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VERY LARGE TELESCOPE

4-wire Pt100 Amplifier
Technical Manual

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Change Record

Issue	Date	Section/Page Affected	Reason/ Remarks
1.0	30-Jan-2003	All	First Issue

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1. SCOPE

This specification establishes the performance, design, development, assembly and test requirements for the 4-wire 2 channels Pt100 Amplifier.

2. APPLICABLE DOCUMENTS

The following documents of the exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of the specification shall be considered a superseding requirement.

[AD1] VLT-SPE-ESO-10000-0015 VLT Electronic Design Specifications

[AD2] VLT-SPE-ESO-10000-0004 Environmental Specification

3. DESCRIPTION

3.1. DEVICE OVERVIEW

The device is part of VLTI. It provides excitation and signal conditioning for the Resistor-Temperature detector PT100 (see Figure 1). The device is designed to support 2 PT100 sensors, connected in a 4-wire configuration, with 2 independent channels.

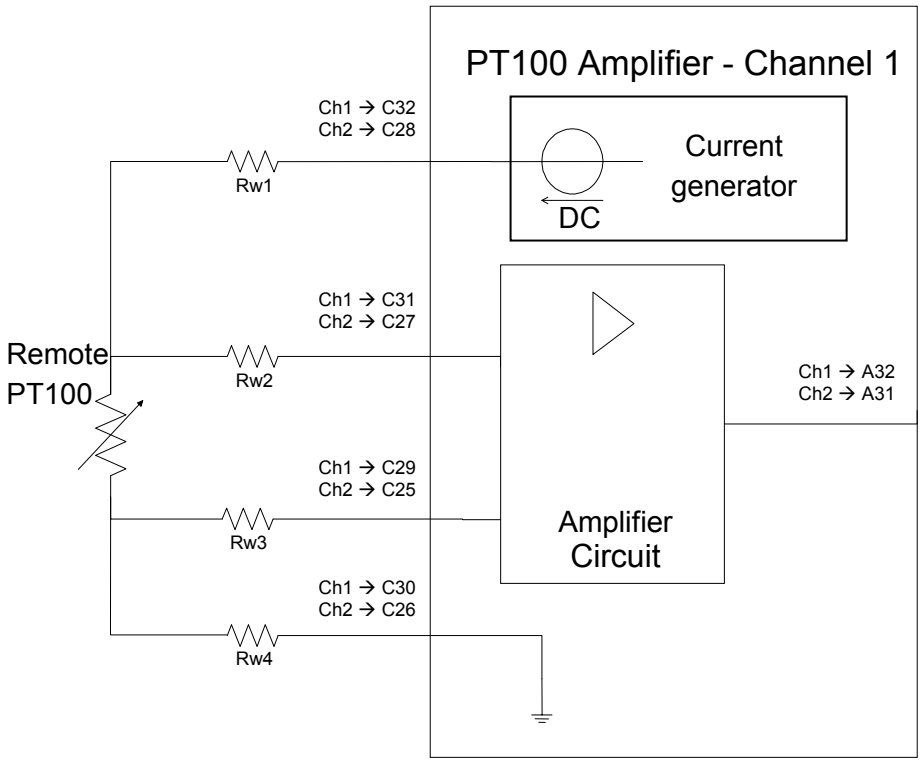


Figure 1 System Block Diagram

3.2. 4-WIRE CONNECTION

In many cases, PT100 sit far from the measurement circuitry (4-wire PT100 Amplifier), which adds a great deal of error into measurement system. The 4-wire connection shown in Figure 1, removes this kind of errors. The current through the lead resistances of wires R_{w2} and R_{w3} does not add inaccuracy because of the high input impedance of the amplifier circuit.

3.3. RESISTOR-TEMPERATURE DETECTOR PT100

The resistor- temperature detectors are the most stable and popular temperature sensors. The Table 1 and the Figure 2 show the characteristic of the Pt100 sensor. The Pt100 response over the specified range o f -50°C… +50°C is almost linear and that simplify the conditioning circuit.

