

**HCX21
I/H CONVERTER
USERS GUIDE**

**TRI-SEN Systems, Inc.
La Marque, Texas**

**Part No.: MANUAL HCX21, Rev. K
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REVISION HISTORY

July 1990	Rev. I	<p>Replaced Hydraulics write-up with new version as Appendix C</p> <p>Replaced Figure 3-4, page 3-8, Drawing 84-1997, now Rev. I</p> <p>Replaced Warranty section as Appendix A</p> <p>Added RMA information as Appendix B</p> <p>Added Disclaimer</p>
Dec 1990	Rev. J	Editorial revision only, converted to document standard
Sept 1991	Rev. K	Removed exchange/replacement program, Appendix D; added new warnings and ESD.

WARNING !

READ THIS ENTIRE MANUAL AND ALL RELATED PUBLICATIONS PERTAINING TO THE WORK TO BE PERFORMED BEFORE INSTALLING, OPERATING, OR SERVICING THIS EQUIPMENT.

- Practice all plant and safety codes and standards. Failure to follow instructions can result in personal injury and/or property damage.
- Do NOT remove covers of Division I units with power applied to prevent ignition of hazardous atmosphere.
- All servicing should be performed by qualified technicians. Dangerous voltages are present on the circuit boards.
- Use extreme caution when working around power-input cables. These cables have potentially lethal voltage on them.
- Be very careful when working on the digital (or discreet) input/output field termination panels. The external devices being controlled can have high, potentially lethal, voltages on them. Turn off the power to the external devices before disconnecting or connecting the cable, or a wire, between the digital (or discreet) input/output field termination panels and the field wiring.
- Replace fuses only with specified parts for continued safe operation.
- Equip the engine, turbine, or other type of prime mover with an overspeed (overtemperature or overpressure, where applicable) shutdown device that operates totally independently of the prime mover control device to protect against run-away or damage to the engine, turbine, or other prime mover, or personal injury or loss of life, should the mechanical-hydraulic or electronic governor, actuator, fuel control, driving mechanism, linkage, or controlled device fail.
- Make sure the charging device is turned off before disconnecting the battery from the system to prevent damage to a control system that uses an alternator or battery-charging device.
- Have qualified personnel verify all wiring and connections against vendor drawings prior to energizing the equipment. Incorrect wiring and/or connections can result in equipment damage.
- Contact appropriate manufacturer for instructions for operation of engine, turbine, or driven unit. This manual does not contain this information.

If you have questions or need more information on installing and operating TRI-SEN equipment, contact TRI-SEN Systems, Inc. at 409-935-3555.

<p style="text-align: center;">ELECTROSTATIC DISCHARGE AWARENESS</p>

1. Keep the following materials away from components and work area:
 - Styrofoam® (polystyrene): cups, packing material
 - cellophane: cigarette packages or candy wrappers
 - vinyl: books or folders
 - plastic: cups, bottles, ash trays
2. Avoid synthetic clothing. Instead, wear cotton or cotton blend materials. Keep components away from elastics, clothing and hair.
3. Discharge static electricity on your body by touching and momentarily holding a grounded metal object (a pipe, a cabinet, equipment, etc.) **before** handling electronic components. This is especially important when walking across carpet.
4. Do NOT handle components in the field unless absolutely necessary. When necessary:
 - Handle components **only** by the faceplate handles, if possible. Do NOT pick up components with anything but your fingers, and even then do not pick up by the leads.
 - Do NOT touch the printed circuit board, the connectors, or the components with conductive devices or with your hands.
 - Do NOT remove the component from the chassis unless absolutely necessary.
 - Place the component into an anti-static protective bag immediately **after** removing it from the chassis. Static-shielding bags are designed to contain sensitive components, not to be used as pot-holders to pick them up. This does absolutely no good.
5. Transport all static-sensitive components only in static-shielding carriers or packages. Place static awareness labels on all components to prevent removal from static-shielding container during transit.
6. Handle all static-sensitive components at a static-safe work area including: floor mat, wrist strap, air ionizer, ground cord, and conductive table mat.
7. Wear a grounded wrist strap in the field whenever possible; where wrist straps are impractical, wear grounded heel straps or special footwear.
8. Do NOT subject components to sliding movements over any surface, at any time.

DISCLAIMER

Because of the variety of uses for this equipment the user of, and those responsible for applying this equipment must satisfy themselves as to the acceptability of each application and the use of the equipment.

The illustrations, charts and layout examples shown in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, TRI-SEN Systems, Inc. cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

In no event will TRI-SEN Systems, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

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ILLUSTRATIONS

DRAWINGS

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84-1171	F	HCX21 Hydraulic Control Transducer Schematic (Sheets 1-2).....	4
84-1898	G	HCX21 Transducer (Sheets 1-2).....	4
84-1996	C	Detail PCB Servo Amplifier HCX21.....	4
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SECTION 1 INTRODUCTION

1.1 PRODUCT DESCRIPTION

The TRI-SEN System HCX21 is a low-cost, single-stage, electric current to hydraulic pressure (I/H) converter. The unit has closed loop pressure control to allow the commanded load to be accurate in spite of changes in supply pressure, return pressure and flow demands.

The unit offers the users excellent dynamic performance, electrically adjustable pressure range, relatively high contamination tolerance and output flow capability.

