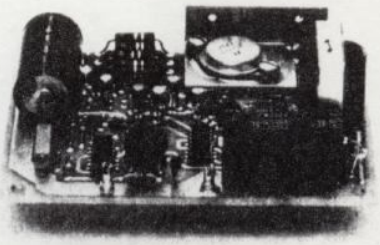
boschert SWITCHING POWER SUPPLIES

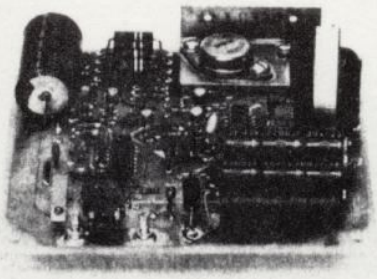
3 TERMINAL REGULATORS PRELIMINARY

168.75
116.70



3T12AP

181.60
129.90



3T5AN

3T MODULES

The three-terminal 20kHz switching regulators are flexible, inexpensive, efficient design modules providing a single adjustable regulated output from a raw positive DC source. The 3T12AP will provide a regulated output of +4.5V to +30V rated at 12A. It requires an input voltage higher than the output voltage. The 3T5AN will provide a regulated output of −4.5V to −30V rated at 5A. This module will provide an output higher or lower in magnitude than the input.

The 3T modules are complete, functional blocks; no complex electronic circuitry is necessary to make them operate. The three major subsections—transistor switch, magnetics, and feedback loop—have been carefully engineered as a system to optimize performance and cost. System design using a 3T switching module is as straightforward as a simple linear design. Eighty-five percent typical efficiency is an added advantage of the switcher which helps reduce transformer and heat sink requirements over an equivalent linear regulator. Also, unlike a linear, efficiency is essentially independent of input voltage. Hence, output current need not be derated with increasing input voltage.

The 3T modules can be used by both OEM and hobbyist for medical, distributed power, and battery-backup applications. They are more economical than linear supplies when entire systems are compared.

STANDARD FEATURES

- +DC Input (3T12AP and 3T5AN)
- +DC Output (3T12AP)
- −DC Output (3T5AN)
- 20kHz Switching Frequency
- 85% Typical Efficiency
- Overload Protection
- Short Circuit Protection
- Low Power Dissipation
- Adjustable Output Voltage
- Adjustable Current Limit
- No External Components Needed

ADVANTAGES OF BUYING VS. BUILDING A SWITCHER

- Lower design risk.
- Lower stock inventory.
- UL recognition pending.
- Shorter design cycle.

ADVANTAGES OF BOSCHERT 3T MODULE OVER EQUIVALENT LINEAR MODULE IN A POWER SUPPLY SYSTEM

- Smaller 60Hz transformer needed.
- No need for multiple transformer taps for multiple outputs.
- No peripheral components such as inductors or pass transistors.
- Lighter weight.
- Less heat.
- Smaller size.
- Smaller rectifier diodes and input caps needed with higher bus voltage.
- Wider practical input voltage range.

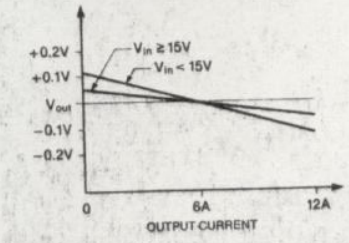
ELECTRICAL CHARACTERISTICS

PARAMETER	MODEL	CONDITIONS	TYPICAL VALUES
Line Regulation $\left(\frac{\Delta V_{out}}{V_{out}} / \Delta V_{in}\right)$	Both		0.12%/Volt
Load Regulation $\left(\frac{\Delta V_{out}}{V_{out}} / \Delta I_{out}\right)$	3T12AP	$V_{in} < 15$ Volts $V_{in} \geq 15$ Volts	0.16%/Amp 0.08%/Amp
	3T5AN	$V_{in} < 15$ Volts $V_{in} \geq 15$ Volts	0.30%/Amp 0.15%/Amp
Temperature Coefficient $\left(\frac{\Delta V_{out}}{V_{out}} / \Delta C^{\circ}\right)$	Both		±3mV/C°
Output Voltage Adjustment Range	3T12AP	$+10V \leq V_{in} \leq +40V$ $V_{in} \geq V_{out} + 3V$	+4.5V to +30V
	3T5AN	$+10V \leq V_{in} \leq +40V$	−4.5V to −30V
Minimum Input-Output Differential	3T12AP 3T5AN		+3 Volts see "Minimum Required Input Voltage" graph
Maximum Average Output Current	3T12AP 3T5AN		12A 5A
Current Limit Range	3T12AP 3T5AN		0 to 20 Amps 0 to 10 Amps
Current Limit Change with Input Voltage $\left(\Delta I_{lim} / \Delta V_{in}\right)$	3T12AP 3T5AN		170 mA/Volt 80 mA/Volt
Input Voltage Range	Both		+10 Volts to +40 Volts
Noise and Ripple (PARD)	3T12AP	$I_{out} = 12A$, $V_{out} < 10V$, Total PARD PARD ≤ 10kHz $V_{out} \geq 10V$, Total PARD PARD ≤ 10kHz	380mV P-P 100mV P-P 450mV P-P 190mV P-P
	3T5AN	$I_{out} = 5A$, $V_{out} < 10V$, Total PARD PARD ≤ 10kHz $V_{out} \geq 10V$, Total PARD PARD ≤ 10kHz	550mV P-P 100mV P-P 900mV P-P 170mV P-P
Efficiency $\left(P_{out} / P_{in}\right)$	3T12AP	$V_{out} < 10$ Volts $V_{out} \geq 10$ Volts	80% 95%
	3T5AN	$V_{out} < 10$ Volts $V_{out} \geq 10$ Volts	75% 82%
Noise Rejection	Both	0–500Hz 500Hz–10kHz	−40dB −20dB
Quiescent Current	Both	$I_{out} = 0$	37mA