Table 1 Pt100 Temperature / Resistance table

T [°C] / R [Ω]	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
-50										80,31
-40	80,70	81,10	81,50	81,89	82,29	82,69	83,08	83,48	83,87	84,27
-30	84,67	85,06	85,46	85,85	86,25	86,64	87,04	87,43	87,83	88,22
-20	88,62	89,01	89,40	89,80	90,19	90,59	90,98	91,37	91,77	92,16
-10	92,55	92,95	93,34	93,73	94,12	94,52	94,91	95,30	95,69	96,09
0	96,48	96,87	97,26	97,65	98,04	98,44	98,83	99,22	99,61	100,00
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	100,00	100,39	100,78	101,17	101,56	101,95	102,34	102,73	103,12	103,51
10	103,90	104,29	104,68	105,07	105,46	105,85	106,24	106,63	107,02	107,40
20	107,79	108,18	108,57	108,96	109,35	109,73	110,12	110,51	110,90	111,29
30	111,67	112,06	112,45	112,83	113,22	113,61	114,00	114,38	114,77	115,15
40	115,54	115,93	116,31	116,70	117,08	117,47	117,86	118,24	118,63	119,01
50	119,40									

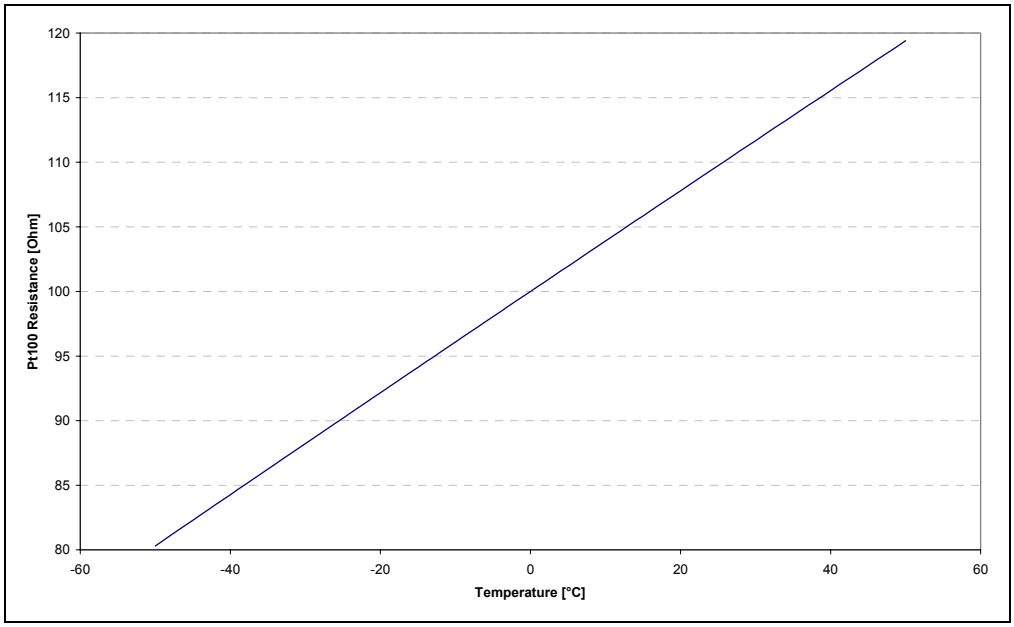


Figure 2 Pt100 Temperature / Resistance characteristic.

3.4. CURRENT SOURCE CIRCUIT

The current source circuit in Figure 3 has been designed to provide a stable excitation to Pt100.

The values of the voltage reference LM285 and of the resistor R_1 have been chosen to provide a current of 0,96mA ± 0,03mA to the Pt100 sensor. This is to avoid a self-heating process of the resistor-temperature detector. The stability over temperature change of the excitation current is guaranteed by the characteristics of the voltage reference LM285 and of the FET transistor 2N3820.