The HCX21 interfaces with TRI-SEN electronic governors to provide positioning control of fuel and steam valve actuators that operate from a proportional, hydraulic pressure.

Three models are available:

<u>Model No.</u>	<u>Application</u>
85-2517	0-100 PSIG Hydraulics, +15 V Power
85-3718	0-300 PSIG Hydraulics, +15 V Power
85-3919	0-100 PSIG Hydraulics, +24 V Power

1.2 SPECIFICATIONS

General

FUNCTION: Current to hydraulic pressure converter

DESIGN: Single stage hydraulic torque motor controlled by integral pressure servo amplifier

Package Aluminum base with hydraulic connections; heavy duty cover for torque motor, amplifier board, and pressure transducer

Hydraulic

FLUID: Turbine lube oil
 FILTRATION: 10 micron nominal (see Appendix C)
 CONNECTIONS: SAE O-ring ports (3)

SUPPLY PRESSURE: 120 PSI (8 bar) nominal
 100-140 PSI (6.9-9.7 bar) allowed

FLOW: 0.6 GPM (10 liters/minute) max
 @120 PSI supply (models 85-2517 & 85-3919)
 @300 PSI supply (model 85-3718)

Torque Motor

COIL RESISTANCE: 55 ohm

CURRENT: 0-200 mA

Output

PRESSURE: Screwdriver adjustable over the range of 0-90 PSI (0-6 bar, models 85-2517 & 85-3919), and 0-270 PSI (0-18 bar, model 85-3718), minimum pressure range 0-30 PSI (0-2 bar)

FLOW: 0.6 GPM (see above)

ACCURACY: $\pm 1\%$ (-20 TO 85°C)

HYSTERESIS: 0.1% max.

LINEARITY: 0.5%

Pressure Sensor

TYPE: Foxboro Model 1225 Strain Gage

ENVIRONMENTAL RATING: NEMA 4

MOUNTING: 1/4" - 18 NPT (under cover)

EXCITATION: +10 VDC from HCX21 Amp PCB

ACCURACY: $\pm 0.5\%$ of span

REPEATABILITY: $\pm 0.02\%$ of span

MEDIAN AND AMBIENT
TEMPERATURE: -40 to +121°C

Mechanical

SIZE: 4" X 4" (101.6mm) x 4.68" (118.9mm)
envelope

MOUNTING: 2 x 0.354" (9mm) mounting holes (bottom)
diagonally (see Drawing 84-1898)

MATERIALS: Base and cover - Aluminum

Electrical

CONNECTIONS: 1/2" (12.7mm) NPT female conduit

LEADS: 3 #18 AWG stranded

Red: 14-16 VDC supply
White: 14-16 VDC return
Black: 4-20 mA signal input
White: 4-20 mA signal return

Length: 18" (457.2 mm) min

Environmental

TEMPERATURE: -20° to 70° C operating

SHOCK: 50 G for 5 ms

VIBRATION: 10 G at 20-20,000 Hz

SEALING: Oil, water, and dust tight

AREA CLASS: Suitable for Class 1 & 2, Groups A, B, C, D,
Div. II, hazardous areas

Amplifier Board

SIZE:	2.5" x 2.5" (63.5mm) x 0.625" (15.9mm)	
ADJUSTMENTS:	Minimum Pressure	0-30 PSI (0-2 Bar)
	Pressure Span	0-60 PSI (0-4 Bar)
	Gain	
	Integral	
	Damping	
POWER:	14-16 VDC @ 250 mA max (+24 VDC for 85-3919)	
INPUT:	4-20 mA into 100 ohm	

SECTION 2 OPERATION

The HCX21 converter is a closed loop dynamic pressure adjusting transducer. The unit produces a continuously controlled hydraulic pressure output proportional to the electrical command.

The HCX21 assemblies are:

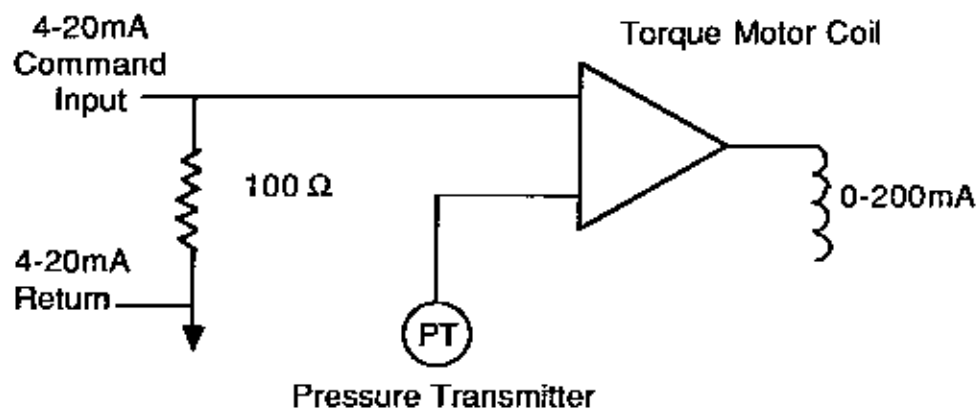
- Servoamplifier
- Feedback transducer
- Servovalve

Drawing 84-1171 illustrates the interrelationship of these assemblies.

