27/
8-29-77
25 to NTL

UCID-17547

Lawrence Livermore Laboratory

THE EFFECT OF A BRIDGE BALANCE NETWORK
ON A SEMICONDUCTOR PRESSURE TRANSDUCER

W. M. Shay

April 23, 1973

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

LAWRENCE LIVERMORE LABORATORY - UNIVERSITY OF CALIFORNIA		FILE NO.	PAGE
ENGINEERING NOTE		ENS 73-9	1
SUBJECT THE EFFECT OF A BRIDGE BALANCE NETWORK ON A SEMICONDUCTOR		NAME W. M. Shay	
PRESSURE TRANSDUCER		DATE April 23, 1973	

Pressure transducers and accelerometers that make use of semiconductors strain gages or have strain gages diffused on a silicon diaphragm cannot be used with a bridge balance network if one wants to achieve thermal zero compensation. Thermal zero compensation is compensating for the change in output due to temperature only, and is typically $\pm 1.5\%$ of the full scale output for a temperature change of 100°F . The reason for not using a balance network is the way in which the transducer is thermally compensated.

There are two ways to obtain thermal zero compensation with a semiconductor transducer: either match each individual gage to each other, or trim one-half of the bridge to match the other half of the bridge. It is the latter that is easiest to do and the method the manufacturers use.

To match the bridge halves two resistors are added, one in parallel, and one in series (R_p and R_s) to one-half of bridge (Figure 1) to match the other half. The values of the resistors depend on the individual transducer, but typically R_p is $50,000\Omega$ and R_s is 10Ω . The resistors used are temperature insensitive therefore they can be located either internal or external of the transducer, depending on the users requirement. The two resistors are called a temperature compensation module.

If the transducer is subjected to a temperature change with no applied pressure and the bridge output monitored, one finds the output due to temperature is low: approximately 2 to 3 millivolts, depending on the full scale output.

But if the transducer is connected to a bridge balance network and the bridge output again monitored, the output can be many millivolts, as

NOTICE
This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research and Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

LAWRENCE LIVERMORE LABORATORY - UNIVERSITY OF CALIFORNIA		FILE NO.	PAGE
ENGINEERING NOTE		ENS 73-9	2
SUBJECT		NAME	
THE EFFECT OF A BRIDGE BALANCE NETWORK ON A SEMICONDUCTOR		W. M. Shay	
PRESSURE TRANSDUCER		DATE	
		April 23, 1973	

the balancing network is effectively shunting the compensation module and thereby overcompensating the bridge (Figure 2). The amount of overcompensation is a function of the value of the balance potentiometer.

To demonstrate the effect of the bridge balance network, three pressure transducers of different pressure ranges were subjected to a change in temperature of approximately 100°F above ambient with and without the balance potentiometer in the circuit.

Each transducer was mounted on an aluminum block with a 0.0005 inch thermocouple between the transducer and block. Each transducer was allowed a minimum of thirty minutes warm up time. Excitation voltage was as recommended by the manufacturer. The transducer output was plotted versus temperature with X-Y recorder. From the six plots, Figure 3 through Figure 8, the effect of the use of the balance potentiometer can easily be seen. Although the transducer in Figure 3 is out of the manufacturers specification to begin with, the effect of bridge balance is still apparent.

Even though the zero temperature compensation claimed by the manufacturer is not met when the balance potentiometer is used, the transducer can still be used to obtain data. Since 99% of the transducer signal conditioners at the Laboratory use a bridge balance potentiometer, one should use caution if a semiconductor transducer, elevated temperature, and a bridge balance potentiometer are used together. If in doubt a test in the laboratory can determine the error of using the transducer with a bridge balance network.

The author wishes to express his appreciation to the author for help in conducting this test.

SEMICONDUCTOR TRANSDUCER WITH COMPENSATION NETWORK

FIGURE 1

SEMICONDUCTOR TRANSDUCER WITH BRIDGE BALANCE NETWORK

FIGURE 2

TRANSDUCER OUTPUT vs TEMPERATURE

No BRIDGE BALANCE

TRANSDUCER OUTPUT ~ MILLIVOLTS

15.0

10.0

5.0

0

-5.0

$E_0 = +8.70 \text{ MV}$
(START)

$E_0 = -14.40 \text{ MV}$
(END)

$\pm 1.5\%$

MANUFACTURE SPEC.

REMAINED AT THIS TEMP.
3 HRS.

ENTRAN PRESSURE TRANSDUCER
MODEL NO. EPF-200-25, S/N 18G2-134-A2
EXCITATION - 6.00 VDC, 202.5 MV FULL SCALE
TEMPERATURE COMPENSATION MODULE OUT OF OVEN

70°F

80°F

100°F

150°F

180°F

190°F

0

1.0

2.0

3.0

THERMOCOUPLE OUTPUT ~ MILLIVOLTS

4.0

5.0

6.0

CH/CON TC

FIGURE 3

TRANSDUCER OUTPUT vs TEMPERATURE

WITH BRIDGE BALANCE

ENTRAN PRESSURE TRANSDUCER
 MODEL NO. EPF-200-25, S/N 1862-134-A2
 EXCITATION - 6.00 VDC, 202.5 MV. FULL SCALE
 TEMPERATURE COMPENSATION OUT OF OVEN
 MODULE

FIGURE 4

TRANSDUCER OUTPUT vs TEMPERATURE

WITH BRIDGE BALANCE

ENTRAN PRESSURE TRANSDUCER
 MODEL NO. EPF-200-50, s/n 25A3-213-1
 EXCITATION - 6.00 VDC, 136 MV. FULL SCALE
 TEMPERATURE COMPENSATION MODULE OUT OF GUN

TRANSDUCER OUTPUT ~ MILLIVOLTS

$\pm 1.5\%$

MANUFACTURE SPEC.

REMAINED AT THIS TEMP.
 3 HRS.

70°F

80°F

100°F

160°F

180°F

190°F

THERMOCOUPLE OUTPUT ~ MILLIVOLTS

CH/CON TC

FIGURE 6

TRANSDUCER OUTPUT vs TEMPERATURE

NO BRIDGE BALANCE

ENTRAN PRESSURE TRANSDUCER
MODEL NO. EPFH-2001-5000, S/N 28K2-172-2
EXCITATION - 6.00 VDC, 166.6 MV FULL SCALE
TEMPERATURE COMPENSATION MODULE IN OVEN

FIGURE 7

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research & Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately-owned rights.

NOTICE

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Energy Research & Development Administration to the exclusion of others that may be suitable.

Printed in the United States of America

Available from

National Technical Information Service

U.S. Department of Commerce

5285 Port Royal Road

Springfield, VA 22161

Price: Printed Copy \$; Microfiche \$3.00

Page Range	Domestic Price	Page Range	Domestic Price
001-025	\$ 3.50	326-350	10.00
026-050	4.00	351-375	10.50
051-075	4.50	376-400	10.75
076-100	5.00	401-425	11.00
101-125	5.50	426-450	11.75
126-150	6.00	451-475	12.00
151-175	6.75	476-500	12.50
176-200	7.50	501-525	12.75
201-225	7.75	526-550	13.00
226-250	8.00	551-575	13.50
251-275	9.00	576-600	13.75
276-300	9.25	601-up	*
301-325	9.75		

*Add \$2.50 for each additional 100 page increment from 601 to 1,000 pages; add \$4.50 for each additional 100 page increment over 1,000 pages.

Technical Information Department

LAWRENCE LIVERMORE LABORATORY

University of California | Livermore, California | 94550