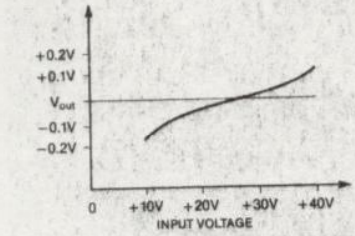
TYPICAL CURVES

3T12AP

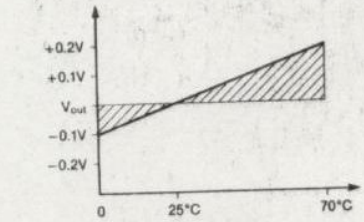
Output Change with Load



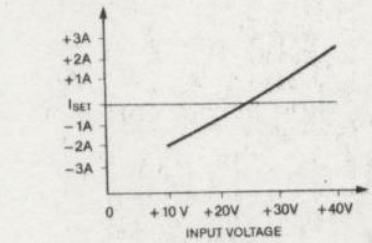
Output Change with Input Voltage



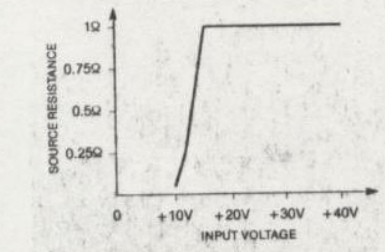
Output Change with Temperature



Current Limit Change with Input Voltage

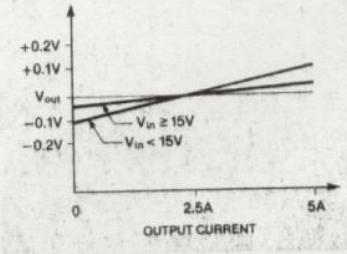


Maximum Allowed Source Resistance

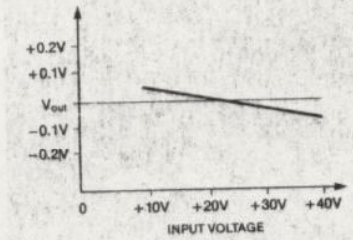


3T5AN

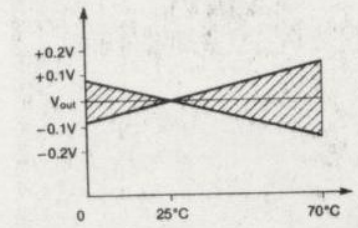
Output Change with Load



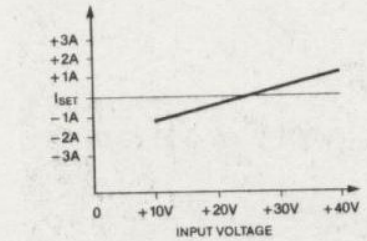
Output Change with Input Voltage



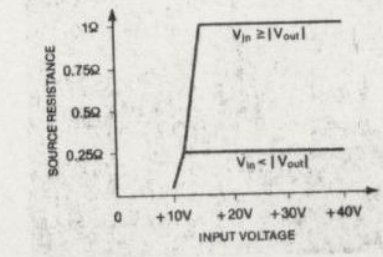
Output Change with Temperature



Current Limit Change with Input Voltage

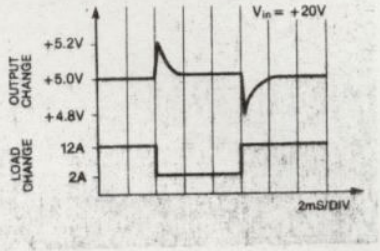


Maximum Allowed Source Resistance

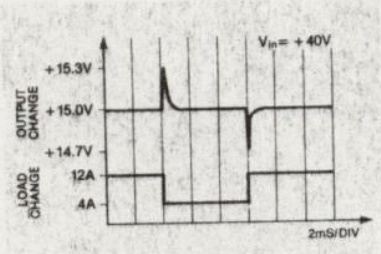


BOTH TYPES

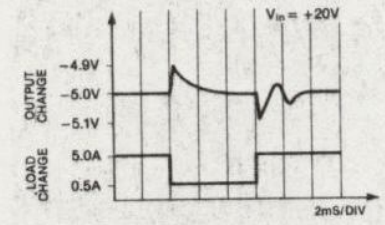
3T12AP Transient Response



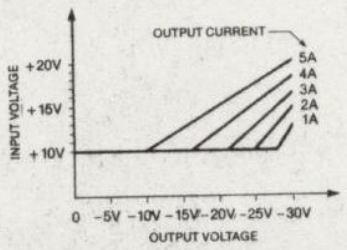
3T12AP Transient Response



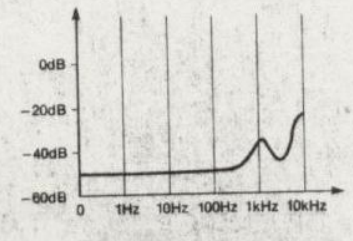
3T5AN Transient Response



3T5AN Minimum Required Input Voltage



3T12AP and 3T5AN Noise Rejection



GENERAL SPECIFICATIONS

Parameter	Conditions	Limits
Shock and Vibration	The power supply shall withstand without degredation any reasonable shock and vibration found in the normal course of storage and operation, when properly packaged, handled, and installed. This includes transportation by a commercial carrier and operation in a non-mobile mainframe.	
Temperature Range	Operating Ambient (see Thermal Characteristics curve)	0°C to +70°C
	Storage Ambient	−20°C to +85°C
	Semiconductor case never-exceed limit	110°C
Relative Humidity Range	Non-condensing	5% to 80%
Altitude	Operating	10,000 ft. max (3048 m)
	Non Operating	30,000 ft. max (9144 m)
Mean Time Between Failure	Calculated according to MIL-HDBK-217B	35,000 hr. min
Weight	3T12AP	7 oz (0.21 kg)
	3T5AN	9 oz (0.25 kg)

THERMAL INFORMATION

Proper cooling of the 3T modules is imperative. With the proper heat sink, they can be run at full current at 70°C ambient. The amount of heat sinking needed can be calculated using Eq. 1 shown in the next column.

First, determine the power to be dissipated by using the graphs to the right and your operating conditions.

Second, calculate the maximum thermal resistance of the heat sink (θ_{SA}) using Eq. 3 and the given values for $T_{B(max)}$ and θ_{BS}. Some representative thermal resistances are given below to give an approximation of the service area involved.

Bare Aluminum, 4" x 4" x 1/8"	3.2° C/W
Bare Aluminum, 5" x 5" x 1/8"	2.5° C/W
Bare Aluminum, 9" x 9" x 1/8"	1.8° C/W

The above figures are for natural convective air flow, with the flat plate heat sink in a horizontal plane. Decrease thermal resistance by 10% for operation in a vertical plane. Also, thermal resistance decreases dramatically if there is any forced air moving over the sink.

EXAMPLE

Given: $V_{in} = +30V$
$V_{out} = +5V$ (3T12AP)
$I_{out} = 10A$
$T_{A(max)} = 50°C$

Find: The maximum thermal resistance of a heat sink, and select a suitable sink.