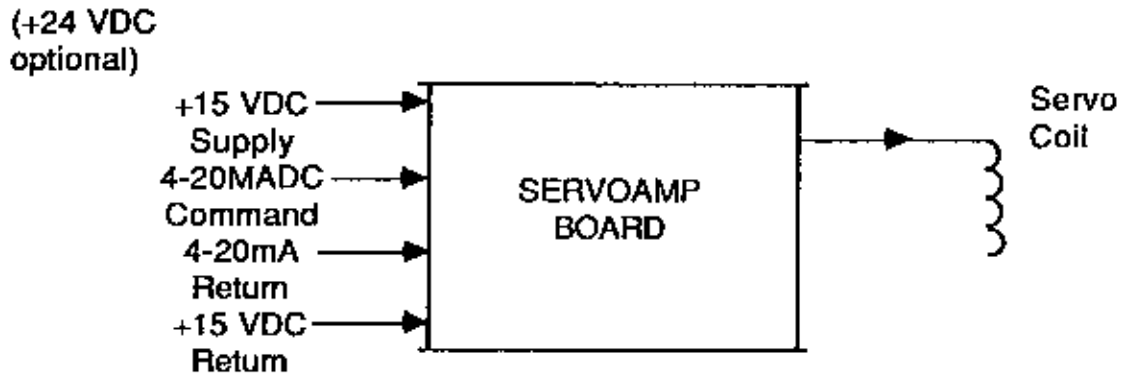
2.1 SERVOAMPLIFIER

(Reference Drawing 84-1997.)

Output pressure control is accomplished by an internal electronic servoamplifier. The servoamplifier modulates the torque motor current (0-200 mA) to maintain the pressure called for by the 4-20 mA command input.



The servoamplifier operates on a single +15 VDC supply from an external source. Most TRI-SEN governors and control systems can provide this voltage. (A servoamplifier is also available to take a +24 VDC supply.)



Adjustments of minimum pressure (R101), maximum pressure (R102), gain (R104), damping (R103), and integral (R105) are made possible in the servo amplifier from potentiometer adjustments at the board.

The servoamplifier PCB outputs a regulated +10 VDC to power the pressure transducer.

2.2 FEEDBACK TRANSDUCER

A strain gage pressure transducer is used to provide output pressure feedback to the servoamplifier.

2.3 SERVOVALVE

Drawing 84-1171 illustrates a schematic representation of the HCX21 servovalve. The unit consists of a torque motor and an integral flapper valve.

The electromagnetic "torque" motor moves the "flapper" valve to allow a corresponding change in the pressure output. The flapper valve changes output pressure by porting changes of supply pressure and drain simultaneously. As more supply pressure is allowed to the output and less is allowed to drain, the output pressure will increase.

Torque Motor

Output pressure is regulated by modulating a flapper with a torque motor. The torque motor consists of a double coil electromagnetic armature inside a permanently magnetized frame. Drawing 84-1171 further illustrates the operating principle of the torque motor.

As the armature coils become polarized from the servoamplifier's output, the armature will move due to the interaction between the permanent magnetic field in the frame and the electromagnetic field in the armature. The armature will tend to rotate from its pivot point toward the direction of dissimilar magnetic fields.

SECTION 3 INSTALLATION

3.1 UNPACKING AND RESHIPMENT

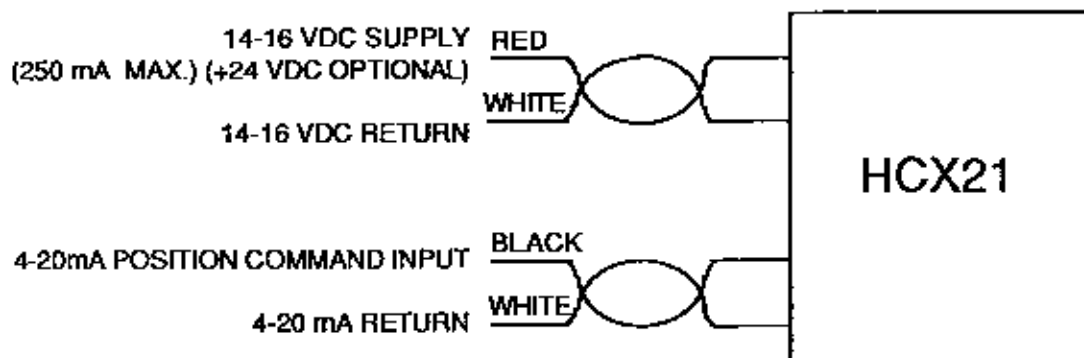
Upon receipt of the unit, unpack it carefully and visually check for damage or breakage. If everything appears in order, proceed to the instructions on mounting. If the unit is found to be damaged, notify the carrier and your TRI-SEN representative. If the unit is found to be badly damaged, is faulty for any reason, or if it has to be returned to the factory for repair or modification, consult Appendix B.

3.2 MOUNTING

The HCX21 I-to-H converter is supplied with two 0.354" inside diameter holes at the bottom of the actuator body for solid mounting. Drawing 84-1898 illustrates mounting details and recommended piping.

3.3 ELECTRICAL

WIRE THE #18 AWG WIRES AS FOLLOWS:



3.4 HYDRAULIC PIPING

Half-inch stainless-steel tubing is recommended for both supply and drain lines. Observe the following when making connections.

1. Leave plastic plugs in the actuator until ready to make final piping tie-ins.

2. Flush all lines thoroughly before connection.
3. Slope lines to avoid air pockets.
4. Use filters as necessary to assure 10 micron or better fluid purity (see Appendix C).
5. Observe absolute cleanliness. Thread burrs, Teflon® tape and other debris can cause the transducer to malfunction.