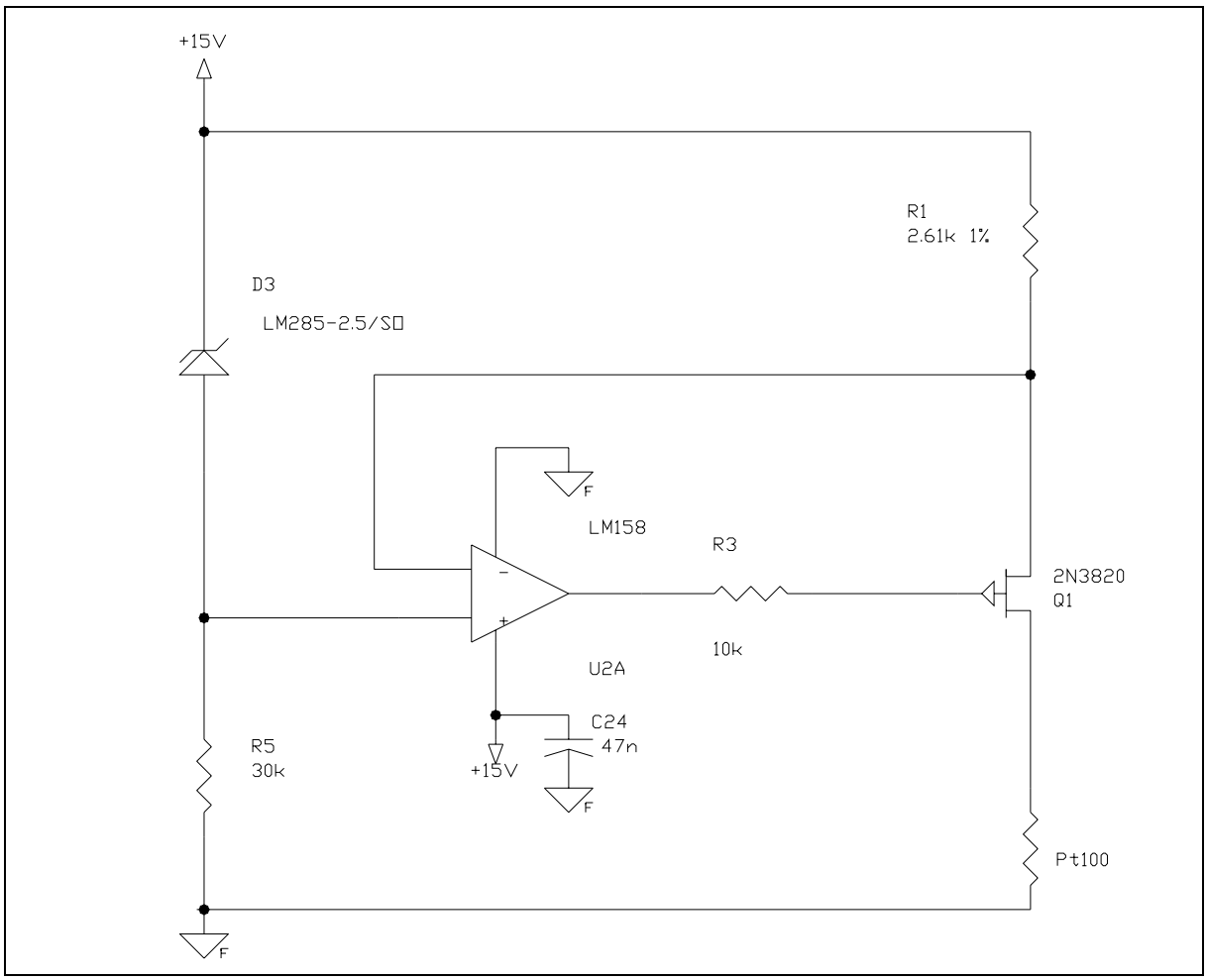


Figure 3 Current Source Circuit

3.5. AMPLIFIER CIRCUIT

The amplifier circuit in Figure 4 has been designed to provide the output -10V…10V over the temperature range of -50°C …+50°C.

