signal.

Thermal Controller	:	Included on the board, but can not be used within the SSA because of Backplane structure. The SSA has a separate heater board.
Thermal Set Point	:	+40°C ±4°C
Thermal Set Point Stability	:	±0.5°C, fixed ambient
Thermal Regulation	:	0.1°C/°C ambient
Limiters and Protection	:	Scanner excursion is limited by over position shut down and AGC failures. Amplifier gain is limited during power up and power down. Heater shut down for open thermistor. A relay in the drive current circuit and a gain limiter protects the scanner from uncontrolled motions during power up and power down as well as at power supply failures. (Only the ±15 V to ±18 V supply is watched.)
Operating Ambient Temperature	:	0°C to +40°C (forced cooling is recommend)
Specification Temperature	:	+20°C ±10°C
Storage Temperature	:	-20°C to +70°C
Typical performance together with G 325 DT and Mirror M3-1515 (Mirror Inertia 2.1 g/cm²)	:	70 Hz Raster speed 5 ms Retrace time for 40° opt.

4. CALIBRATION AND ADJUSTMENT

The AE1000 must be adjusted for each scanner. If the AE1000 and the scanner were purchased together, the factory will have adjusted the control amplifier for the scanner. Unless the load, applied to the scanner, have been changed, no further adjustments should be required.

Note:

(i) Any mechanical or electrical change (such as other mirrors or mirror holders, shorter or longer cables etc.) alters the system, so that the servo amplifier adjustment must be carried out again.

(ii) For a correct adjustment it is absolutely necessary that the following sequence is strictly observed.

4.1 Required equipment

I.) 1 mW He-Ne laser
II.) Optical bench (see Fig. 4-1: Optical bench preparation on page 6)
III.) Calibrated angular scale (see Fig. 4-1: Optical bench preparation on page 6)
IV.) Function generator
- variable square wave
- symmetrical about zero
- zero-point accuracy ±10 mV
- output impedance typically 100 Ohm or less
- trigger output would be advantageous

V.) Dual trace Oscilloscope
- Y-Frequency Response min. 20 MHz.
- Y-Sensitivity min. 10 mV

4.2 Optical bench preparation

Mount the scanner on the optical bench without connecting it to the AE1000. Adjust the scanner so that the laser beam points to zero on the scale.

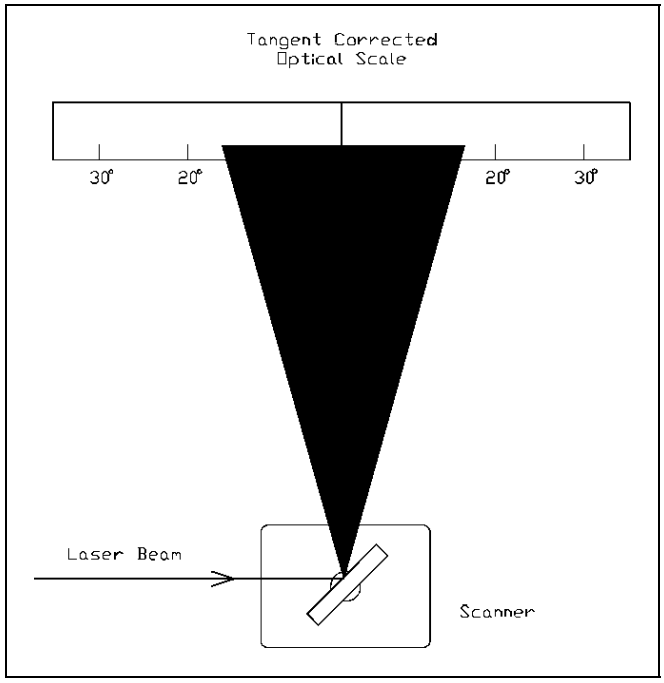

Fig. 4-1: Optical bench preparation

4.3 Initial settings

4.3.1 Jumpers

- Input	
B 101 open closed	input filter enabled input filter disabled
B 104 open closed	differential input enabled differential input disabled
- AGC-setting	
B 201 2/3 closed B 202 1/2 closed	AGC disabled AGC enabled
B 201 1/2 closed B 202 2/3 closed	AGC disabled AGC enabled
- Integrator settings	
B 102 open B 103 open	fast setting speed to 100 mV typical setting accuracy
B 102 closed B 103 open	medium setting speed to 10 mV typical setting accuracy
B 102 closed B 103 closed	slow setting speed to 1 mV typical setting accuracy