3.5 CALIBRATION

The HCX21 is calibrated in three steps:

1. Initial output calibration
2. Tuning
3. Final output calibration

3.5.1 Preliminary

1. Check hydraulic tubing for proper sizing and connections (see Installation section).
2. An accurate pressure gage should be connected in the output pressure line.
3. Commission the hydraulic system and verify that pressure and temperature of the fluid are normal. Supply pressure should be between 100-140 PSIG on standard units (300 PSIG on model 85-3718).
4. Apply +15 VDC (± 1 V) (or +24 VDC on model 85-3919) supply to the unit.
 - White wire - 15 V return
 - Red wire - +15 V
5. Connect a 4-20 mA DC current source to the unit.
 - White wire -
 - Black wire +
6. Remove the top cover (2 screws) to expose the printed circuit board.
7. Set GAIN, INTEGRAL, and DAMPING fully counter-clockwise (reference Drawings 84-1996 and 84-1997).

3.5.2 Initial Output Calibration

1. Adjust the signal input to 4 mA.
2. Adjust R101 (min) for desired minimum output pressure.
3. Raise input to 20 mA.
4. Adjust R102 (max) for desired maximum pressure.

3.5.3 Tuning

1. Adjust input to 12 mA. Input pressure should be approximately mid-range.
2. Turn GAIN slowly clockwise until output pressure begins to fluctuate rapidly (oscillation).
3. Back off on GAIN (counter clockwise) until output becomes stable.
4. Repeat 2 and 3 using INTEGRAL adjustment.
5. Repeat 2 and 3 using DAMPING adjustment.
6. Repeat 2 through 5 to further optimize settings. Back off on each adjustment slightly to guarantee stability.

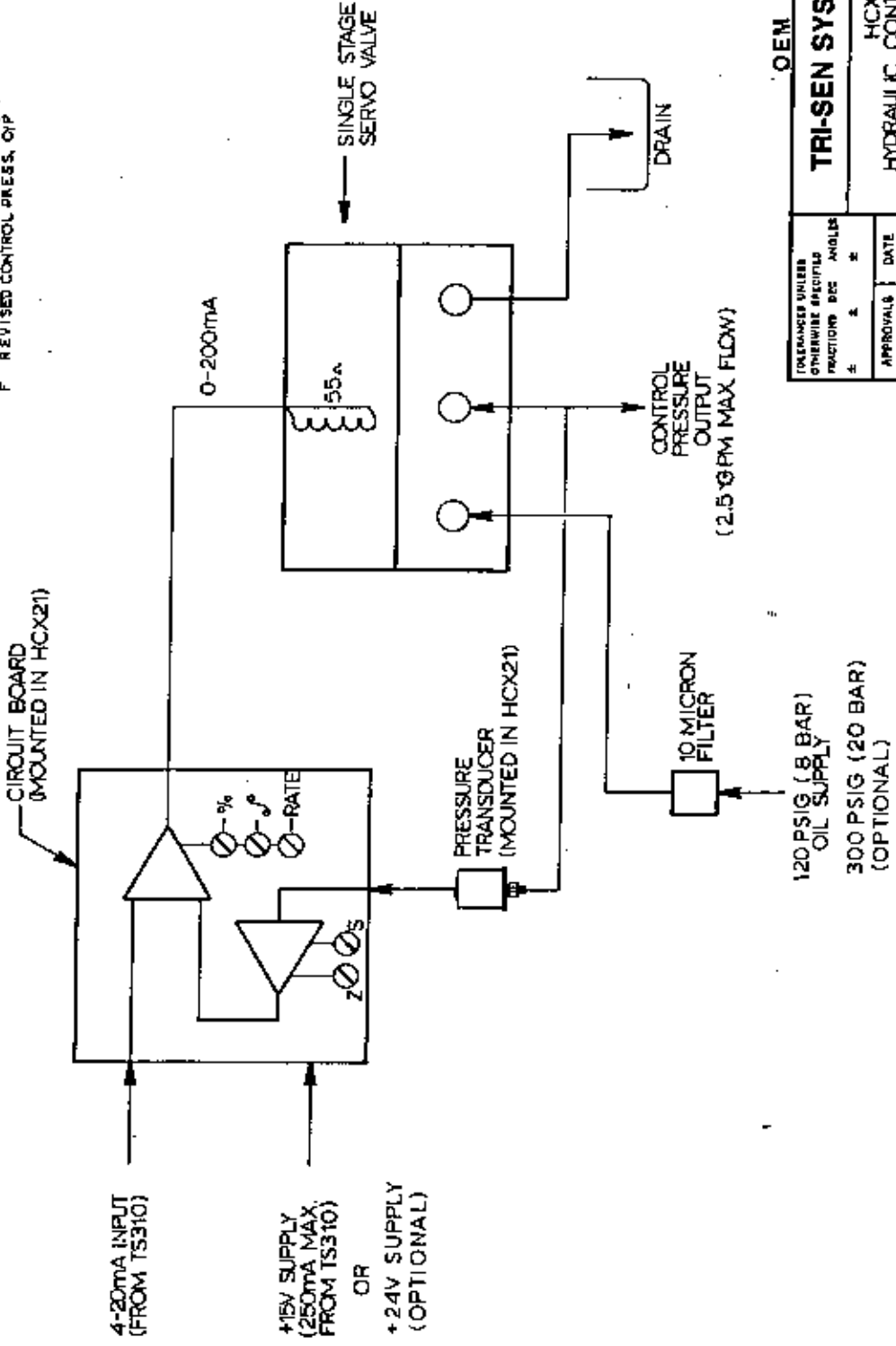
3.5.4 Final Output Calibration

1. Repeat steps 1-4 of paragraph 3.5.2 as necessary until desired accuracy is achieved.
2. Check output at 12 mA DC input (mid-scale) to verify linearity.
3. Seal all adjustments.
4. Replace circuit board cover and screws.