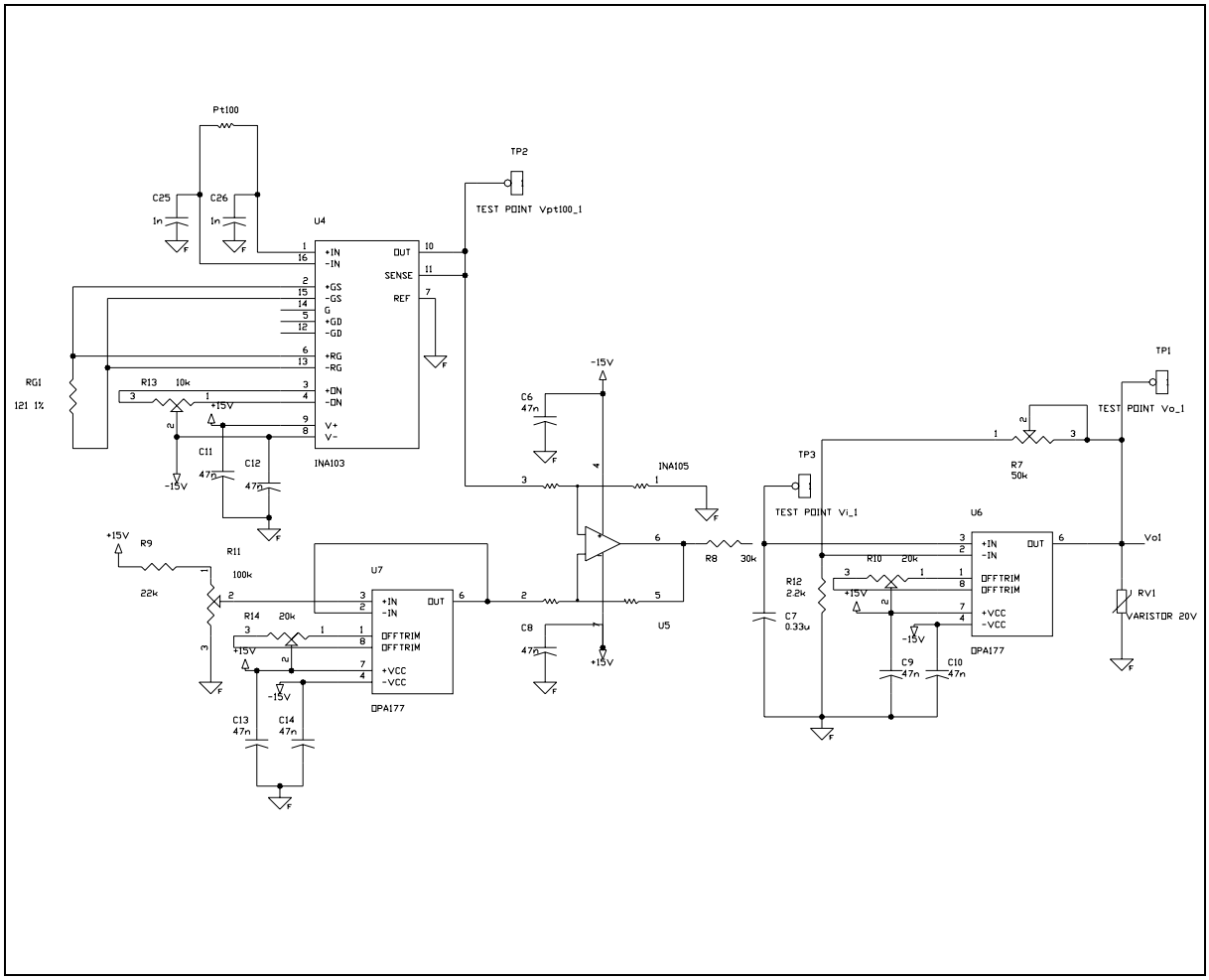


Figure 4 Amplifier circuit

3.5.1. Calibration

This paragraph intend to describe a calibration procedure of the “4-wire Pt100 Amplifier” board. To calibrate the board, the user shall follow the following steps for both channels of the board:

1. Power on the board 5-10 minutes before starting the calibration process.

2. Connect a resistor of 100Ω to one input of the board. Table 1 and Table 2 show that the Amplifier shall provide 0V at the Output.

3. Adjust the reference voltage by means of the related 100kΩ potentiometer (R11, R16) until you get 0V at the V_{i_x} Test Point (see Figure 5).

4. Adjust the offset by means of 20kΩ potentiometer (R10, R18) until you get 0V at V_{o_x}.

5. Disconnect the 100Ω resistor and connect a resistor R_t. The resistance of R_t should be one of the values indicated in Table 1.