4.3.2 Standard Settings of the Jumpers

B 101	closed
B 104	closed
B 201 1/2	closed
B 202 2/3	closed

Note:

For a direct replacement of a AE 800 or AE 850 by a AE1000 or when the AE1000 is used in the SSA 3001 rack, the following jumper setting must be used:

B 101	closed
B 104	closed
B 201 2/3	closed
B 202 1/2	closed

4.3.3 Pots and switches

Attenuator	P 106	fully clockwise
Damping	P 101	mid range
Servo Gain	P 102	fully clockwise
Integrator	P 103	fully clockwise
Position Detector Gain	SW 1 P 104	0 mid range
Position Detector Offset	SW 2 P 105	8 mid range
Output Stage	P 107	fully counter-clockwise
/Position Acknowledge	P 301	any position

4.4 Adjustment procedure

4.4.1 First Power up

- Before connecting a galvanometer for the first time, open jumpers X+ and X- and make sure that there is no power connected to J2A/2C and J28A/28C of the VG connector.
  Alternatively you can pull down the signal line Power Disable, which terminates at Pin J1A/1C at the VG connector to GND to open the drive coil via the relay. To pull down this line you can use a simple switch or an open collector circuit. Never apply voltage to J1A/1C. Please make also sure that there is no power on J4A/4C and J28A/28C.

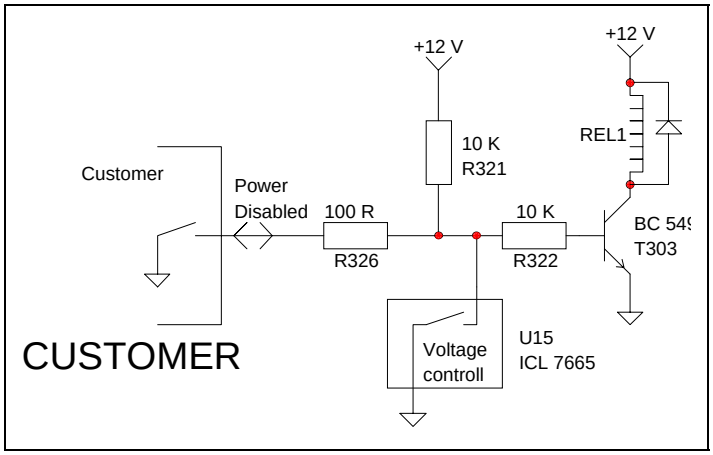

Fig. 4-2: Power Disable circuit

- Connect galvo to AE1000

- Switch power on

- Check the two LEDs on the board which indicate whether the power supply is o.k.. If one or both LEDs are dark, check your power supply and also the connections. If the power supply and also the connections are o.k. return the board for factory testing.

Turn galvo rotor by hand back and forth and check whether the position signal (T 7) reacts when turning the rotor.

If the position signal does not react when the rotor is turned do not proceed otherwise damage may occur at the next stage. Return the equipment for factory testing.
If the position signal reaction was correct, switch power off.

If the control circuitry and the output stage are supplied by the same power supply, close the jumpers X+ and X-.

If there are separate power supplies for the control circuitry and the output stage, do not close the jumpers X+ and X- but connect J2A/2C and J28A/J28C to the output stage supply.
Remove the GND connection of Pin J1A/1C.

4.4.2 Position detector offset adjustment

- Switch Power off.
- Adjust the galvo until the laser beam points to zero on the optical scale.
- Connect the input signal to GND.
- Switch Power on.
- Bring the laser spot back to the center of the optical scale using SW2 for coarse adjustment and P105 for fine adjustment.

4.4.3 Servo loop PRE-adjustment

- Connect the Position Signal (T 7) to channel 1 and the Position Error Signal (T 1) to channel 2 of the scope.
- Connect a 20 Hz square wave with an amplitude of ±2.5 V to the input.
- Monitor the Position and the Position Error Signal, adjust the Servo Gain and the Damping to obtain a reasonable approximation to a square wave.
  An over-damped response is best at this time (see Fig. 4-3: Position and Position Error Signals).
- Connect Test Point T2 to one of the scope channels and turn the output stage pot. (P 107) clockwise while the galvo is running, until the output stage starts to oscillate, which can be observed on either T2.
- Now turn P 107 ½ turns counter-clockwise.