SECTION 4 DRAWINGS

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED
A	REVISED AS PER D.J.T. 503	03-15-85	[Signature]
B	REVISED PER DWO-541	5-23-85	[Signature]
C	REVISED PER DWO-2543	12-5-85	[Signature]
D	REVISED PER DWO-4227	06-30-86	[Signature]
E	REVISED COIL TO 55Ω-DWO-5977	3-20-87	[Signature]
F	REVISED CONTROL PRESS. O/P	11-08-85	[Signature]

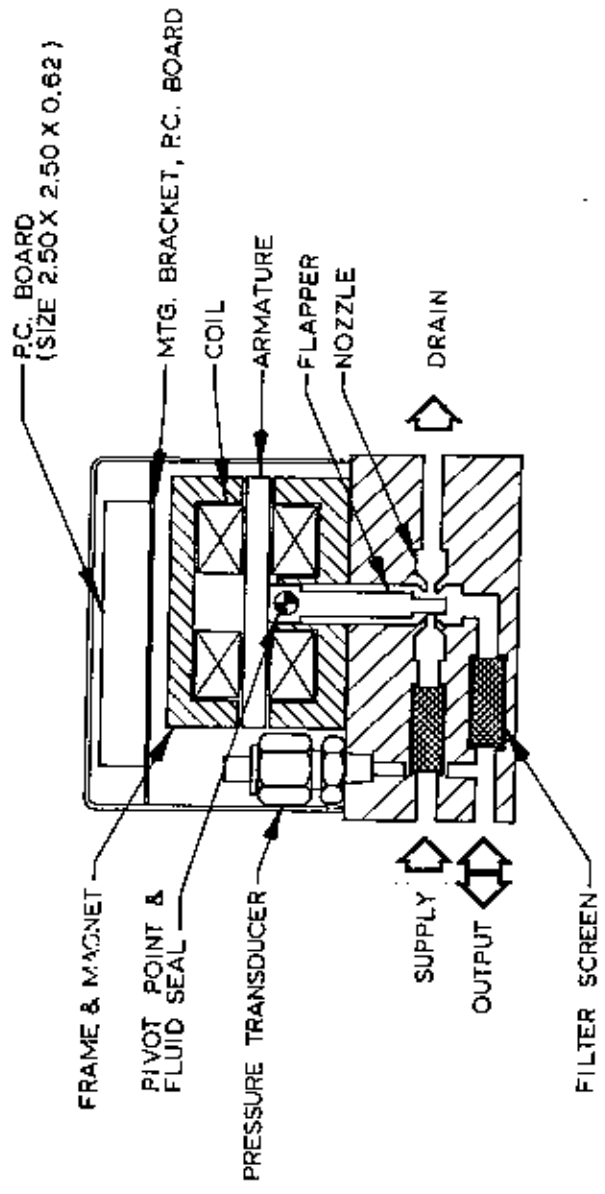


OEM OEM MANUAL	
TRI-SEN SYSTEMS, INC.	
HCX21	
HYDRAULIC CONTROL TRANSDUCER	
SCHEMATIC	
SCALE	SIZE DRAWING NO.
NONE	B
DO NOT SCALE DRAWING SHEET 1 OF 2	

DESIGNED BY	DATE
DRAWN BY	DATE
CHECKED BY	DATE
APPROVED BY	DATE
PROJECT NO.	2-21-84

REVISIONS

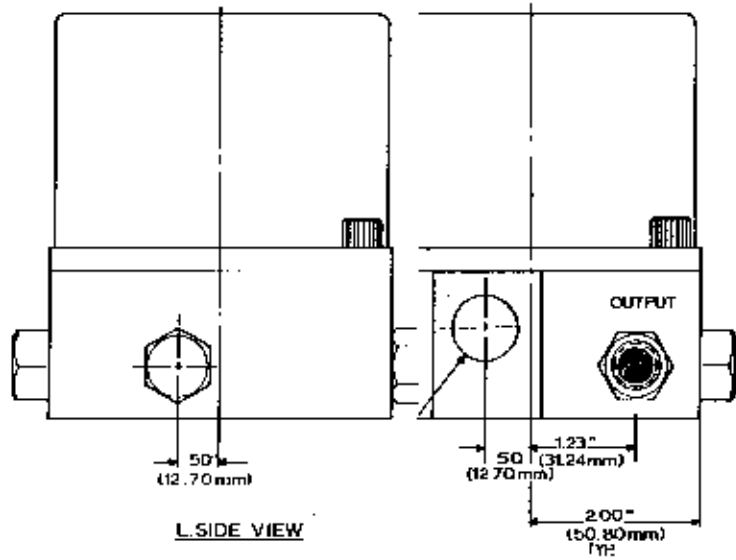
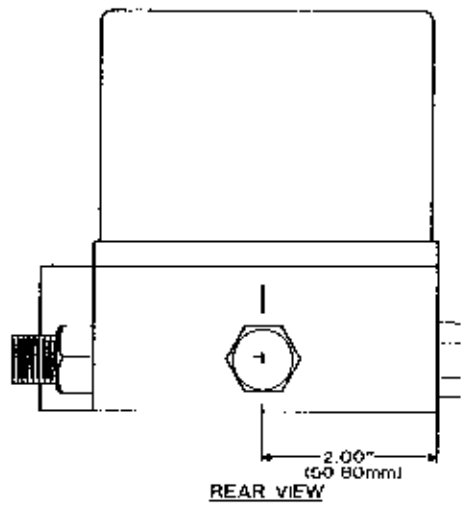
LTR	DESCRIPTION	DATE	APPROVED
E	SEE SK 1	3-20-87	FMD
F	"	7/6/88	



