Route

INDUSTRIAL
AUTOMATION

Route

2700 SERIES TRANSMITTER/INDICATOR

# OPERATIONS MANUAL

(Distributer)

*Loadcell Systems (Pty) Ltd*

Trading As

*Route Industrial Automation*

1 DESCRIPTION.....3
2 SETTING UP.....3
2.1 Initial Start Up.....3
2.2 Excitation Supply.....3
2.3 Preamplifier.....4
3 CALIBRATION.....5
3.1 Procedure.....5
3.2 Zero Adjustment.....5
3.3 Gain Adjustment.....5
3.4 Display Adjustment LCD / LED.....6
3.5 Analog Output Adjustment.....7
3.6 Setpoint or Alarm Outputs.....7
3.7 Alternative Calibration Methods.....8
3.7.1 Simulation.....8
3.7.2 Without Known Masses.....8
Minimum Weights / Loadcell Signal.....8
4 TECHNICAL DESCRIPTION.....10
4.1 Power Requirements.....10
4.2 Supply to Loadcells.....10
4.3 Input Signals.....10
4.4 Voltage Output.....10
4.5 Current Output.....10
4.6 LED / LCD Display.....11
4.7 Alarm or Setpoint Relays.....11
4.8 BCD Output.....11
4.9 Zero Stability.....11
4.10 Span Stability.....11
4.11 Ambient Temperature Range.....11
4.12 Enclosure.....11
4.13 Protection Class.....11
5 FUNCTIONAL DESCRIPTION.....12
5.1 General Notes on Loadcell Applications.....13
5.2 Circuit Description.....13
6 SCHEMATICS.....14

## 1. DESCRIPTION

The ROUTE Model 2700 is a low cost, high accuracy loadcell Indicator/Transmitter especially suitable for field mounted applications (IP 65 enclosure).

The unit has a four and a half digit LED or LCD display and offers retransmission signals of 0-10 V and 4-20 mA as standard. Additionally, the Model 2700 can be equipped with four relay setpoints (additional plug in card) and a parallel BCD output fitted to the display board.

The Model 2700 is self-contained requiring either 110V or 220V ac supply. It provides a regulated (and adjustable) 10 V dc excitation for up to four loadcells.

## 2. SETTING UP

### 2.1 Initial Start up

Before power is connected to the instrument, a visual check should be performed:

Check if the correct fuse (500mA) is inserted.
Check if the correct supply voltage is selected as per the jumper links:
JP4 jumper on the middle two pins. (220 Volts),
JP4 jumper on the pin 1 & 2 and 3 & 4. (110 Volts),
JP5 Excitation jumper on the first two pins.
JP6 & JP7 jumper must be in place.

Check if the connection from the main board to the display board is present (ribbon cable).
Check the wiring carefully (avoid loose connections).
If a 4-wire loadcell cable is used, check that terminals 6-7 and 8-9 are jumpered.

Initial measurement:

Connect a loadcell (or loadcells) and then:

* Apply power
* Verify d.c. supply voltage
* Verify reference voltage
  (+15 V dc ± 0,1 V measured between TP1 and TP2
  (-15 V dc ± 0,1 V measured between TP3 and TP2

## 2.2 Excitation Supply

Adjust Potentiometer VRI to obtain an excitation voltage of 10 Volt dc, measured between terminals 6 and 8. The excitation voltage can also be measured between TP4 (-10 Volts) and ground (TP2)

## 2.3 PreAmplifier

The input signal to the amplifier can be measured between terminals 10 (+) and 11 (-). For proper functioning of the instrument the following input signals should not be exceeded:

| | |
|---|---|
| Live signal (full scale) | minimum 3,3mV<br>maximum 30mV |
| Tare signal | minimum 0mV<br>maximum 14mV |
| Gross signal (full scale) | minimum 3,3mV<br>maximum 30mV |

The amplified signal (gain of 330) is measured between TP5 and TP2

The gain of the preamplifier is determined by the ratio of R9:R8 and R11:R10 respectively. The standard values are: R8 = R10 = 1K, R9 = R11 = 330K

Should it be necessary to further increase the gain of the instrument, the values of R11 & R9 can be increased of the values of R11 = R9 and R8 = R10.

## 3 CALIBRATION

### 3.1 Procedure

Calibration of the ROUTE 2700 is to be done in the following sequence:

1. Zero adjustment
2. Gain adjustment
3. Display adjustment.

### 3.2 Zero Adjustment

After installation of the loadcells and initial setup (paragraph 2) the tare mass that needs to be zeroed is done as follows:

1. Adjust the coarse zero (rotary switch) SW1 until the display is closest to zero (hopper empty).
2. Adjust the fine pot VR2 until exactly zero is displayed.
3. Measure the voltage between TP6 and TP2 ( it should be 0,00 V).