6. Adjust the gain of the Output Amplifier OPA177 by means of the 50kΩ potentiometer (R7, R15) in order to have the related voltage shown in Table 2 at Test Point V_{o_x}. The board is now calibrated and ready to use.

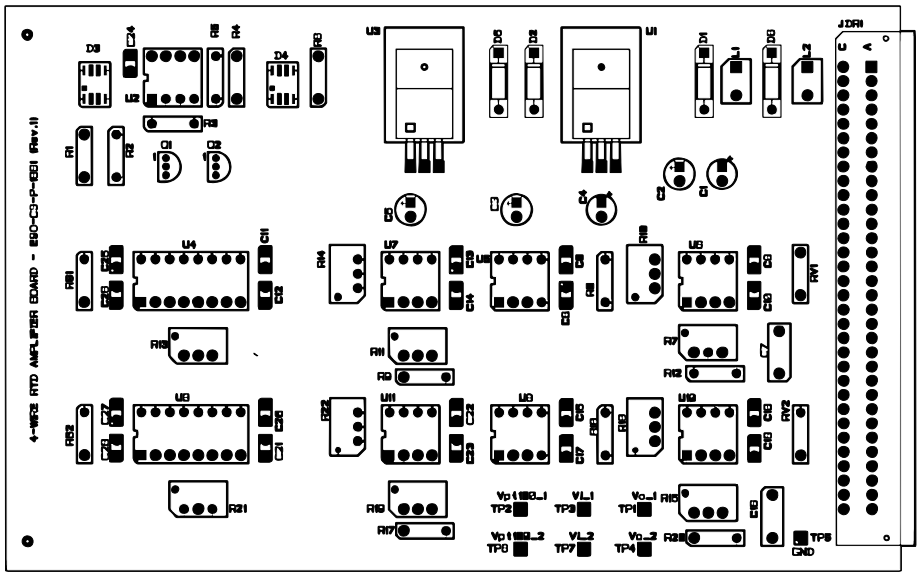


Figure 5 Pcb Components Layout

Table 2 Pt100 Amplifier Output (After Calibration)

T [°C]/Vo [V]	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
-50										-10,149
-40	-9,948	-9,742	-9,536	-9,335	-9,129	-8,923	-8,722	-8,515	-8,314	-8,108
-30	-7,902	-7,701	-7,495	-7,294	-7,088	-6,887	-6,680	-6,479	-6,273	-6,072
-20	-5,866	-5,665	-5,464	-5,258	-5,057	-4,851	-4,649	-4,448	-4,242	-4,041
-10	-3,840	-3,634	-3,433	-3,232	-3,031	-2,825	-2,624	-2,423	-2,222	-2,015
0	-1,814	-1,613	-1,412	-1,211	-1,010	-0,804	-0,603	-0,402	-0,201	0,000
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	0,000	0,201	0,402	0,603	0,804	1,005	1,206	1,407	1,608	1,809
10	2,010	2,211	2,412	2,613	2,814	3,015	3,216	3,418	3,619	3,814
20	4,015	4,216	4,418	4,619	4,820	5,015	5,216	5,418	5,619	5,820
30	6,015	6,216	6,418	6,613	6,814	7,015	7,216	7,412	7,613	7,809
40	8,010	8,211	8,407	8,608	8,804	9,005	9,206	9,402	9,603	9,799
50	10,000									

4. CHARACTERISTICS

4.1. GENERAL CHARACTERISTICS

Manufacturer	:	ESO
Schematic Drawing	:	4-Wire Pt100 Amplifier Schematic
Marking / Print on pcb	:	4-WIRE RTD AMPLIFIER BOARD - ESO-CS-P-1961 (Rev.1)
Application	:	Use in VLTI

4.2. ELECTRICAL CHARACTERISTICS

Positive Supply Voltage	:	Minimum 18 Vdc Nominal 24 Vdc
Positive Supply Voltage	:	Maximum -18 Vdc Nominal -24 Vdc
Power Consumption (Nominal Supply Voltage)	:	< 10W
Output Voltage	:	-14,5Vdc to +14,5Vdc
Output Current	:	≤ 30mA
Excitation Current	:	< 1mA
Number of Channels	:	2
Connection to Pt100	:	4 wires configuration (see schematic)
Kind of connector	:	Female DIN 64 a+c (see schematic for pinout)