HYDRAULIC SCHEMATIC

DIMENSIONS UNLESS SPECIFIED IN FRACTIONS DEC ANGLES		OEM		OEM MANUAL	
APPROVALS	DATE	TRI-SEN SYSTEMS, INC.		HCX21	
DRAWN	DATE	HYDRAULIC CONTROL TRANSDUCER		SCHEMATIC	
CHECKED	DATE	SCALE	SIZE	DRAWING NO.	
		NONE	B	84-1171	
		DO NOT SCALE DRAWING		SHEET 2 OF 2	

REVISIONS			
LTR.	DESCRIPTION	DATE	APPROVED
A	ADDED SH 2 of 2 AS PER DWG 582	03-19-85	JLC
B	REVISED PER DWG 2540	02-5-85	
C	REVISED PER DWG 3069	07-11-86	
D	REVISED AS PER DWG 3329	05-02-87	SLP
E	REVISED NOTES-DWG 3571	3-9-87	
F	ADDED WHT WTRL-DWG 3578	3-18-87	
G	REVISED DWG	6-27-91	PLJ



- NOTES**
1. FLUID: TURBINE LUBE OIL
 2. COIL RESISTANCE: 55 OHMS
 3. CURRENT: 200mA MAX. AT 11VDC MAX. AT
 4. OPERATION: NORMALLY CLOSED AT 4mA (
 5. FLOW: 10L/MIN. MAX.
 6. OUTPUT PRESSURE: NOMINAL ADJUSTABLE
 7. SUPPLY PRESSURE: 8 BAR
 8. AREA CLASSIFICATION: HAZARDOUS DIV 1
 9. RECOMMENDED FILTRATION: 10 MICRON