### 3.3 Gain Adjustment

Load (or simulate) at least 50% of full capacity onto the weigh element and adjust the gain as follows (NB: Ignore the digital display at this stage):

1. Measure the voltage between TP6 and TP2 (0-10 V);
2. Calculate what portion of full capacity is applied (if full capacity is 10 t and only 5 t is applied, then adjustment is 50% of 10 V);
3. Turn rotary switch SW2 until closest reading to value determined in 2. is achieved (e,g, 5 V);
4. Fine tune to exact value with potentiometer VR3.

## 3.4 Display Adjustment LCD

With the calibration mass still loaded as described in the previous paragraph, follow the steps below to adjust the display:

1. Decide what engineering units, resolution and decimal point position is required;

2. Select the decimal position with SW2-3,4,5 or 6 on the display board;

3. Adjust rotary switch "Coarse Span" SW1 until the display is closest to the required value. Adjust span fine adjustment VR1. Span can be multiplied or divided by switching SW2 1 (UP divide DOWN multiplied).

4. Blank the last digit with SW2-2 if necessary;

Note: Under normal circumstances, do not exceed the resolution of the loadcells.

Display Adjustment LED

With the calibration mass still loaded as described in the previous paragraph, follow the steps below to adjust the display:

1. Decide what engineering units, resolution and decimal point position is required;

2. Select the decimal position with SW1-3,4,5 or 6 on the display board;

3. Adjust rotary switch "Coarse Span" CODESW until the display is closest to the required value. Adjust span fine adjustment VR1. Span can be multiplied or divided by switching SW1 1 (UP divide DOWN multiplied).

4. Blank the last digit with SW1-2 if necessary;

Note: Under normal circumstances, do not exceed the resolution of the loadcells.

## 3.5 Analog Output Adjustment

The current (4-20 mA) and/or voltage (0-10 V) outputs can now be fine tuned by connecting a multimeter in series to terminals 14 and 15 for current, or in parallel to 12 and 13 for voltage.

Adjust potentiometer VR4 for 4 mA (current) or 0,0 V.

Adjust potentiometer VR5 for 20 mA (current) or 10,0 V or a calculated portion as required.

JP8 jumper in = 4 - 20 mA output.
JP8 jumper out = 0 - 20 mA output.

## 3.6 Setpoint or Alarm Outputs - Relay Board

In order to adjust the high or low levels of the four contact outputs, VR1, VR2, VR3, and VR4 must be adjusted.

The voltage of 0 to +10 Volts (TP6 to Tp2) resembles zero to full load and the switching levels of the contact outputs are set within this range, but with negative polarity.

E.g. If a high alarm is to be set at 75% of full load then the setpoint voltage measured on test points TP1, TP2, TP3 or TP4 for relays 1 to 4 respectfully are measured and set to 75% of -10,0 Volts = -7,5 V.

The same applies for a low alarm. An alarm level to be set at 25% of full load is set to -2,5 V.

Adjust JP6, JP7, JP8, and JP9 for normally on or normally off.

| | | |
|---|---|---|
| Relay 1 | : | J6 |
| Relay 2 | : | J7 |
| Relay 3 | : | J8 |
| Relay 4 | : | J9 |

Note: One jumper position must always be selected namely high or low level other wise the relays cannot be activated.

## 3.7 Alternative Calibration Methods

### 3.7.1 Simulation

By simulating an input signal to the amplifier, zero and span adjustments can be done without using a live mass.

Loadcell simulators are available for this purpose, but few of them offer an adjustable impedance. The total resistance of the simulator should be the same as the total resistance of the loadcells in use (e.g. 3 x 350ohm loadcells = 116,7 ohms).

If a 350 ohm simulator is used, it can be connected in place of one of the loadcells with the other loadcells signal connections disconnected. This however only offers a 30% span adjustment (for a 3-loadcell system) as the signals are parallelled.

### 3.7.2 Without Known Masses

Calibrating a weighing system with known masses is the most accurate method to use. The system can be checked for repeatability and linearity to within the accuracy of the loadcells in use.

However, it is not always possible to handle 200, 50 or even 10 tons of test weights! Two procedures can be followed to calibrate such systems:

1. Using Minimum Test Weights:

   E.g. Use 1 ton test weights and calibrate the system. Remove, fill with material to 1 ton and replace the 1 ton test weights again. Calibrate for 2 tons. Repeat until 50% of maximum capacity is calibrated.

   This procedure is tedious and might be impractical for large hoppers.

