INDU
VERTICAL SPEED INDICATOR
Manual

Kanardia d.o.o.

February 2020

Revision 1.1

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A lot of useful and recent information can be also found on the Internet. See `http://www.kanardia.eu` for more details.

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Revision History

The following table shows the revision history of this document.

Rev.	Date	Description
1.0	Oct 2015	Initial release
1.1	Feb 2020	Revision - more details added.

Contents

1 Introduction

First of all, we would like to thank you for purchasing our device. Indu Vertical Speed Indicator is an electronic device, which mimics classical variometer construction and combines it with the state of the art electronics. This results in the best of both worlds; a perfect and intuitive analogue reading combined with high precision of modern electronics.

This manual describes the technical description of the unit, installation and operation.

CAUTION: Indu Vertical Speed Indicator is not TSO approved as a flight instrument.

1.1 General Description

Indu Vertical Speed Indicator is an electromechanical device. It consist of high precision electronic barometric sensor, which provides static pressure information in digital form. The electronics reads the pressure sensor and numerically calculates the altitude change. The result drives stepper motor turning a needle. The calculated rate of change is also shown on a colour LCD display. When connected to a CAN bus Indu Vertical Speed Indicator outputs the vertical speed information. Analog scale is divided lineary with a zero speed on the left side. An optional dim knob can be connected to the device and it is used to adjust the brightness of the screen.

1.2 Technical Specification

Table 1 shows some basic technical specification of Indu Vertical Speed Indicator.

Description	Value
Weight	57 mm: 160 g
	80 mm: 210 g
Size	57 mm: 62 x 62 x 45 mm
	80 mm: 82 x 82 x 45 mm
Altitude range	-500 to 15000 m, (-1500 to 45000 ft)
Operational voltage	6 $\sim$ 32 V
Power consumption	1.26 W
Current	105 mA at 12 V 53 mA at 24 V
Operating temperature	-30 $\sim$ +85 °C
Humidity	30 $\sim$ 90 %, non condensing
Barometric sensor	24 bit, 10 $\sim$ 1200 hPa, 20 cm resolution
Communication	CAN bus, 29 bit header, 500 kbit, Kanardia protocol

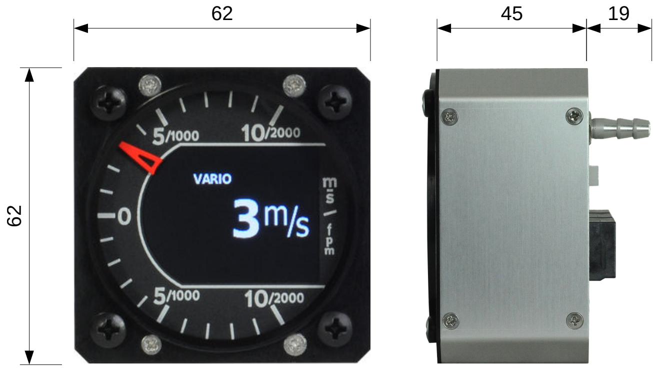
Table 1: Basic technical specifications.

1.3 Options

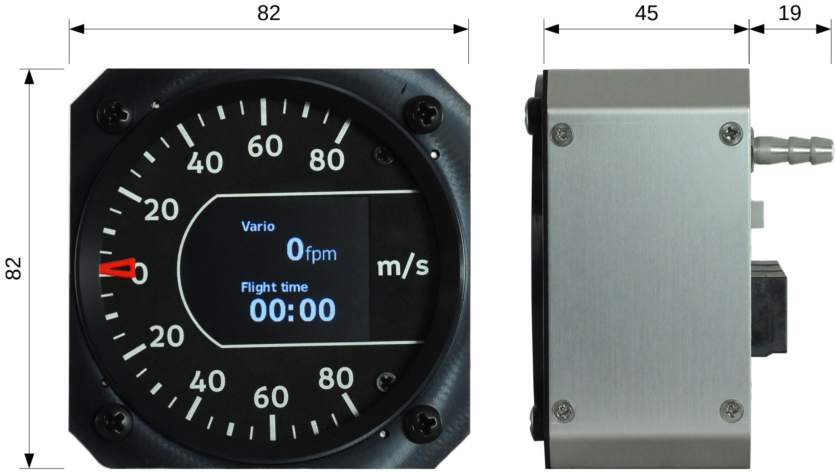
Indu Vertical Speed Indicator is available in two different sizes, different scale units and different scale ranges. The scale units and range must be specified at the time of order.