- Let the system run for about 15 minutes for thermal stabilisation.
- **Connect input to GND**
- **Repeat 4.4.1 First Power up on page 9.**

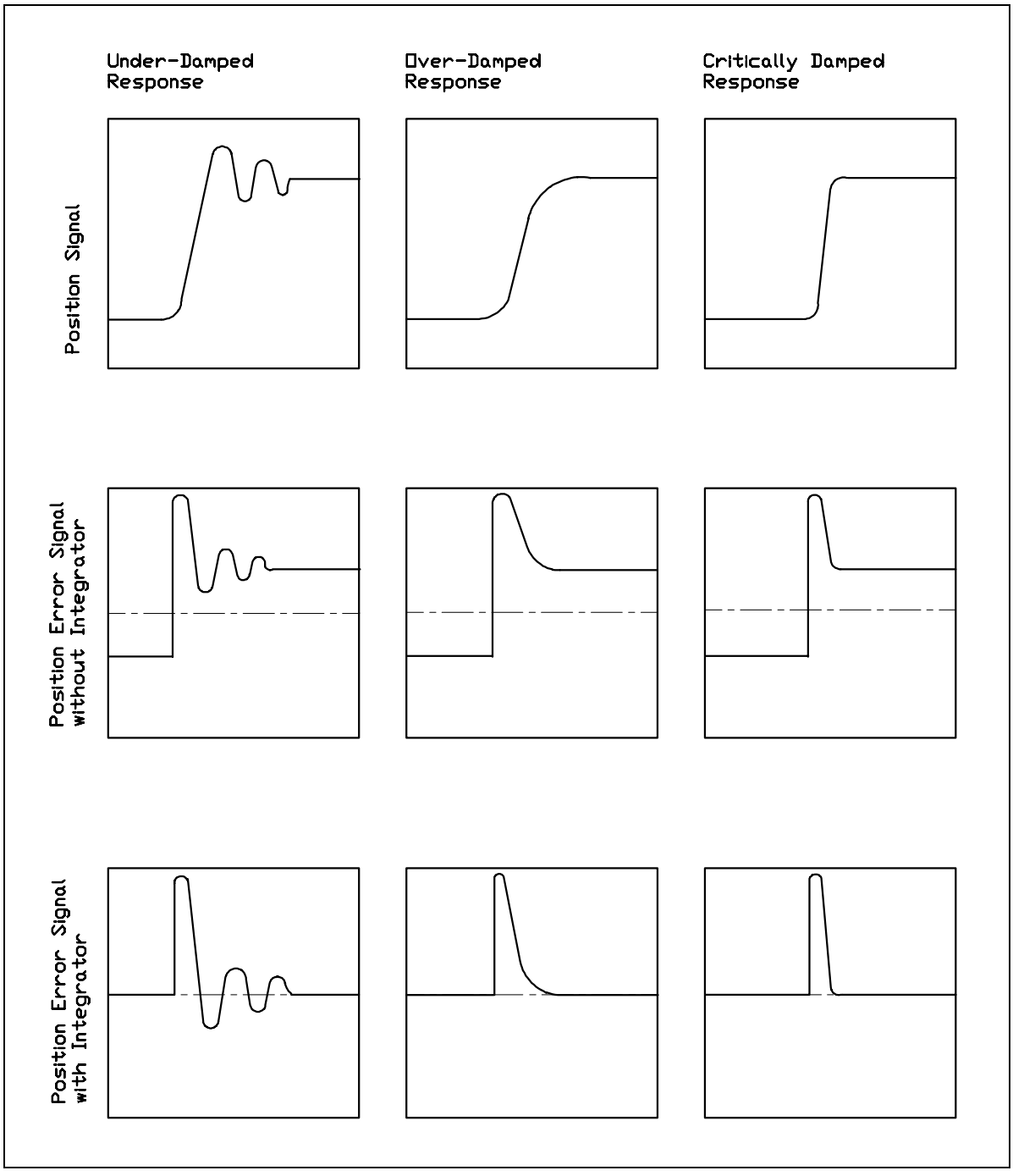

Fig. 4-3: Position and Position Error Signals

4.4.4 Position detector gain adjustment

- Switch power off.
- Connect the input to 0 V.
- Turn the Integrator to mid range.
- Connect channel 1 of the scope to the input signal (DC source set to 0 V in the beginning) and channel 2 to the position signal.
- Switch Power on.
- Adjust both scope traces to zero.
- Slowly increase a DC input source until it reaches exactly 2.5 V.
- Adjust P 106 until the position signal is exactly 2.5 V.
- Turn SW 1 clockwise until the galvo deflects as close as possible half the rated angle (10° opt. G 120 D(T), 12.5° opt. G 325 D(T)).
- Now increase the input to exactly 5 V and check if the position signal is also exactly 5 V.
- Use P 104 to direct the galvo exactly to the full rated angle.
- Put the input signal back to zero and turn the Integrator fully clockwise.