4.3. MECHANICAL CHARACTERISTICS

Dimensions of the pcb	:	100 x 160 mm
Kind of pcb fixation	:	pcb mounted in VME rack
Pcb insert force	:	< 50N
Stress to the pcb during assembly	:	< 70N

4.4. STORE AND TRANSPORTATION CHARACTERISTICS

Temperature	:	-50°C to 80°C
Relative humidity	:	20% to 95%

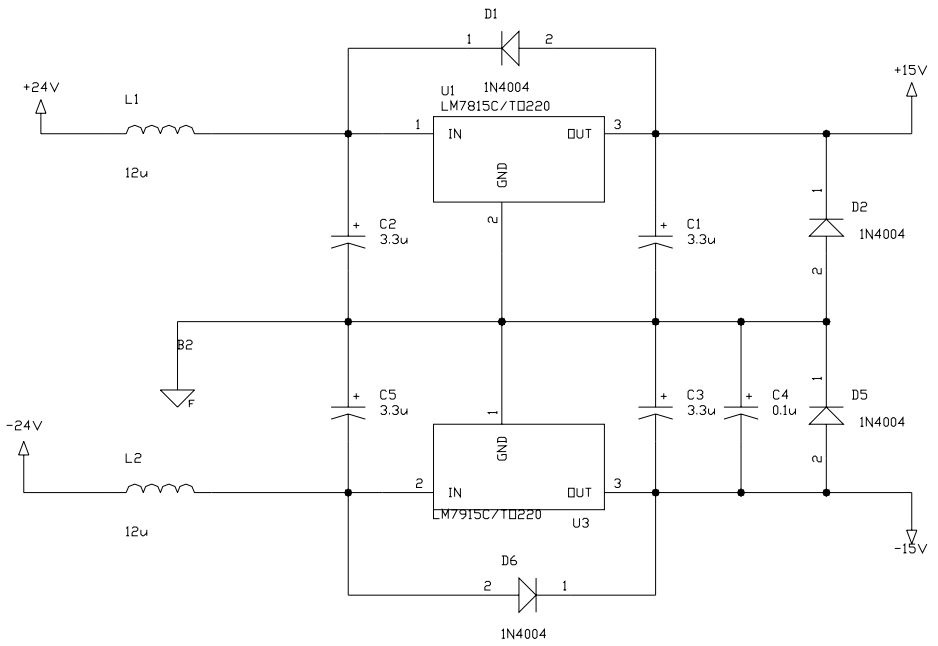
5. APPENDIX I – COMPONENT LIST

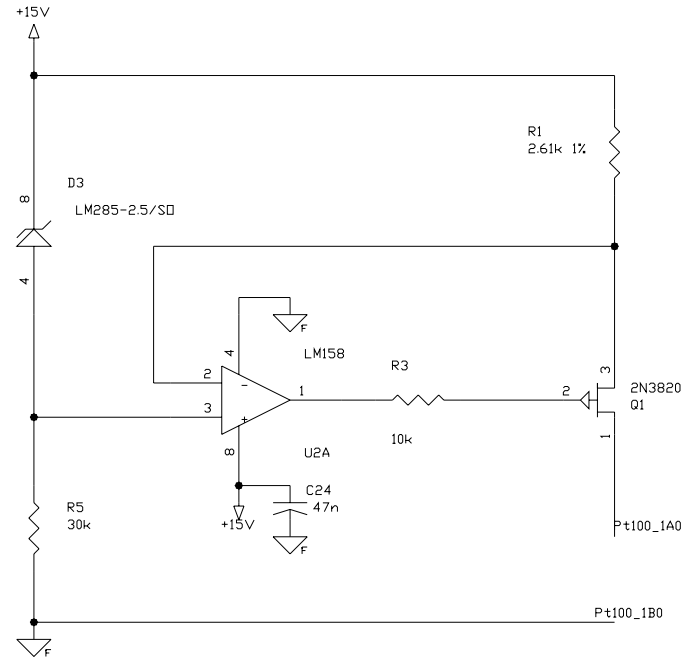
4-wire RTD amplifier Revised: Tuesday, February 11, 2003
CS-P-1961 (Rev.1) Revision: 1.2