Referring to the dissipation curves to the right, interpolation yields about 20 watts dissipated by a 3T12AP running at the given conditions. This value is substituted into Eq. 3 to find the maximum thermal resistance:

$$\theta_{SA} \leq \frac{85°C - 50°}{20W} - 0.3°C/W$$

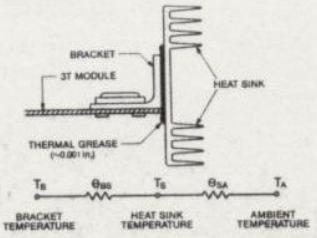
$$\theta_{SA} \leq 1.45°C/W$$

Heat sink thermal resistance is usually listed in a manufacturer's catalog. Using Thermalloy, for example, extrusion No. 6175 has $\theta = 1.9°C/W$ for a 3" length. To a first approximation, thermal resistance is inversely proportional to heat sink length:

$$3" (1.9°C/W) = x" (1.45°C/W)$$

$$x = 4"$$

A 4" length of Thermalloy extrusion No. 6175 should keep the bracket temperature below 85°C in a 50°C ambient environment when dissipating 20 watts.



Eq 1: $T_{B(max)} = T_{A(max)} + P_{diss}(\theta_{BS} + \theta_{SA})$

or

Eq 2: $\theta_{SA} \leq \frac{T_{B(max)} - T_{A(max)}}{P_{diss}} - \theta_{BS}$

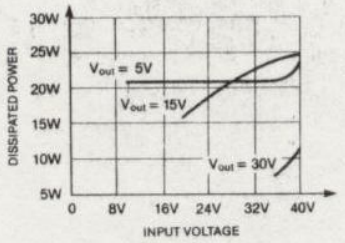
For the 3T series:
$T_{B(max)} = 85°C$ (This allows semiconductor case temperatures to meet but not exceed 110°C)

$\theta_{BS} \approx 0.3°C/W$

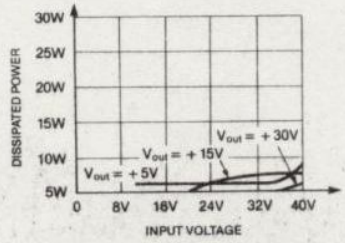
(This assumes the use of a good thermal grease, such as Dow Corning #340)

Eq 3: $\theta_{SA} \leq \frac{85°C - T_{A(max)}}{P_{diss}} - 0.3°C/W$

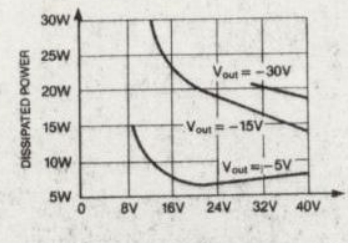
3T12AP Dissipation $I_{out} = 12A$



3T12AP Dissipation $I_{out} = 6A$

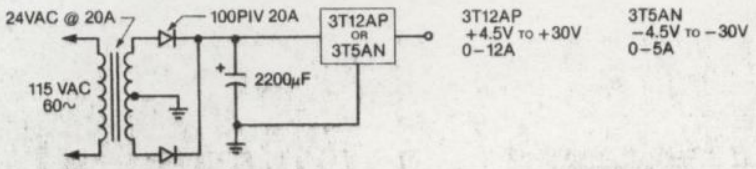


3T5AN Dissipation $I_{out} = 5A$



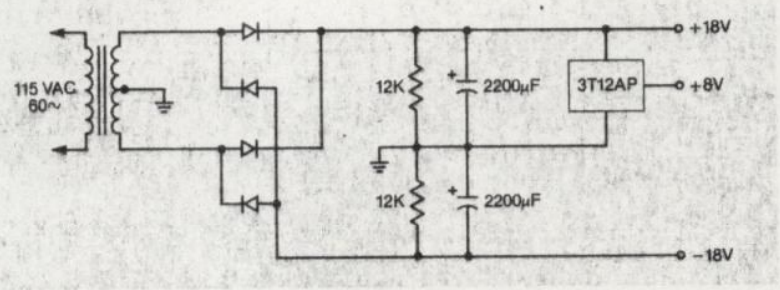
TYPICAL APPLICATIONS

Typical Connection

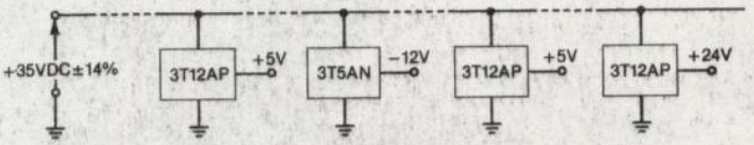


Higher input voltages to the 3T module will reduce stress on the rectifier diodes, input capacitor and 3T module.

S100 Buss Supply

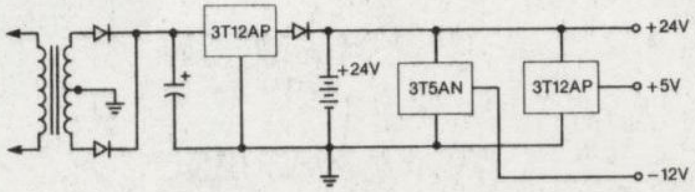


High Voltage Power Distribution

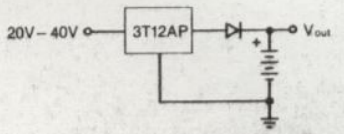


Minimizes IR drops, provides excellent local regulation, accepts wide input voltage range, including brownout.

Battery Backup Supply

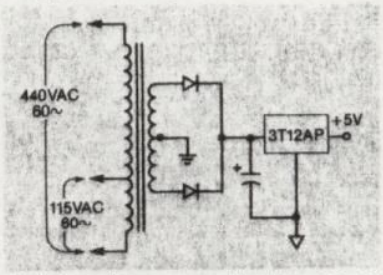


Battery Charger



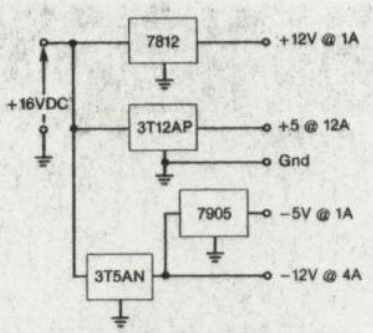
Set V_{out} no load to 13.8V for float charging a 12V lead acid battery, or to 14.4V for a fast charge. I_{lim} sets max charge current.

Supply with High Isolation



60Hz transformer provides low ground leakage current, high isolation—can conform to UL544 leakage spec.