4.4.5 Servo loop final adjustment

- Connect the square wave generator to the input and adjust to 20 Hz at ±5 V. At this point, the SERVO GAIN and DAMPING should be adjusted to obtain critical damping and to minimise the full angle rise time.
  The fastest rise time is obtained by using the maximum servo gain allowed by the available damping. As the servo gain is increased the maximum rated angle of the scanner could be exceeded during the adjustment. If the position signal exceeds ±5 V to ±5.6 V the over position shut down becomes active. The amplitude must be decreased by using the attenuator pot. P 106, to keep the scanner within its maximum rated angle.

- At some point during the Servo Gain Adjustment Procedure, further increases in Servo Gain will degrade the scanner response. Reducing the Servo Gain slightly may actually improve the settling time. Patience is required to get a feeling for each control and to optimise the adjustment of the amplifier.
  Little over-oscillations which are no longer visible on the scope can be observed at the laser beam. The adjustment is correct if you get a sharp end of the beam on the scale and a smooth Position Error Signal without ripple.

- Now turn the Integrator P 103 counter-clockwise until the flat parts of the Position Error Signal meet at the center line on the scope.

- The achievable settling speed and settling accuracy of the position error signal are dependent on the integrator characteristics.

- During the integrator adjustment also slight readjustments of Servo Gain and Damping may be required.

- If the AE1000 is used without utilising the integrator the attenuator can be used to compensate the control deviation and to maintain the full rated angle for a ±5 V input signal.

4.4.6 Position acknowledge signal adjustment

- While monitoring Test Point T 8 the threshold of the TTL signal can be adjusted by P 301. 5 V on T 8 are equal to 100 mV of position error. That means if the voltage on T 8 is adjusted to 5 V by P 301 the /PosAck Signal is active.

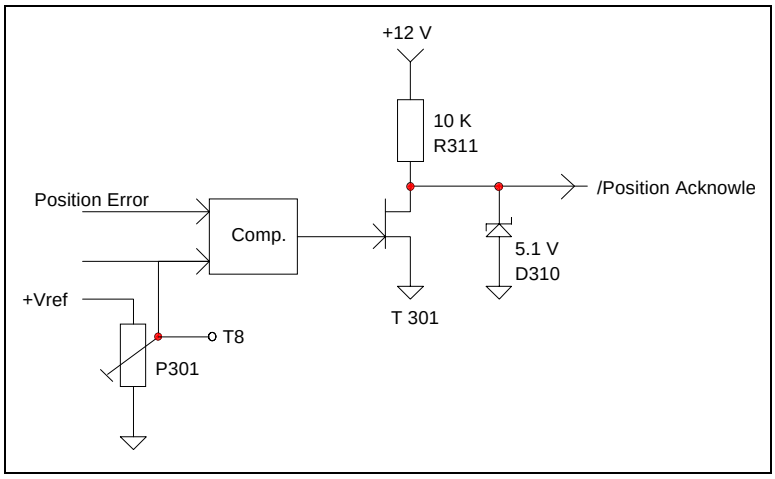

Fig. 4-4: /Position Acknowledge circuit

5. AE1000 CIRCUIT DESCRIPTION

5.1 Servo amplifier

The AE1000 servo amplifier compares the signal generated by the position transducer to an input signal, then causes a current proportional to this difference in the scanner drive coils. The direction of the current causes the scanner to rotate so as to minimise the position error signal (T1). When the amplifier is set up as an integrating servo, the position signal will be equal to the input voltage, i.e. for a DC input voltage the integrating servo reduces the position error voltage to zero.

The scanner position transducer produces a differential output current proportional to rotor position. This current is converted to a position voltage by the current-to-voltage converter. The position voltage is calibrated, i.e. offset errors subtracted and position transducer gain adjusted by SW 1, P 104, SW 2, P 105.

The calibrated position signal is connected to the position error amplifier and is then subtracted from the output of the input preamplifier to generate the position error signal T 1. The position error voltage is applied to the transconductance output stage to produce current in the drive coils of the scanner.

The servo gain potentiometer P 102 adjusts the proportional action and the damping potentiometer the derivative action of the control circuitry.

The position error signal T 1, is also connected to an integrator. If the integrator is properly adjusted, the integrator can drive the position error signal to zero. However the position error signal will not go to zero if the input signal is changing, as the integrator cannot instantaneously follow changes in the position error voltage.