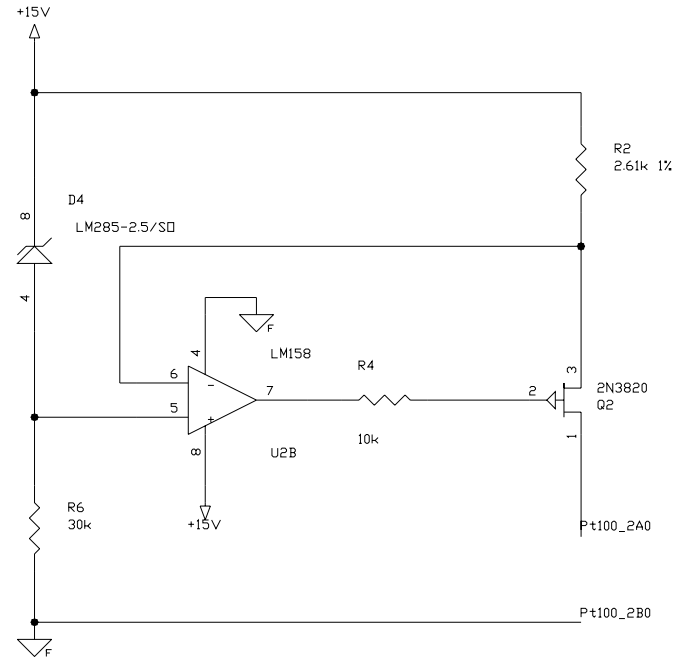
Bill Of Materials February 11,2003 10:47:06 Page1