The instrument is available in meters per second and feet per minute units. The standard range is ±10 m/s or ±2000 fpm.

Different units and range is also possible with additional charges.



(a) 57 mm



(b) 80 mm

Figure 1: Front and side view of the Indu Vertical Speed Indicator with its principal dimensions.

1.3.1 Display

Standard LCD display layout displays two values: Vario on top of the screen and flight time on the bottom.

If you want a different LCD display layout, you can configure it yourself with our Customizer desktop application. This option requires Kanardia's Blu device for transfering the configuration from your android device to your Indu Vertical Speed Indicator. Please read our *Customizer Manual* for more information.

2 Installation

Indu Vertical Speed Indicator requires a standard size 80/57 mm hole in the instrument panel. The position of the hole must ensure visibility from the pilot's perspective.

2.1 Mounting Dimensions

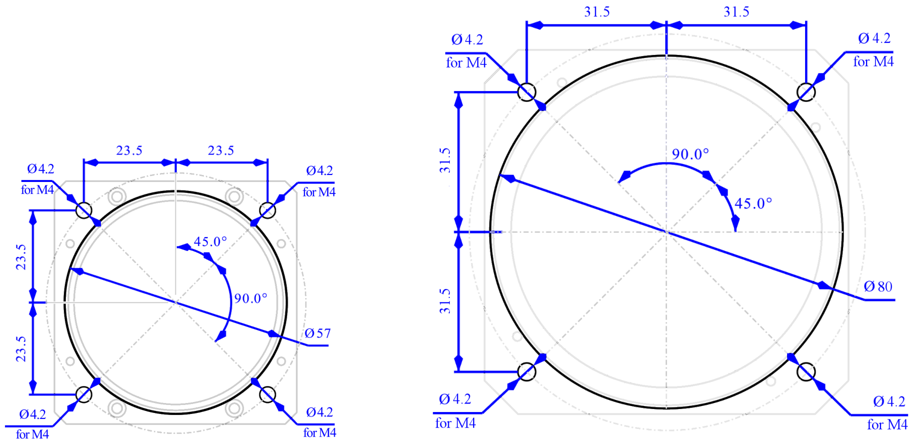
The mounting screw holes are located on a circle of 89/66.5 mm diameter. The instrument is mounted using four screws type M4. To prevent internal stresses, please make sure that the instrument panel is flat. It is highly recommended that the instrument panel is mounted using rubber shocks, which reduce the vibrations. Figure 2 illustrates the panel cutout and mounting holes.

2.2 Connections

Figure 3 illustrates all connections at the back side of the instrument.

2.2.1 Static Pressure - `Pst`

Indu Vertical Speed Indicator must be connected to the static pressure source. Static pressure source is usually obtained from pressure sources located on the fuselage side surfaces or from the static port on the pitot tube.



(a) 57 mm (b) 80 mm

Figure 2: Instrument panel cutout and mounting hole. Note: Figures are not in scale.

Locate the existing tube, cut it at an appropriate place and insert a T junction. Install a new tube from junction to the instrument.

It is highly recommended to keep the static tubing as short as possible. The tubing must avoid sharp bends and twists. The tubing must be airtight. Water must not be allowed to enter the tubing.

It is strongly recommended to label each tube before connecting to Indu Vertical Speed Indicator. This will help a lot if you ever have to remove and re-install the instrument.

2.2.2 CAN Bus - `CAN`

Connection to the CAN bus is optional and is not required for the normal operation.