The scanner position signal is also connected to the over-position shutdown circuit. When the scanner position signal exceeds ±5 V (+10 %), this circuit drastically reduces the gain of the amplifier. The scanner over-position shutdown circuit protects the scanner from damage due to over angle position requests.

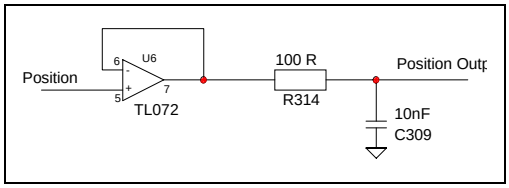

Fig. 5-1: Position Output circuit

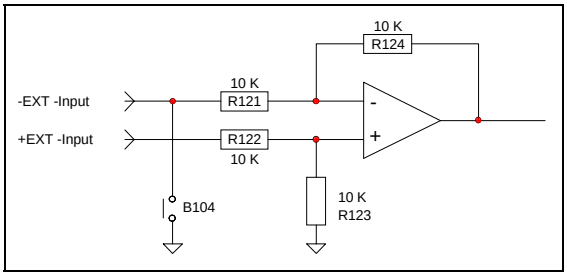

Fig. 5-2: Differential Input circuit

5.2 AGC/Voltage regulator

An integral part of position stability is the stabilisation of the scanner position oscillator, which is located in the scanner. To enable the AGC mode, B 201 must be closed between Pin 1 and 2 and B 202 must be closed between 2 and 3.

When the AGC/voltage regulator is used as a low noise voltage regulator B 201 must be closed between Pin 2 and 3 and B 202 must be closed between Pin 1 and 2.

The latter mode must be used in the following cases:

- If the AE1000 is used together with a scanner which has no AGC feedback
- If the AE1000 is used in the SSA 3001 rack
- If the AE1000 should directly replace a AE 800 / AE 850

5.3 Temperature regulator

The temperature regulator circuit is for use with thermally controlled scanners. These scanners have a thermistor inside the scanner and a heater blanket on the outside. The thermistor forms one leg of a bridge circuit. The output of the bridge is connected to a high gain amplifier whose output drives the scanner's heater blanket. Temperature controlled scanners are elevated to a nominal temperature of 40°C. The set point can vary ±4°C. The set point will remain stable to within 0.5°C once the scanner reaches temperature. Components of the temperature regulator have been chosen so that the controller is critically damped.

As part of the thermal control circuit, an over-temperature shutdown circuit is implemented. If the thermistor inside the scanner is shorted or open or the scanner temperature exceeds 70°C, the gain of the servo amplifier is drastically reduced.

5.4 Position acknowledge signal

The Position Acknowledge Signal is a TTL signal, indicating if the scanner has settled at its destination to a desired accuracy. The falling edge of the TTL signal indicates that the scanner has settled.