Single Input Voltage—Multiple Outputs

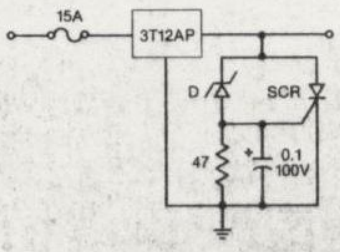


7812 and 7905 are commercially available three terminal I.C. regulator circuits.

OVERVOLTAGE PROTECTION

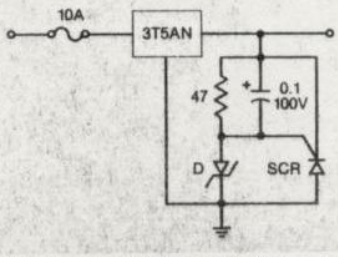
Overvoltage protection circuits are recommended to protect the user's load from overvoltages caused by supply failure. Although the chance of failure is remote, an overvoltage would cause the zener to conduct, firing the SCR, which would blow the input fuse. The zener voltage should be 10% to 20% higher than the intended operating voltage. The SCR should be rated for 50V, 15A and 10W.

Overvoltage Protection Circuit for 3T12AP



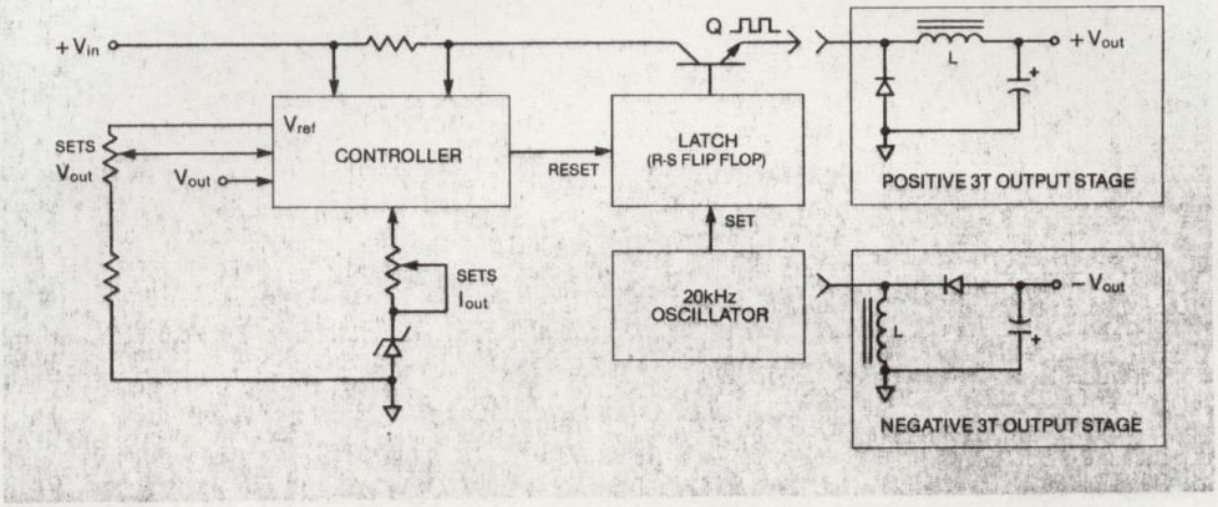
V_z(D) should be 5% to 10% higher than the max output voltage.

Overvoltage Protection Circuit for 3T5AN



V_z(D) should be 5% to 10% higher than the max output voltage.

HOW DOES IT WORK?



A cycle starts when the 20kHz oscillator provides a pulse to the "set" terminal of the latch. The latch turns on Q and current begins to ramp up in the inductor L. The controller monitors the output voltage rise. When it reaches a level set by the voltage adjust pot, the controller pulses the "reset" of the latch which turns off Q. Switch Q will remain off until a "set" pulse from the oscillator starts the next cycle.

If the output voltage starts to drop, due to an increased load for example, the controller will sense this drop. The controller will allow Q to remain on for a longer time during the cycle which will restore the output voltage. Thus the output voltage is regulated by varying the duty cycle of Q.

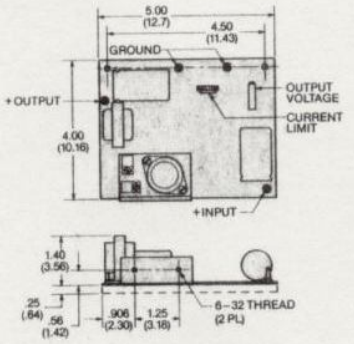
The current limit is performed in an analogous way. When output current reaches a point predetermined by the current limit adjustment, the controller will adjust the duty cycle of Q to maintain a constant output current. (The output voltage will drop, and the supply will act as a constant current source.)

Each type of 3T module has a distinctly different output configuration. The positive 3T configuration is known as a "buck" stage, because the positive output voltage is always lower than the positive input voltage. This type of converter "bucks" the input voltage down to a lower voltage.

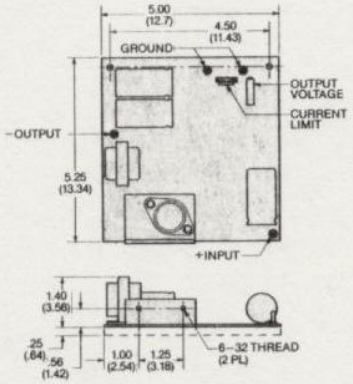
The negative 3T configuration is known as a buckboost, because the negative output can be lower or higher in magnitude than the positive input.

MECHANICAL SPECIFICATIONS

Note Terminals are intended for solder connection. Dimensions are in inches and (cm.).



3T12AP-1001



3T5AN-1001

boschert SWITCHING POWER SUPPLIES

Boschert Incorporated
384 Santa Trinita Avenue
Sunnyvale, California 94086
408/732-2440 TWX 910-339-9241

Tom Simon
3/12/80

A. INITIAL SET-UP 3T12AP-1001

1. Ensure D.C. input power switch is OFF, and all loads are OFF.
2. Set the current limit pot (R18) on the unit under test about center position.

B. TEST SEQUENCE

1. Turn on the power switch and increase the D.C. input voltage until the voltage on the input reads from 19.5 to 20.5 volts.
2. Set the output voltage from the unit under test (UUT) to read from 4.99 to 5.01 volts, by adjusting R13 on the UUT.
3. Adjust the load to 18 Amps output current.
4. Adjust the current limit pot (R18) on the UUT slowly CCW until the output current drops to approximately 16 Amps.
5. Turn the load down to 9 Amps then back up to recheck the current limit, the maximum point the current obtains with increase in load. It should be between 16.8 and 17.2 Amps. If not, readjust R18.
6. Set the load to 12 Amps; the output voltage should be from 4.96 to 5.04 volts.