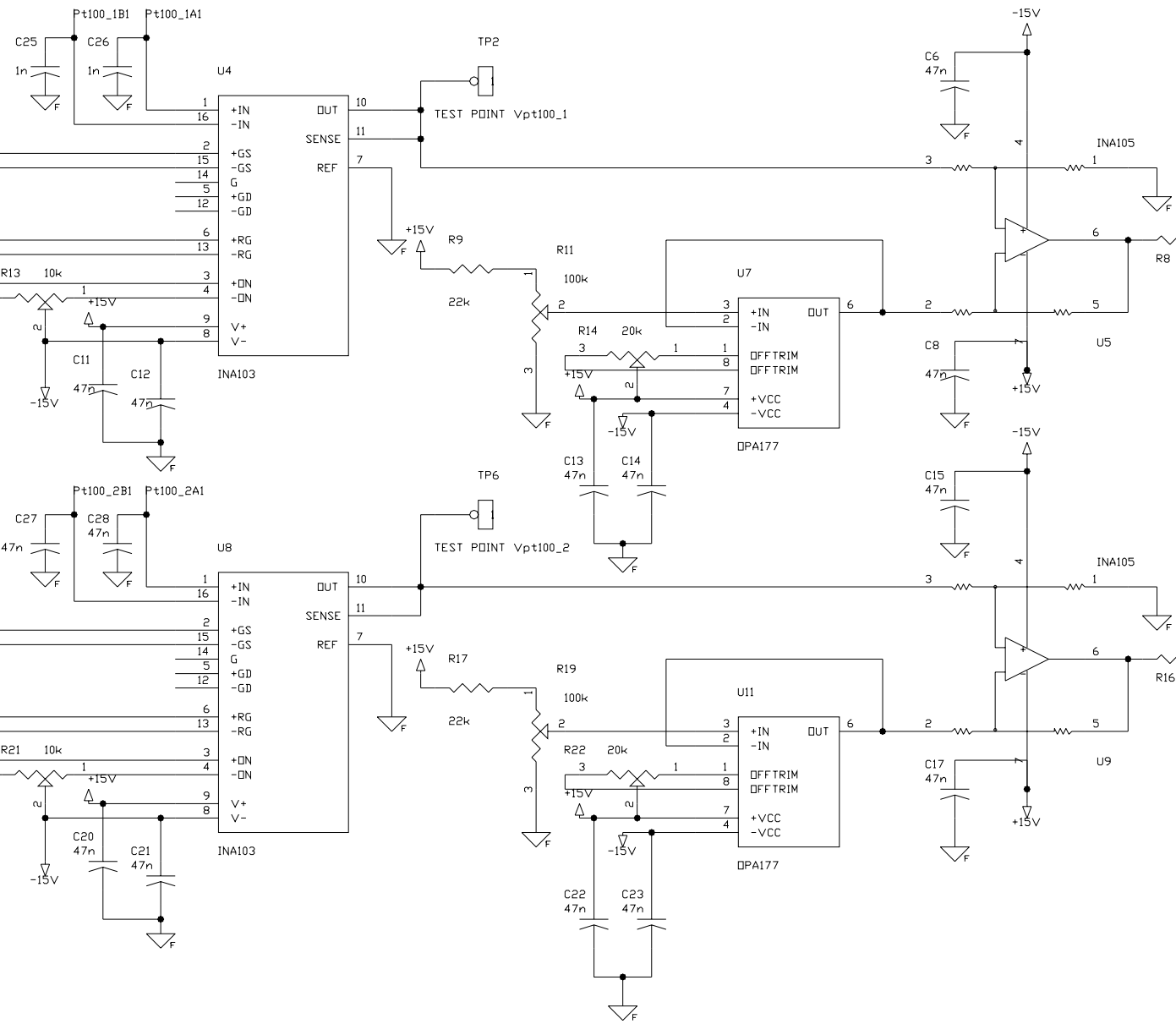
Item	Quantity	Reference	Part
1	4	C1,C2,C3,C5	3.3u
2	1	C4	0.1u
3	19	C6,C8,C9,C10,C11,C12,C13, C14,C15,C17,C18,C19,C20, C21,C22,C23,C24,C27,C28	47n
4	2	C16,C7	0.33u
5	2	C25,C26	1n
6	4	D1,D2,D5,D6	1N4004
7	2	D3,D4	LM285-2.5/SO
8	1	JDR1	DIN64_AC_F
9	2	L1,L2	12u
10	2	Q1,Q2	2N3820
11	2	RG1,RG2	121 1%
12	2	RV1,RV2	VARISTOR 20V
13	2	R2,R1	2.61k 1%
14	4	R3,R4,R13,R21	10k
15	4	R5,R6,R8,R16	30k
16	2	R15,R7	50k
17	2	R17,R9	22k
18	4	R10,R14,R18,R22	20k
19	2	R19,R11	100k
20	2	R12,R20	2.2k
21	1	TP1	TEST POINT Vo_1
22	1	TP2	TEST POINT Vpt100_1
23	1	TP3	TEST POINT Vi_1
24	1	TP4	TEST POINT Vo_2
25	1	TP5	TEST POINT GND

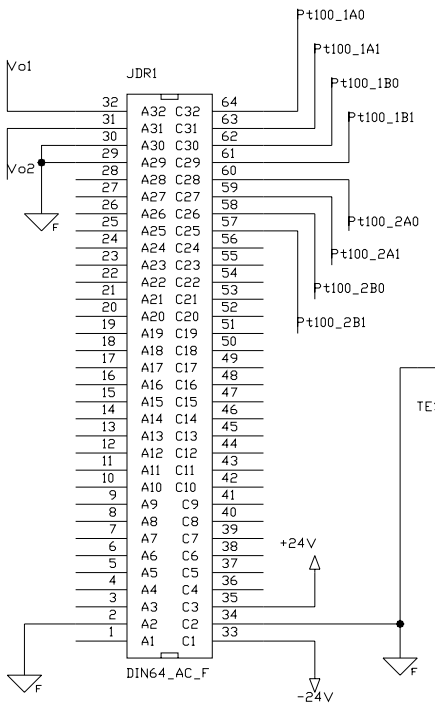
26	1	TP6	TEST POINT Vpt100_2
27	1	TP7	TEST POINT Vi_2
28	1	U1	LM7815C/TO220
29	1	U2	LM158
30	1	U3	LM7915C/TO220
31	2	U8,U4	INA103
32	2	U9,U5	INA105
33	4	U6,U7,U10,U11	OPA177











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Date: Tuesday, February 11, 2003	Sheet 1 of 1	