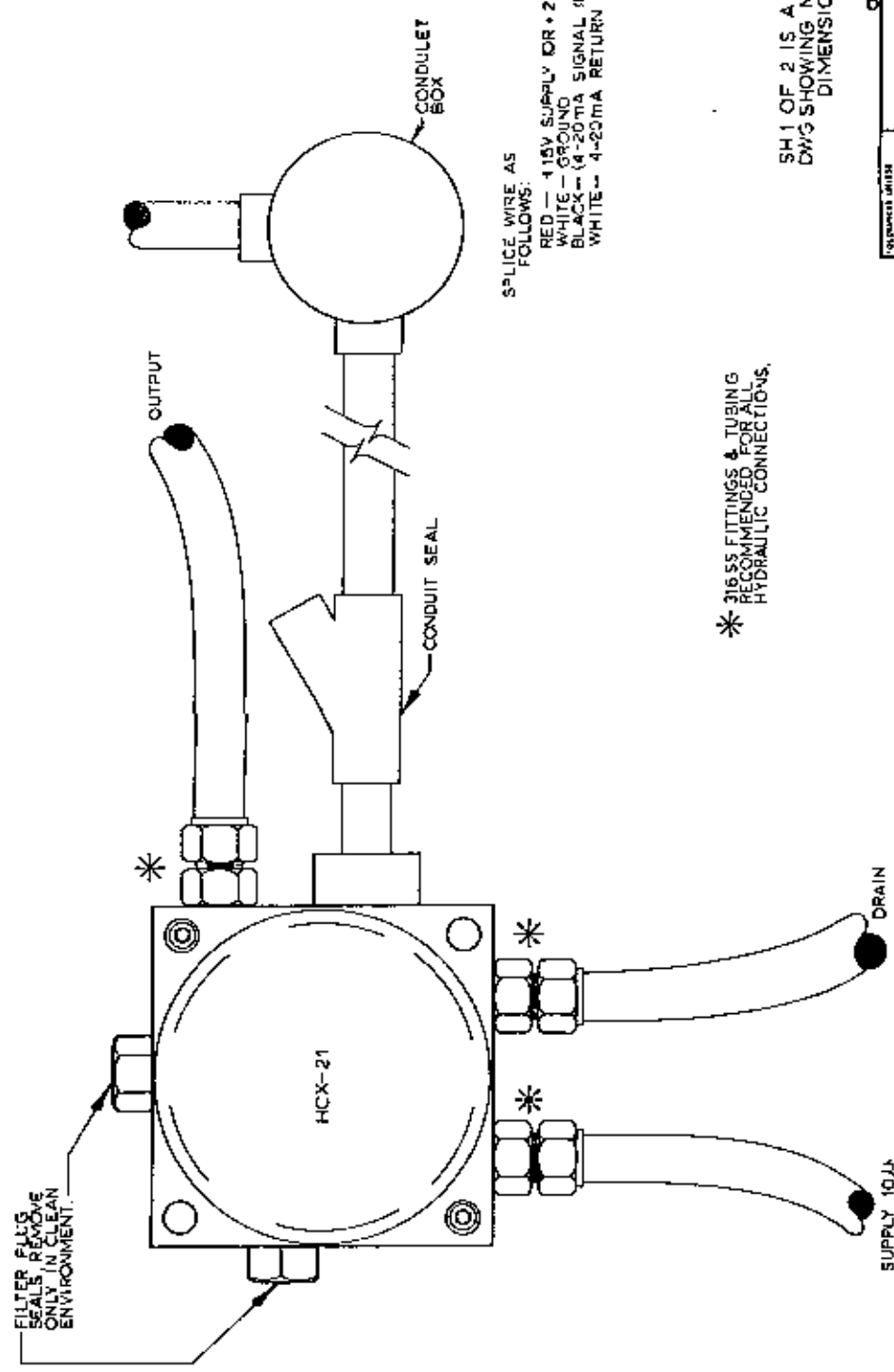
R. SIDE VIEW

SH 2 OF 2 IS A "C" SIZE
 DWG SHOWING INSTALL-
 ATION DETAILS.

REVISIONS		DATE		APPROVED	
NO. OF CHANGES	DATE	DATE	DATE	DATE	DATE
1	03-19-85	02-5-85	07-11-86	05-02-87	3-9-87
2	02-5-85	07-11-86	05-02-87	3-9-87	3-18-87
3	07-11-86	05-02-87	3-9-87	3-18-87	6-27-91
4	05-02-87	3-9-87	3-18-87	6-27-91	
5	3-9-87	3-18-87	6-27-91		
6	3-18-87	6-27-91			
7	6-27-91				

OEM OEM MANUAL	
TRI-SEN SYSTEMS, INC.	
HCX21 TRANSUDCER	
SCALE: 1:1	SIZE: D
DRAWING NO. B4-1898	
DO NOT SCALE DRAWING	
SHEET 1 OF 2	

REV	DESCRIPTION	DATE	APPROVED
1	SEE SH-1 FOR CURRENT REV LEVEL	7/11/86	
2	FOR PART A	03-07-87	
3	SEE SH-1 FOR CURRENT REV LEVEL	3-19-87	
4	SEE SH-1	3-18-87	
5	SEE SH-1	4-27-87	



SH1 OF 2 IS A "D" SIZE DWG SHOWING MOUNTING DIMENSION

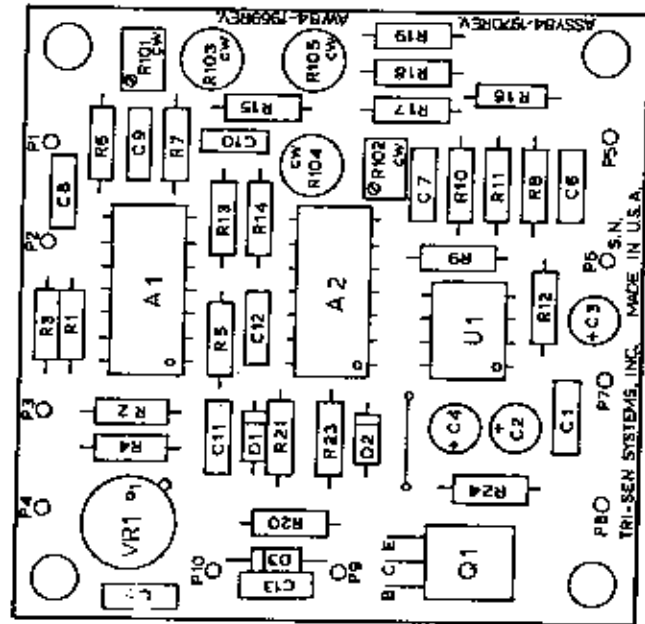
REVISIONS		DATE		APPROVED	
SEE SH-1 FOR CURRENT REV LEVEL		7/11/86			
FOR PART A		03-07-87			
SEE SH-1 FOR CURRENT REV LEVEL		3-19-87			
SEE SH-1		3-18-87			
SEE SH-1		4-27-87			

DESIGNED BY	TRAI-SEN SYSTEMS, INC.
APPROVED BY	HCX 21
DATE	TRANS-DUCER
SCALE	1:1
DRAWING NO.	84-1896
DO NOT SCALE DRAWING	
HEET 2 OF 2	

SUPPLY 10µm FILTER RECOMMENDED 120 PSIG (8 BAR) OR 300 PSIG (20 BAR)

REVISIONS

LTR	DESCRIPTION	DATE	APPROVED
A	REVISED PER DWG 2062	10/1/85	
B	REVISED PER DWO 6114	6.9.87	
C	ADDED DAMP CIRCUIT	4/7/88	OP



TOLERANCES UNLESS OTHERWISE SPECIFIED		DIMENSIONS UNLESS OTHERWISE SPECIFIED	
FRACTIONS	DEC	ANGLES	
±	±	±	±
APPROVALS		DATE	
DRAWN PAV		9-21-84	
CHECKED		9-21-84	
SCALE		2" : 1"	SIZE B
DRAWING NO.		84-1996	
DO NOT SCALE DRAWING		SHEET 1 OF 1	