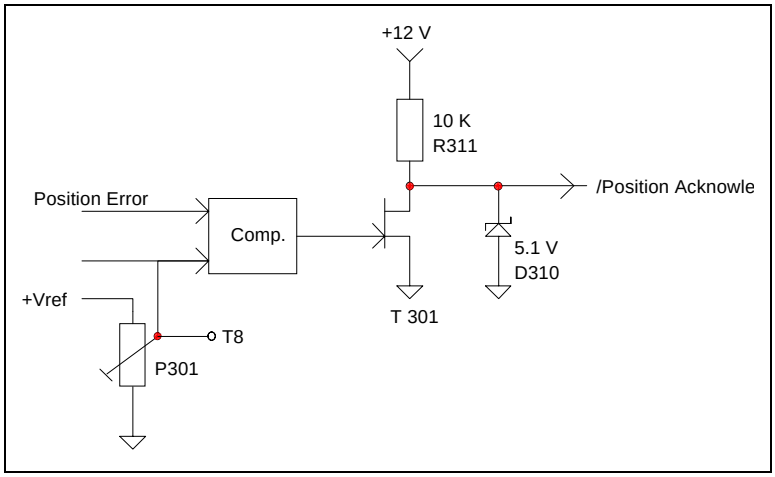

Fig. 5-3: /Position Acknowledge circuit

6. PIN ASSIGNMENT

1A & 1C	/Drive coil disable	
J2A & 2C	+VSS MIN = +15 V MAX = +18V	
J3A & 3C	NOT CONNECTED	
J4A & 4C	+VSS2 when jumper +X is removed MAX = +30 V	
J5A & 5C	GROUND	
J6A & 6C	-EXT-INPUT	
J7A & 7C	+EXT-INPUT	
J8A & 8C	GROUND	
J9A & 9C	POSITION -INPUT (SCANNER)	D-TYPE PIN 11
J10A & 10C	POSITION +INPUT (SCANNER)	D-TYPE PIN 3
J11A & 11C	OSC. SUPPLY VOLTAGE COMMON	D-TYPE PIN 13
J12A & 12C	GROUND	
J13A & 13C	NOT CONNECTED	
J14A & 14C	NOT CONNECTED	
J15A & 15C	POSITION OUTPUT	
J16A & 16C	AGC INPUT	D-TYPE PIN 12
J17A & 17C	/POSITION ACKNOWLEDGE	
J18A & 18C	POSITION INPUT COMMON	D-TYPE PIN 4
J19A & 19C	THERMISTOR	D-TYPE PIN 15
J20A & 20C	HEATER OUT HIGH	D-TYPE PIN 7
J21A & 21C	HEATER OUT LOW ((-VSS-(1.4 V))	D-TYPE PIN 5
J22A & 22C	GROUND	
J23A & 23C	SCANNER DRIVE COIL LOW	D-TYPE PIN 10
J24A & 24C	SCANNER DRIVE COIL LOW	D-TYPE PIN 2
J25A & 25C	SCANNER DRIVE COIL HIGH	D-TYPE PIN 1
J26A & 26C	SCANNER DRIVE COIL HIGH	D-TYPE PIN 9
J27A & 27C	OSCILLATOR SUPPLY VOLTAGE	D-TYPE PIN 8
J28A & 28C	-VSS2 when jumper X is removed MAX = -30 V	
J29A & 29C	GROUND	
J30A & 30C	GROUND	
J31A & 31C	-VSS MIN = -15 V MAX = -18 V	
J32A & 32C	GROUND	

7. TEST POINTS

T1	Position Error
T2/T5	Drive Coil current can be measured using T2 and T5
T3	Velocity
T4	Voltage Temperature Regulator
T6	AGC/Voltage Regulator output in AGC mode +9 V to +12 V output in Voltage Regulator mode +10.5 V ±10 %
T7	Position Signal max 5.5 V
T8	Window Comparator for /Posack level adjustment 0.5 V = 10 mV of position error
T9/T10	GND