2. Utilising the Loadcell Signal and Tare mass.

   Loadcells are linear transducers and their signals can be used to calibrate a system within reasonable accuracy.

Follow the steps below:

a. Measure the excitation signal closest to the load-cells (i.e. at the field junction box). Record "EXC V"

b. With the weigh element empty, first disconnect the loadcell signal cables from terminals 10 and 11 Measure (0-20 mV) and record "EMPTY mV".

c. Connect the signal cables. Now short wires and and zero system. Disconnected short and the display will display the hopper's empty mass. Set the display to read the calculated mass at the measured mV.
Re-zero the system (display) via SW1 and VR2 on bottom board.

d. Use the following formula to calculate the nett mass:

$$\frac{\text{FULL mV} - \text{EMPTY mV}}{\text{EXC V} \times \text{SENSITIVITY}} \times \text{TOTAL LOADCELL CAPACITY}$$

$$= \text{NETT MASS}$$

Where: "TOTAL LOADCELL CAPACITY" = Sum of the load cells in use (e.g. 3 x 10t=30t)
"SENSITIVITY" = Rated loadcell sensitivity or output (e.g. 2 mV/V)

e. Connect the signal cables and adjust the gain and display as described earlier.

f. Reset display to previous reading before gain was adjusted.

# TECHNICAL MANUAL

## 4. Specification

### 4.1 Power Requirement

- Supply voltage : 230V ± 10% / 110V ± 10%
- Power requirement : Approximately 16VA

### 4.2 Supply to Load Cells

- Excitation voltage : 10V (adjustable) +- 1,0%
- Load on excitation supply : 4 x 350 ohm cells in parallel<br>6 x 350 ohm on special request
- Short circuit protection : Current limit at approximately 180mA

### 4.3 Input Signals

- Live signal (range) : Min. 0 to 3,3mV<br>max. 0 to 30mV
- Tare signal : Min. 0mV, max 14mV
- Gross signal : Min. 3,3mV, max. 30mV

### 4.4 Voltage Output

- Range : 0 to 10V
- Maximum current : 10 mA

### 4.5 Current Output

- Range : 4 to 20mA<br>0 to 20 mA (modification to standard circuit required -
- Max. loop Res. : 1000 ohm

4.6 LED Display

- Readout : 4½ digit (last digit blanking option)
- Independent span adjustment
- Character height : 15mm
- Decimal point : Switch selectable pos.

4.7 Alarm or Setpoint Relays (Optional)

Four independent adjustable setpoint relays

- potential free contacts : 220V AC 2A

4.8 BCD Output

- 4½ digit parallel BCD code.
- Run/hold mode facility.

4.9 Zero Stability

- ± 0,05% / 10°C. max. to full scale.

4.10 Span Stability

- ± 0,05% / 10°C. max. (input 20mV)

4.11 Ambient Temperature Range

- 10°C to 50°C.

4.12 Enclosure

- Alucast
- 260mm x 160mm x 90mm.

4.13 Protection Class

- IP55.

# 5. Functional Description

## 5.1 General Notes on Load Cell Applications

A load cell is a force transducer, converting a mechanical force into an electrical signal. The conversion is achieved by means of strain sensing film resistors, which, configured in a bridge arrangement, are bonded to the load cell material (steel or aluminium). A highly constant voltage is applied to this 'bridge' circuit for the purpose of excitation. If a mechanical force is applied to the cell, the strain in the metal is sensed by the film resistors, and the bridge becomes unbalanced. This results in the generation of a small voltage signal (0 to 20mV) on the output of the load cell. The output signal is directly proportional to the applied force, which makes accurate weight measurements possible. This instrument provides the excitation supply and amplifies the signal from the load cells to give the following output signals:

1. 0 to 10 volts.
2. 4 to 20mA.
3. 4½ digit readout.

As an option, high and low alarm or setpoint relays can be provided.

## 5.2 Circuit Description

### a) Supply

The instrument is designed to operate directly from mains (220 or 110 volts selected by solder links). Two on board regulators, IC9 and IC10, provide a supply of + 15 volts. To verify the supply voltage the following test points are provided:

| | |
|---|---|
| TP2 | : Gnd |
| TP1 | : + 15 V |
| TP3 | : - 15 V |

### b) Reference

In order to supply the load cells with a stable supply voltage of 10 V, an ultra stable temperature controlled reference IC with an output of +10 +-0.2V is used. ( This voltage can be verified on TP4 against ground (TP2).