OEM OEM MANUAL

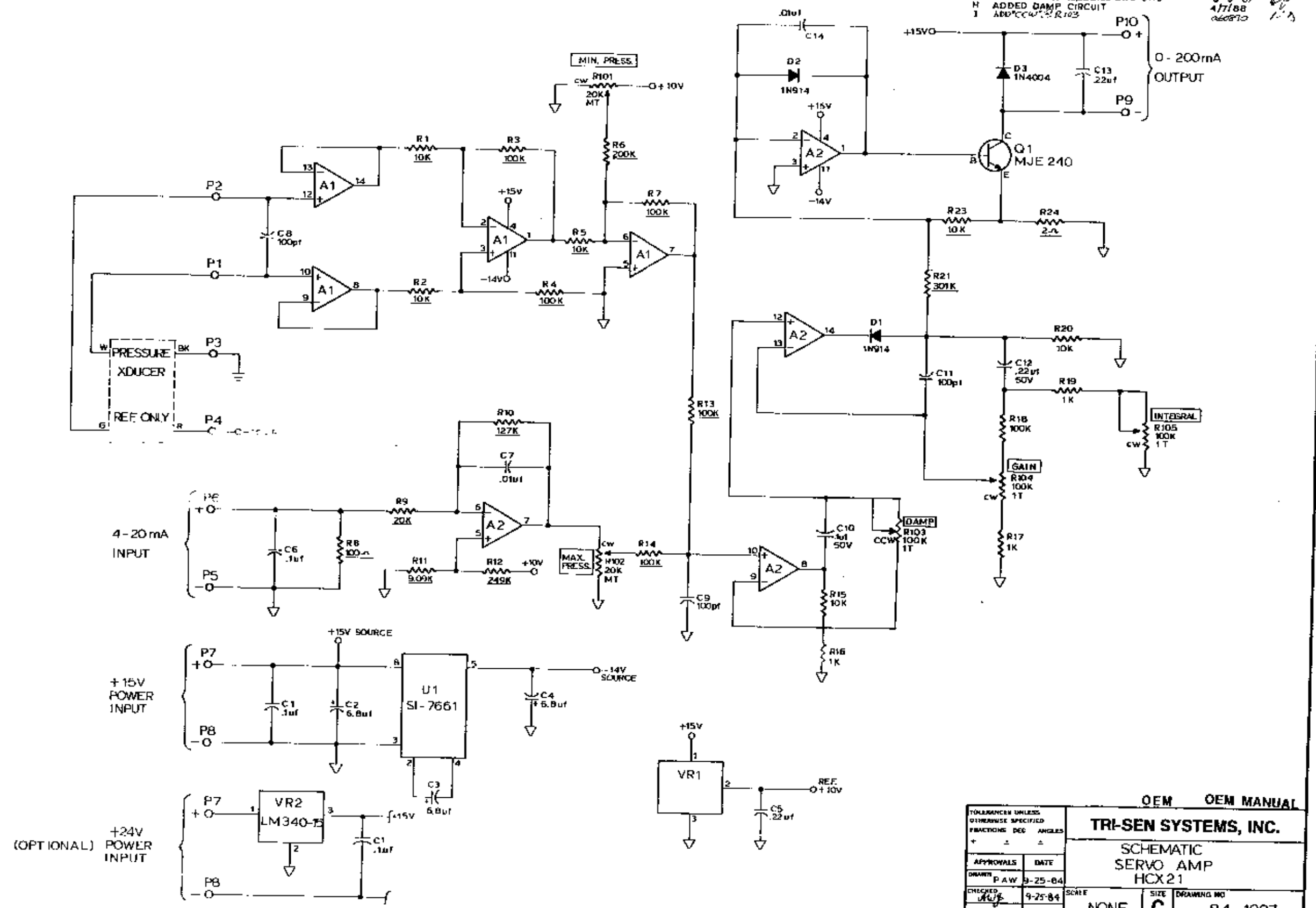
TRI-SEN SYSTEMS, INC.

DETAIL
PCB SERVO AMP
HCX21

SCALE 2" : 1" SIZE B
DRAWING NO. 84-1996

NOTES:
 AMPLIFIERS (A1, A2) - LM124J/883
 VOLT REGULATOR (VR1) - LH0070 - OH / 883

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	CHANGED VALUE OF R21 & R24, INTERCHANGED R2 & R3	11-27-84	
B	CHANGED VALUE OF R11 & R12	2-1-85	
C	REVISED PER DWO 2641	12-5-85	
D	REVISED PER DWO 4424	8-6-86	
E	ADDED C14, REV. Q1 - DWO 5560	3-3-87	
F	REV. C14, ADDED C13 - DWO 5679	3-18-87	
G	REMOVED C10, R15, R22, R103 - DWO 6113	6-9-87	
H	ADDED DAMP CIRCUIT	4/7/88	
I	ADD "CCW" TO R103	6/8/88	



APPROVALS		DATE	SCALE		SIZE	DRAWING NO
DRW	P AW	9-25-84	NONE	C		84-1997
CHEK	AW	9-25-84				

OEM OEM MANUAL
TRI-SEN SYSTEMS, INC.
 SCHEMATIC
 SERVO AMP
 HCX 21

DO NOT SCALE DRAWING SHEET 1 of 1