C. INITIAL SET-UP 3T5AN-1001

1. Ensure D.C. input power switch is OFF, and all loads are OFF.
2. Set the current limit pot (R18) on the unit under test about center position.

D. TEST SEQUENCE

1. Turn on the power switch and increase the D.C. input voltage until the voltage on the input reads from 19.5 to 20.5 volts.
2. Set the output voltage from the unit under test (UUT) to read from -4.99 to -5.01 volts, by adjusting R13 on the UUT.
3. Adjust the load to 9 Amps output current.
4. Adjust the current limit pot (R18) on the UUT slowly CCW until the output current drops to approximately 7.5 Amps.
5. Turn the load down to 5 Amps then back up to recheck the current limit, the maximum point the current obtains with increase in load. It should be between 7.8 and 8.2 Amps. If not, readjust R18.
6. Set the load to 5 Amps; the output voltage should be from -4.96 to -5.04 volts.

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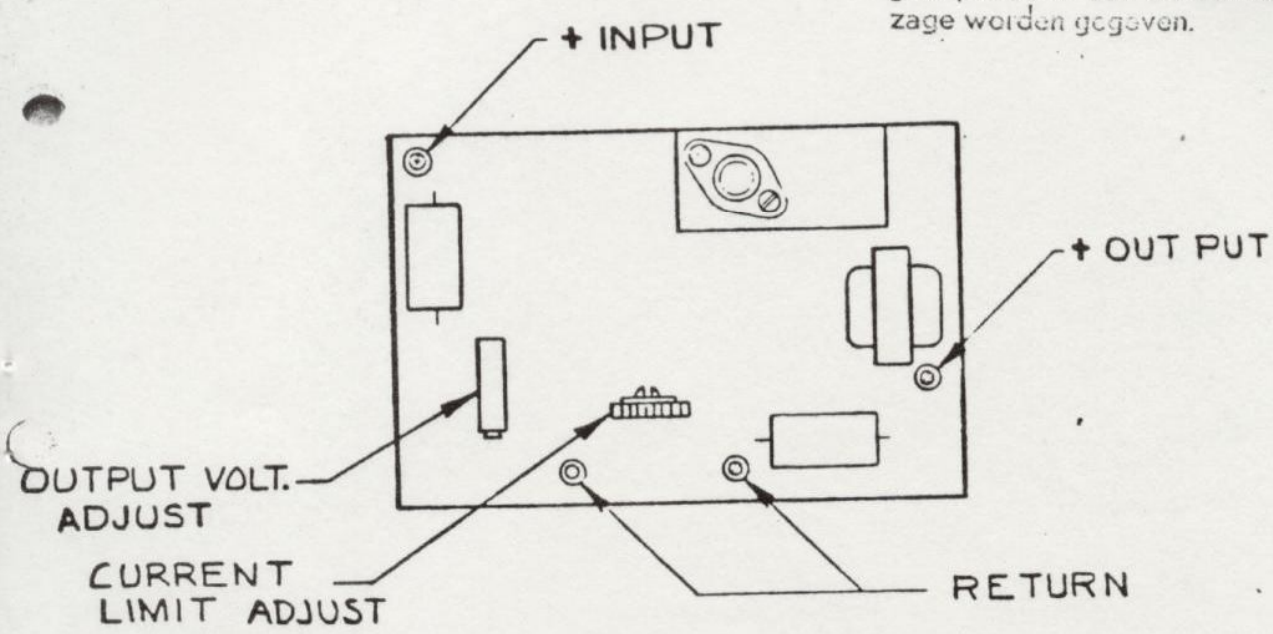
VERRIJN STUARTLAAN 29
Phone (070) 99 57 50
Telex 32506

APPLICATION		REVISION				
NEXT ASSY	USED ON	REV	ECO	DESCRIPTION	DATE	APPROVED
	3T12AP-1001	2		PRE-REL TO PROD	1-2-79	TJ
		A	3297	REL. FOR PROD.	9-5-79	EJC TJ



COMP. SIDE

RODELCO B.V.
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Rijswijk-ZH / The Netherlands
VERRIJN STUARTLAAN 29
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Telex 32506

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
.XX ± ___ ± ___
.XXX ± ___
MATERIAL
FINISH
DO NOT SCALE DRAWING

APPROVALS	DATE
DRAWN F. Davis	3.23.79
CHECKED A Schatzman	4/2/79
ENG	4-3-79
MFG MGR.	4/3/79
QA MGR.	4/6/79
RELEASED	4/11/79