### c) Excitation Supply

This section of the circuit supplies the load cells with the necessary excitation, output terminal 6 (EX+) and 8 (EX-). The voltage can be adjusted with Potentiometer VR1 and observed at TP5 against ground. The supply is designed to feed up to four load cells (350 ohms in parallel). To prevent damage to the instrument by accidental short circuit on the output terminals, the circuit is equipped with a current limiting facility.
(setting : Approximately 180mA)

Note: The circuit allows for remote sensing of the excitation supply. If this facility is not used (four wire connection), terminals 6 and 7 as well as terminals 8 and 9 have to be shorted.

d) Preamplifier

The signal from the load cell is led to the input terminals numbers 10 and 11. A high stability instrumentation amplifier is used to amplify the signal by a gain of 330. The pre amplified signal can be observed between TP5 and ground. (TP2)

e) Zero (Tare) and Span Adjustment

Zero or Tare

The tare or zero setting is achieved by means of rotary switch SW1 for coarse and Potentiometer VR2 for fine adjustments. The gain setting is achieved by means of rotary switch SW2 for coarse and Potentiometer VR3 for fine adjustments.
Gain adjustment factor: 0 to 9,24.
NOTE: The display is set independently of the gain adjustment.

f) Current Output / Voltage Output

The on board 'voltage to current convertor' converts the 10 volts to a 4 to 20mA output signal through output terminals 14 and 15, adjustment 4 mA VR4 and 20 mA VR5.
Voltage output is measured on terminals 12 and 13, adjustments as per current setting.

Note: Conversion to 0 to 20mA
This conversion can be achieved by means of a simple modification to the standard circuit, as shown below:

1. Remove R45 on the base board.
2. Change R48 from 3K9 to 4K7.

Scaling:
As the 0 to 20mA signal does not reach right down to 0,0mA, but only to 0,2mA, the scaling can be performed as follows:

| Voltage on TP6 | Current Output |
|---|---|
| 0,25V | 0,5mA |
| 10,00V | 20,00mA |

g) Alarm or Setpoint Relays (Optional)

This option provides the user with up to four setpoint relays and hence four sets of potential free contacts. The switching level for each relay can be individually set by multi-turn potentiometers.

| Relay | Potentiometer | Test Point |
|---|---|---|
| Relay 1 | P7 | TP9 |
| Relay 2 | P8 | TP10 |
| Relay 3 | P9 | TP11 |
| Relay 4 | P10 | TP12 |

Each switching level can be adjusted over the full range of the 0 to 10V output signal, as observed on T.P.8 of the instrument.

In order to allow remote adjustment of the switching levels, terminals 20 and 21 is the 0 - 10V to a remote potentiometer where terminals 16, 17, 18 and 19 are the inputs to the relays 1 to 4 respectfully.

The repeatability of the switching level is very high, in order to permit the use of the instrument for applications such as batching systems, etc.

h) Filter

An adjustable filter provides the possibility to filter out low frequency vibrations.

Jumper JP2 increases damping. Must be in.
Jumper JP3 increases damping. Must be in.
Maximum filter effect. ( $\tau$ = .33s)

i) Display

The upper board of the instrument provides a 4½ digit LED or LCD display. The readout can be adjusted without interference with the operation of the 0 - 10V, 4 to 20mA output signals. The following switches and potentiometers are used:

| | | |
|---|---|---|
| Span adjustment : | Coarse: | Code switch and SW1(1) |
| | Fine : | VR1 |
| Decimal point selection: | | SW1 (3, 4, 5 and 6) |
| Last digit blanking : | | SW1(2) |

j) Parallel BCD Output

The display board optionally offers a 4 1/2 Digit parallel BCD output facility. In order to read the BCD output without update interference, the A.D. convertor can be halted by applying a 24V signal on the run/hold input, pin 15 of the 'D' type connector.

Signals provided:

| Digit | BCD Position | Connector Pin |
|---|---|---|
| D5 (MSD) | 1 | 11 |
| D4 | 8 | 3 |
| D4 | 4 | 7 |
| D4 | 2 | 8 |
| D4 | 1 | 9 |
| D3 | 8 | 10 |
| D3 | 4 | 6 |
| D3 | 2 | 5 |
| D3 | 1 | 4 |
| D2 | 8 | 16 |
| D2 | 4 | 17 |
| D2 | 2 | 18 |
| D2 | 1 | 19 |
| D1 (LSD) | 8 | 23 |
| D1 | 4 | 22 |
| D1 | 2 | 21 |
| D1 | 1 | 20 |
| OR (over range) | | 13 |
| POL(polarity) | | 12 |
| +24V | | 2 |
| Gnd | | 1 |

All the signals are provided as open collector outputs. Each output is current limited by a 1K5 resistor.

ROUTE 2700 SCHEMATIC