$$\text{Coil Current} = \frac{V(T5) - V(T2)}{0.5}$$

8. DRAWINGS OF THE AE1000

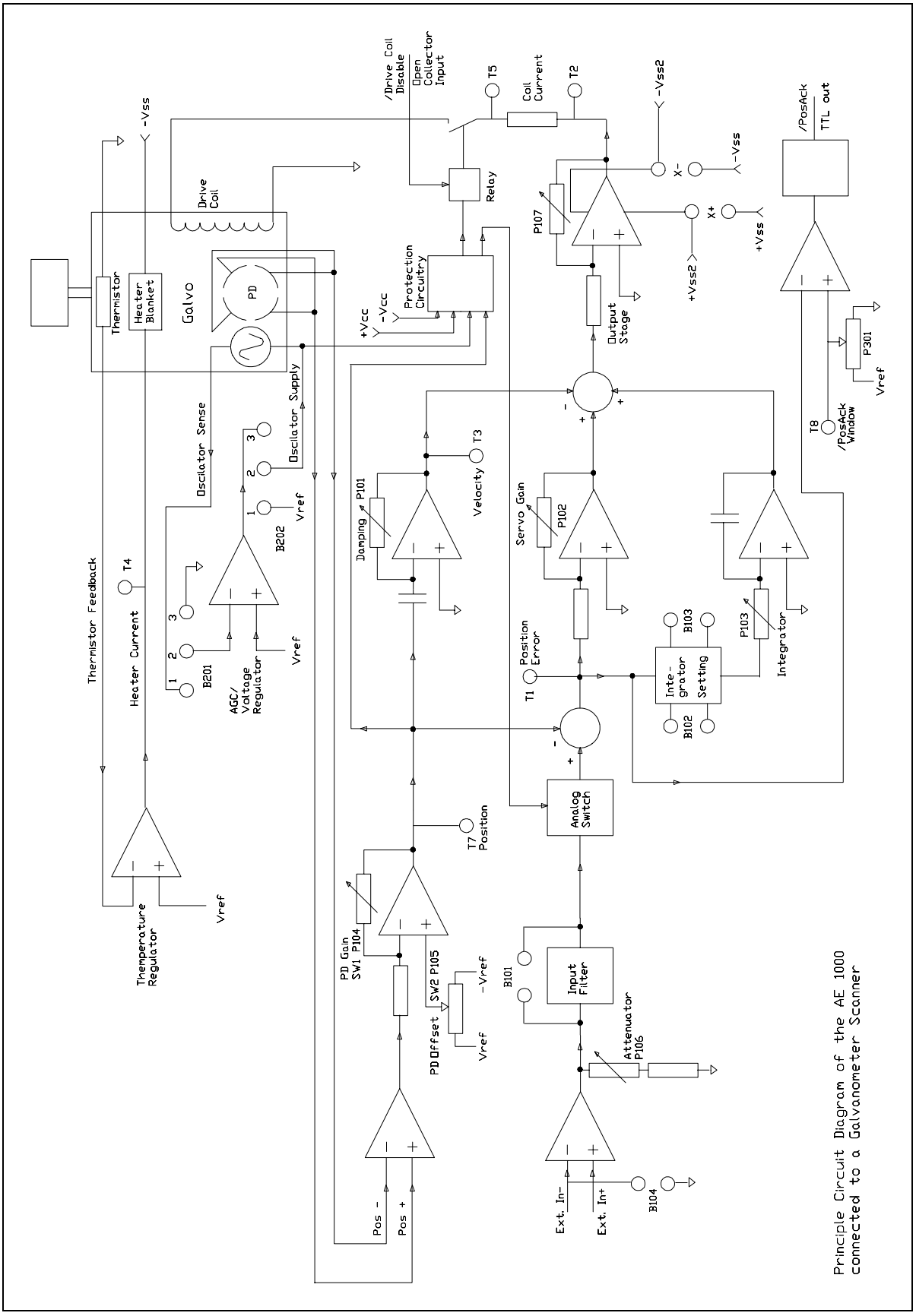

Fig. 8-1: Prinicple Circuit Diagram of the AE1000

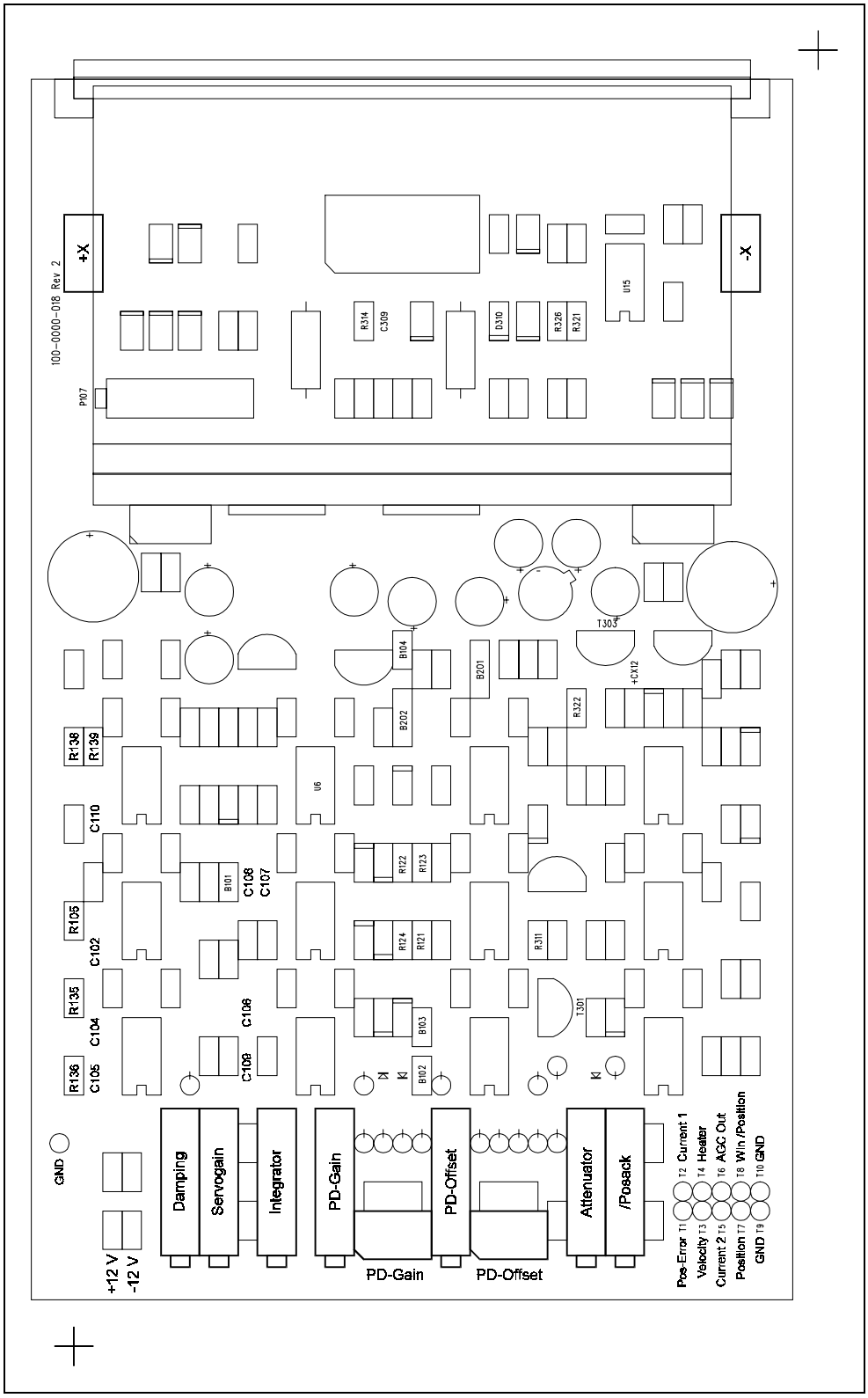

Fig. 8-2: Photo plot of the AE1000

9. OPTIONAL BACKPLANE

The Backplane provides quick and easy connection between the AE1000 and

- galvo
- power supply
- Signal input
- status

9.1 Pin assignment

CONNECTOR-TYPE	PIN-LIST	DESCRIPTION
INPUT-CONNECTOR	ST1-01	GROUND
Type IDC-System	ST1-02	-INPUT SIGNAL
T & B	ST1-03	GROUND
2 No: 609-1030	ST1-04	+INPUT SIGNAL
	ST1-05	GROUND
	ST1-06	POSITION OUTPUT
	ST1-07	GROUND
	ST1-08	/POSITION ACKNOWLEDGE
	ST1-09	GROUND
	ST1-10	POWER DISABLED (LOW ACTIVE)
POWER-CONNECTOR	J5-01	GROUND
TYPE CLG	J5-02	+VSS (MAX = +18 V)
PANDUIT	J5-03	-VSS (MAX = -18 V)
No: CE 156-F-22-05C	J5-04	GROUND