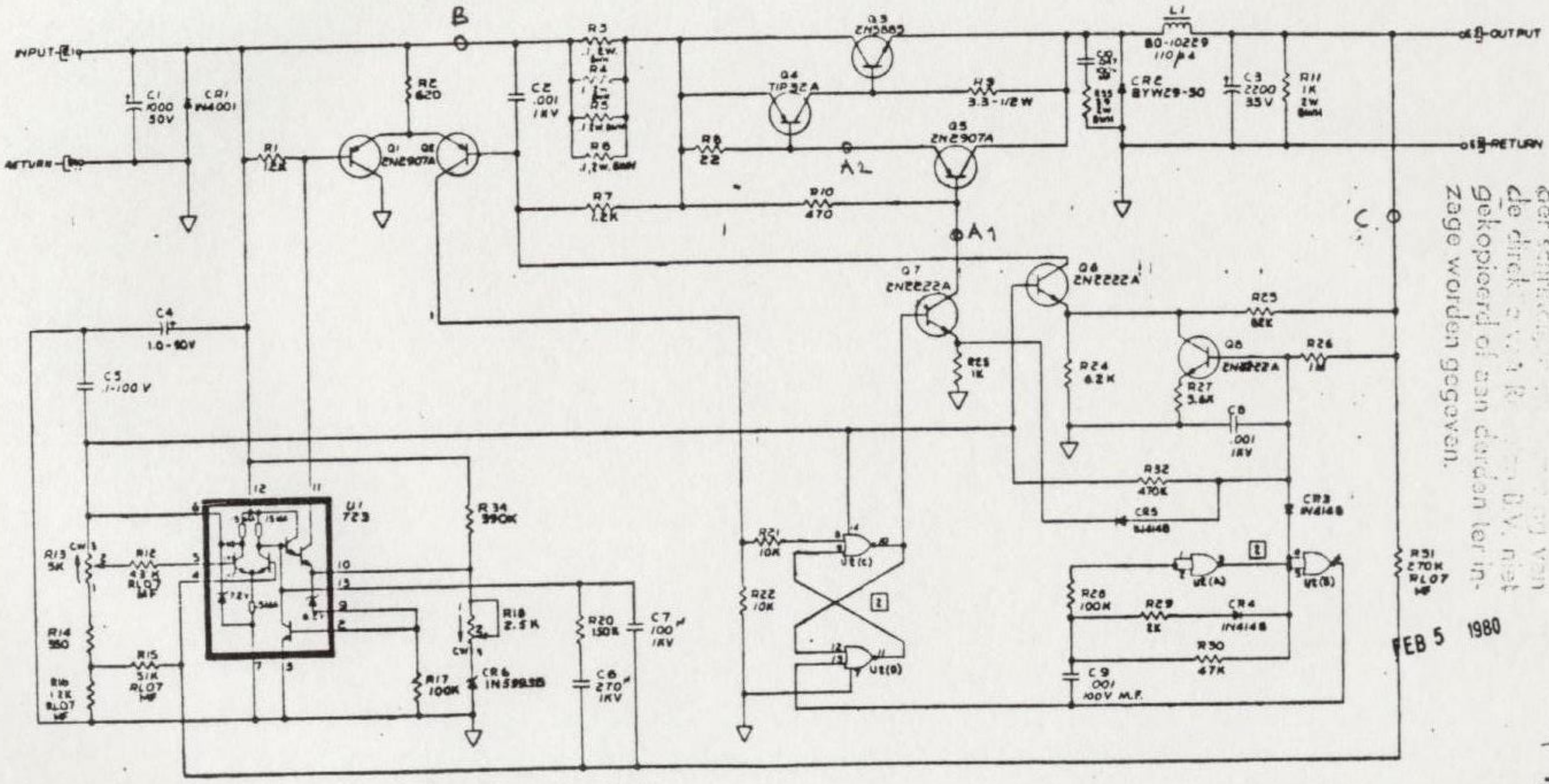
BOSCHERT INCORPORATED
SUNNYVALE, CALIFORNIA

PIN OUT CHART
POS., 3 TERM. REG

SIZE	DRAWING NO.	REV
A	97-10508	A

SCALE N/A SHEET 1 OF 1

LTR	DESCRIPTION	ECO	DATE	APPROVAL
/	ENG. PROTOTYPE			
I	PRE. REL. TO PROD.			
A	REL. FOR PRODUCTION	3297		
B	CHG R31 FROM 470K TO AGREE WITH ASSY. NO ECO CHG.	—		
C	INCORPORATED	3580		



INPUT
RETURN
OUTPUT
B
A1
A2
C
C1 1000 50V
CR1 1N4001
R1 1.2K
R2 620
Q1 Q2 2N2907A
C2 .001 1KV
R3
R4
R5
R6 .1,2W
R7 1.2K
R8 22
R10 470
Q3 2N5883
Q4 TIP32A
Q5 2N2907A
R9 3.3-1/2W
L1 80-10229 110µH
CR2 BYW29-50
C3 2200 35V
R11 1K 2W
Q6 2N2222A
Q7 2N2222A
Q8 2N2222A
R23 1K
R24 6.2K
R25 82K
R26 1M
R27 5.6K
C8 .001 1KV
R32 470K
CR5 1N4148
CR3 1N4148
R31 270K RLO7 MF
C4 1.0-50V
C5 .1-100V
U1 723
R34 390K
R13 5K
R12 43K RLO7 MF
R14 550
R15 51K RLO7 MF
R16 12K RLO7 MF
R17 100K
R18 2.5K
CR6 1N5993B
R20 150K
C6 270 1KV
C7 100 1KV
R21 10K
R22 10K
U2(C)
U2(D)
U2(A)
U2(B)
R28 100K
R29 1K
CR4 1N4148
R30 47K
C9 .001 100V M.F.

KONFIDENTIEEL

Deze gegevens zijn [illegible] van Rodelco [illegible] zonder schriftelijke [illegible] van de direktie van Rodelco B.V. niet gekopieerd of aan derden ter inzage worden gegeven.

FEB 5 1980

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Phone (070) 99 57 59
Telex 32506