Use standard RJ45 ethernet cable to connect it with other Kanardia equipment.

Figure 3: Back view of the 80 mm instrument with connections.

When connected to the bus, vaiometer will transmit vertical speed to other units connected on the bus.

2.2.3 Illumination

LCD display brightness level can be adjusted. Here are two options: new instruments have a push-rotate knob, while older instruments have only rotating knob. When Indu Vertical Speed Indicator is connected to the CAN bus, the knob adjusts brightness of all instruments connected to the bus.

On instruments with a push knob, simply push the knob, adjust the brightness and push the knob once more.

For instruments with only rotation knob, an optional external illumination knob can be connected to the back of the instrument. Illumination knob part number is I-ALT-ILLUM and it must be ordered separately. Please refer also to section **??** on page **??** for the activation procedure.

2.2.4 Power - `POWER`

Connect supplied connector at the back of Indu Vertical Speed Indicator. The connector has a notch on one side, which protects from wrong orientation.

Connect blue lead to negative (ground) terminal and red lead to positive (+12-24 V) terminal.

3 Maintenance & Repair

No special maintenance is required.

The instrument has no serviceable parts inside. In the case of malfunction, it must be sent to factory for a repair.

4 Sensor Calibration & Altitude Calculation

4.1 Calibration Procedure

Each unit is factory calibrated against reference barometer at different pressure points. In standard calibration range we calibrate in following pressure sequence: 1100, 1000, 900, 800, 700, 600, 500, 400, 280, 550, 650, 750, 850, 950 and 1050 hPa. These measurements are then repeated at different temperatures ranging from -10 to 60 °C in 7 °C steps.

Please note that FAA Part 43, Appendix E does not require calibration/verification at different temperatures. But temperature calibration is essential for any electronic sensor.

This means that each instrument is calibrated against $13 \cdot 11 = 143$ different temperature - pressure pairs. The least squares method is then applied on this results in order to obtain corrections coefficients. A two dimensional, third degree polynomial is used for the correction model.

You can't change calibration parameters, but you can adjust the altitude. Please refer to the section **??** for more details.

4.2 Pressure Altitude Calculation

Pressure altitude is calculated according to the ISA 1976 model of athmosphere. First two athmosphere layers are used; throposphere and thropopause. The throposphere is modeled by equation (1) up to 11000 meters of geopotential altitude. The thropopause layer is modeled by equation (2) up to 20000 meters of geopotential altitude.

As the pressure sensor is calibrated down to 100 hPa (about 16000 meters) altitudes above 16000 meters are not reliable.

$$p = p_0 \left[\frac{T_0 + T_0' \cdot z}{T_0} \right]^{\frac{-g_0}{RT_0'}} \tag{1}$$

$$p = p_1 \exp \left[-\frac{g_0(z - z_1)}{RT_1} \right] \tag{2}$$

The equations converts geopotential altitude into pressure. Here z means geopotential altitude, $g_0 = 9.806645$ m/s^2 is gravity constant, $R = 287.0528$ N $\cdot$ m/kg $\cdot$ K. is gas constant for dry air, $p_0 = 1013.25$ hPa is standard pressure at sea level, $p_1 = 226.321$ hPa is standard pressure at throposphere/thropopause limit, $z1 = 11000$ m is geopotential altitude of the limit, $T_0 = 288.15$ K is temperature at sea level, $T_1 = 216.65$ K is temperature at limit and $T_0' = -0.0065$ K/m is temperature gradient in throposphere.

Besides the equations given below, their inverse and derivatives of inverse are also used.

4.3 Altitude Derivative

Altitude calculated from pressure is numerically derived to get rate of altitude change – vertical speed. The derivative is mathematically correct and as such does not introduce any error. We are using multiple point numerical derivation.

5 Limited Conditions

Although a great care was taken during the design, production, storage and handling, it may happen that the Product will be defective in some way. Please read the following sections about the warranty and the limited operation to get more information about the subject.

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