	J5-05	NOT CONNECTED
OPTIONAL POWER	J6-01	+VSS2 (MAX = +30 V)
	J6-02	-VSS2 (MAX = -30 V)
	J6-03	GROUND
GALVO-CONNECTOR	G -01	GALVO DRIVE-COIL HIGH
	G -02	GALVO DRIVE-COIL LOW
	G -03	+POSITION-INPUT
	G -04	GND POSITION-INPUT
	G -05	HEATER-OUTPUT LOW -VSS-(1.4 V)
	G -06	NOT CONNECTED
	G -07	HEATER-OUTPUT HIGH
	G -08	OSCILLATOR SUPPLY VOLTAGE
	G -09	GALVO DRIVE-COIL HIGH
	G -10	GALVO DRIVE-COIL LOW
	G -11	-POSITION-INPUT
	G -12	NOT CONNECTED
	G -13	GROUND OSCILLATOR SUPPLY
	G -14	NOT CONNECTED
	G -15	THERMISTOR-INPUT

Note:

The power-connector for J5 is included in the shipment of the Backplane.

9.2 Mechanical detail

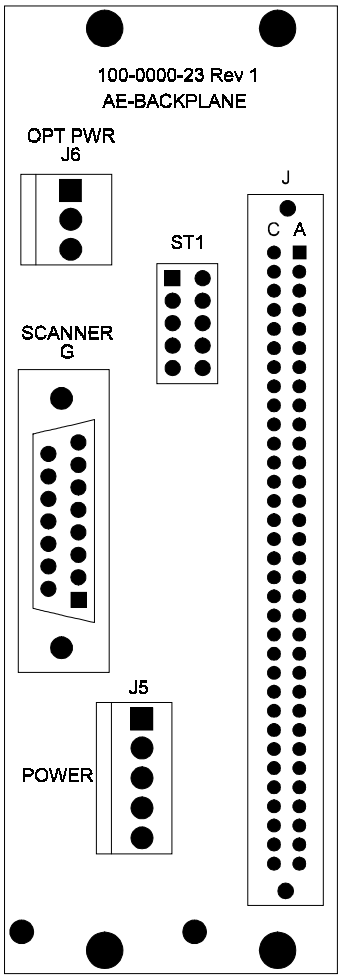

Fig. 9-1: Photo plot of the Backplane

Note:

The Backplane is not included within the AE1000. Please order it separately.

10. LIST OF FIGURES