LAST USED	NOT USED
R34	R19
C10	
CR6	
L1	
Q8	
A2	

NEXT ASSY 45-10484

boschert

SCHEMATIC
3 TERMINAL REGULATOR
MODEL 3T12AP-1001R

D

[2] U2 IS 4001B

1. UNLESS OTHERWISE SPECIFIED CAPACITANCE IS IN MICROFARADS, RESISTANCE IS IN OHMS, 1/4 WATT, CARBON FILM.

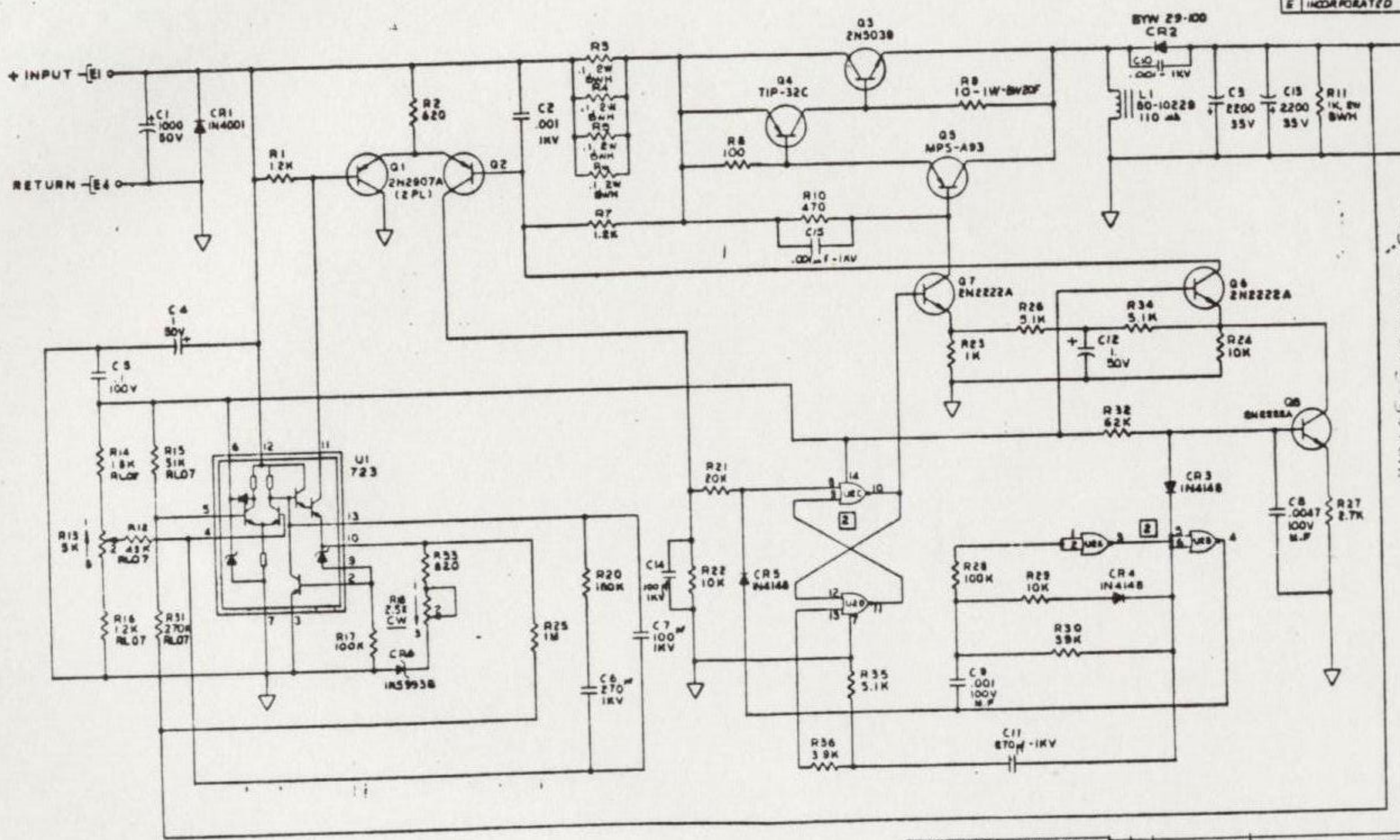
NOTES

REV	DESCRIPTION	ECO	DATE	APPR
1	ENG PROTOTYPE			
2	PRE REL FOR PROD			
A	REL. FOR PRODUCTION			
B	R24 WAS 20K R25 WAS 100K, R33 WAS 1.2K, CHANGED TO AGREE WITH ASSY.			
C	C10 WAS 270 pF-1KV, C14 WAS ...			
D	INCORPORATED			
E	INCORPORATED			

90-10432

KONFIDENTIEEL
Deze gegevens zijn eigendom van Boschert B.V. en mogen zonder schriftelijke toestemming van de directie van Boschert B.V. niet gekopieerd of aan derden ter inzage worden gegeven.

FEB 5 1980



+ INPUT E1
RETURN E4
OUTPUT E2
RETURN E3
C1 1000 50V
CR1 1N4001
R1 1.2K
R2 620
Q1 2N2907A (2 PL)
Q2
C2 .001 1KV
R3 .1 2W BWH
R4
R5
R6
R7 1.2K
R8 100
Q4 TIP-32C
Q3 2N5038
R9 10-1W-BW20F
Q5 MPS-A93
R10 470
C15 .001 F-1KV
BYW 29-100 CR2
C10 .001-1KV
L1 80-10229 110 µH
C3 2200 35V
C13 2200 35V
R11 1K, 2W BWH
Q7 2N2222A
Q6 2N2222A
R26 5.1K
R34 5.1K
R23 1K
C12 1 50V
R24 10K
Q8
R32 62K
C8 .0047 100V M.F
R27 2.7K
CR3 1N4148
C4 1 50V
C5 1 100V
R14 1.8K RL07
R15 51K RL07
U1 723
R13 5K
R12 43K RL07
R16 1.2K RL07
R31 270K RL07
R33 820
R18 2.5K CW
R17 100K
CR6 1N5993B
R20 180K
R25 1M
C6 270 1KV
C7 100 1KV
R21 20K
C14 100 1KV
R22 10K
CR5 1N4148
R35 5.1K
R36 3.9K
R28 100K
R29 10K
CR4 1N4148
R30 39K
C9 .001 100V M.F
C11 270 -1KV

LAST USED	NOT USED
C14	
R36	R19
Q8	
CR6	
U2	
L1	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
NEXT ASSY: 43-10469
MOD NO: ST3AN-100LR
DO NOT SCALE DRAWING

boschert — BOSCHERT ASSOCIATES, SUNNYVALE, CALIFORNIA

SCHEMATIC
3 TERMINAL REGULATOR
NEGATIVE

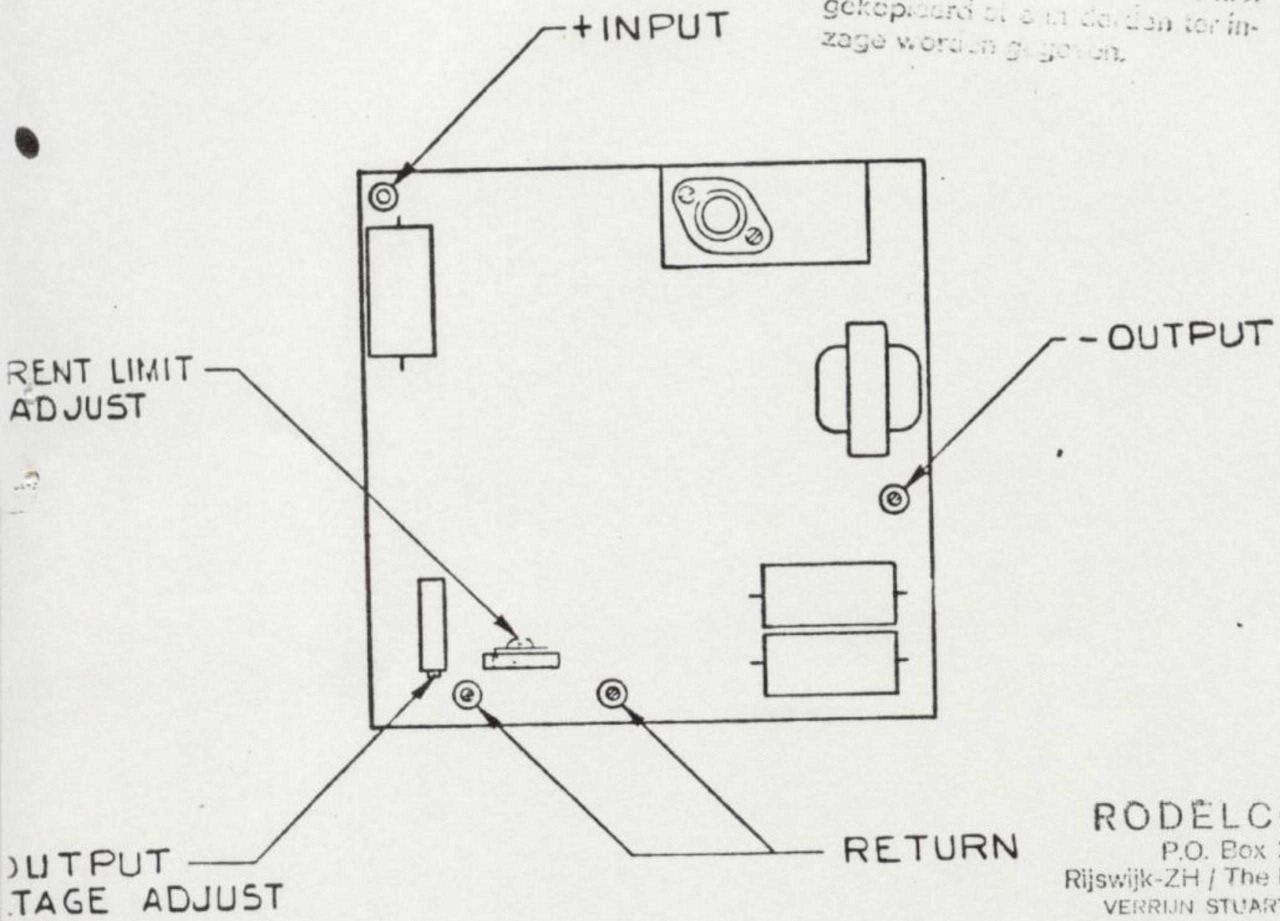
SIZE D — DWG NO 90-10432 — REV E
SCALE N/A — SHEET 1 OF 1

NOTES:

1 UNLESS OTHERWISE SPECIFIED CAPACITANCE IS IN MICROFARADS; RESISTORS ARE IN OHMS, 1/4 WATT, ± 5% CARBON FILM.

2 U2 IS P/N 19-10579-01.

APPLICATION		REVISION				
NEXT ASSY	USED ON	REV	ECO	DESCRIPTION	DATE	APPROVED
0469	BTS AN-1001	1	—	PRE-REL TO PROD	5-11-79	[illegible]
		A	3301	REL FOR PROD.	9-6-79	ESC [illegible]



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Phone (070) 99 57 50
Telex 32[illegible]

COMP. SIDE

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
FRACTIONS DECIMALS ANGLES
.XX ± ___ ± ___
.XXX ± ___
MATERIAL

APPROVALS	DATE
DRAWN P. Dams	5.8.79
CHECKED [illegible]	[illegible] 79
ENG [illegible]	[illegible]
MFG MGR [illegible]	[illegible]
QA MGR [illegible]	[illegible]
RELEASED [illegible]	[illegible]

DO NOT SCALE DRAWING

BOSCHERT INCORPORATED
SUNNYVALE, CALIFORNIA

PIN OUT CHART
3 TERM, NEG.

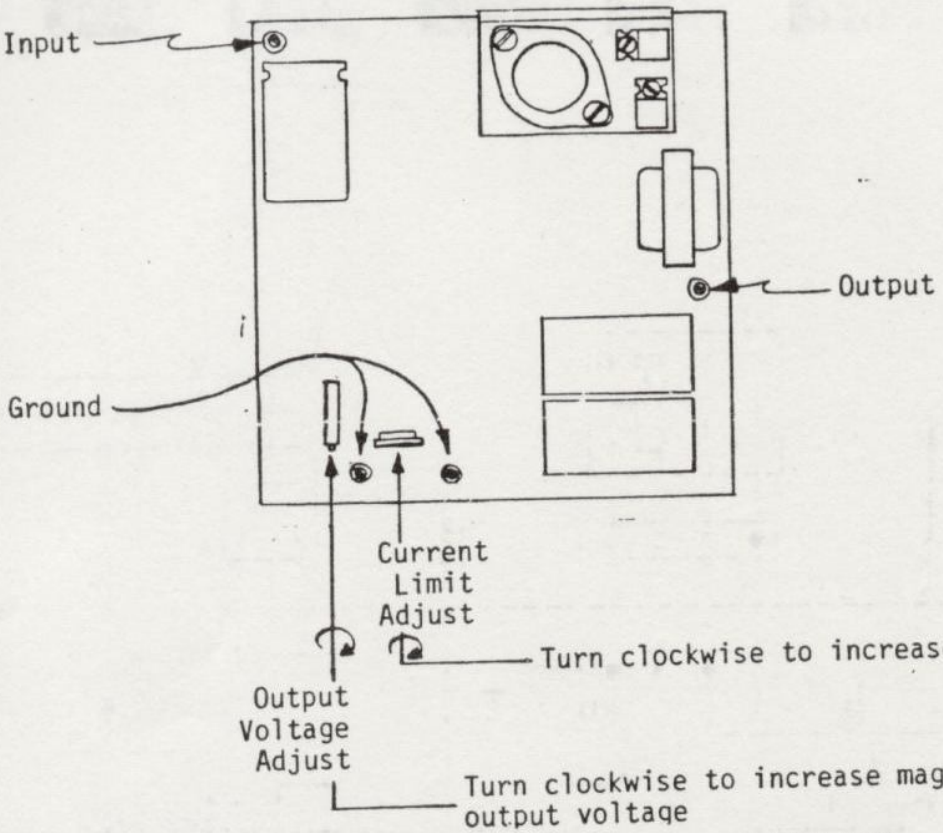
SIZE	DRAWING NO.	REV
A	97-10742	A

SCALE N/A SHEET 1 OF 1

97-10742 -[illegible]

PHOTOGRAPHICS ACCUPRESS ORDER NO. A-4[illegible]

PIN ORIENTATION



PIN		VOLTAGE
_____	INPUT	+10V to +40V
_____	OUTPUT #1	-4.5V to -30V
_____	OUTPUT #2	_____
_____	OUTPUT #3	_____
_____	OUTPUT #4	_____
_____	OUTPUT #5	_____
_____	OUTPUT #6	_____
_____	RETURN	
_____	NOT USED	

MODEL NO. 3T5AN-1001

MFG. ASSEMBLY NO. 10469

MATING CONNECTOR None - solder terminals

AUTOMATIC SHORT CIRCUIT RECOVERY ☐

AUTOMATIC SHORT CIRCUIT SHUT DOWN ☐

Current Limit ☒