ROTORAMA

MicoVIO

Visual-inertial odometry (VIO) module
for flight controllers running ArduPilot and PX4



Read this entire manual carefully before installation and the first flight, especially the safety instructions. Keep the manual for future reference.

User manual · Rotorama, s.r.o. · www.rotorama.com

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1. Safety instructions

1.1 Before you start

MicoVIO is a visual-inertial odometry module designed to be installed in a drone. It provides the flight controller (FC) with position, velocity and height-above-ground data even where no GPS signal is available. Installation and setup require experience with configuring ArduPilot or PX4 firmware.

- Read this entire manual before installation and keep it for future reference. The product is intended for persons aged 14 and over.
- **Remove the propellers** from the drone while wiring, configuring and bench testing.
- Do not modify the module and do not open its housing.

1.2 Electrical connection

- Power the module only with **5 V**. A higher voltage will damage the module.
- The serial interface uses **3.3 V** logic levels. When connecting through a USB-to-TTL adapter, set the adapter to 3.3 V.
- Connect the wires according to the pinout (Chapter 4.2), **never by wire colour alone**. Before connecting, verify both the supply voltage and the logic level of the flight controller port.
- Connect and disconnect the connectors only with the drone's power disconnected.

1.3 Flying with VIO positioning

- The module determines position **relative** to the point of initialization, not absolutely like GPS. Flight controller functions that depend on geographic position (geographical zones, geofence) do not work without GPS.
- Positioning accuracy and reliability depend on surface texture, lighting and surface reflectance. Make your first flights in a safe open area at low height and be ready to switch at any time to a flight mode that does not use position.
- Distance-to-ground data are available only within the range of the ToF rangefinder (Chapter 2.3). If the rangefinder is set as the height source (Chapter 5), stay within this range when flying with VIO positioning.
- After power-on, it takes approximately 12 seconds before the module starts outputting data. Do not take off before then.

1.4 Operating environment

- Keep the camera lens and the rangefinder window clean and unobstructed.
- The manufacturer does not specify any water or dust resistance – protect the module from moisture, dirt, impacts and heat.

2. Product description

2.1 Package contents

Item	Qty
MicoVIO module	1
Cable GH1.25-4P → SH1.0-4P, 20 cm (for MicoAir743)	1
Cable GH1.25-4P → MX1.25-6P, 20 cm (for Pixhawk 1/2)	1
Cable GH1.25-4P → GH1.25-6P, 20 cm (for Pixhawk 4/5/6)	1

2.2 Parts description



MicoVIO module – view of the bottom (sensing) side and the side connectors

No.	Part	Description
①	Camera lens	wide-angle lens, global-shutter camera
②	ToF rangefinder window	measures the distance to the ground
③	Arrow	must point toward the nose of the drone when mounted
④	USB-C	connection to a computer – testing and setup in MicoAssistant
⑤	GH1.25-4P connector (GVRT)	connection to the flight controller: GND, VCC, RX, TX

2.3 Specifications

▶ Positioning and tracking

Parameter	Value
Positioning method	visual-inertial fusion (camera + IMU); an integrated ToF range sensor provides height information
Output data	relative position, three-axis velocity, attitude, distance to the ground, positioning quality
VIO trajectory error	1% (typical) ※1
VIO update rate	typically 50 Hz; generally 45–70 Hz depending on scene texture
Tracking speed	typically up to 15 m/s at 2 m above the ground; varies with height, lighting, texture and motion
Max. VIO operating height	30 m; the effective height varies with texture, lighting and ground reflectance
Min. initialization clearance	1 cm ※2
Max. operating tilt angle	60°
Max. tracking angular rate	300 °/s
Local loop closure	enabled by default
Startup time	approx. 12 s from power-on until data output begins

▶ Camera and ranging

Parameter	Value
Lens field of view	120° (diagonal)
Ambient illumination	> 1 lx
ToF ranging distance	0.02–12 m; up to 12 m indoors or outdoors under overcast skies, approx. 8 m in bright sunlight ※3
ToF update rate	43 Hz
IMU	6-axis (gyroscope and accelerometer)

▶ Communication

Parameter	Value
Output protocol	MAVLink 2
Odometry message	ODOMETRY (ID 331)
Ranging message	DISTANCE_SENSOR (ID 132)
Interface	serial, 3.3 V LVTTL
Baud rate	921600 Bd, 8 data bits, no parity, 1 stop bit (8N1)

Parameter	Value
Connector	GH1.25-4P

▶ **Electrical and mechanical data**

Parameter	Value
Supply voltage	5 V
Average operating current	approx. 200 mA
Typical operating power	approx. 1 W
Dimensions	29.5 × 29.5 × 15 mm
Weight	16 g
Mounting	downward-facing, in the specified orientation

※1 The typical 1% error is the three-dimensional trajectory error (ATE RMSE) divided by the total length of the reference trajectory. Actual performance varies with environmental and motion conditions.

※2 The minimum ground clearance at which initialization is permitted. It does not guarantee ToF ranging or positioning accuracy at that height.

※3 Actual ranging performance depends on ambient light, target reflectivity, angle of incidence and mounting conditions.

2.4 How the module works

Visual-inertial odometry (VIO) tracks visual features on the ground across successive camera images and combines them with acceleration and angular-velocity measurements from the IMU. From this, the module continuously estimates the drone's position, velocity and attitude relative to the starting point. Unlike an optical flow sensor, which mainly provides horizontal velocity, VIO also provides position – so the flight controller knows where the drone is relative to its starting point.

Local loop closure re-matches current images with previously captured ones and thereby suppresses accumulated drift. It improves hover and position-hold accuracy without affecting dynamic flight. When supported by the flight controller firmware, the accurate trajectory estimation also enables return to the starting point without GPS.

The global-shutter camera and large-aperture lens handle low light, abrupt lighting changes between indoors and outdoors, low-texture surfaces and reflective floors. In complete darkness (tunnels, mines) the module can be operated with supplemental lighting.

2.5 Manufacturer

MicoAir Tech, Shenzhen, China · e-mail: service@micoair.com · web: micoair.com

3. Legal conditions of operation

3.1 The law of the country where you fly applies

Regulations (EU) 2019/947 and 2019/945 apply in all Member States of the European Union, but national implementing rules differ from country to country – registration portals, minimum pilot age, geographical zones, compulsory insurance and other conditions. The information in this chapter describes the situation in the Czech Republic. If you operate a drone with this module in another country, you must follow the regulations of the country in which you fly.

3.2 The module as part of a drone

MicoVIO is a component for installation and is not an unmanned aircraft in itself. The drone in which you install it is operated in accordance with Regulation (EU) 2019/947. The operator and the pilot of the drone are responsible for compliance with the operating rules – operational category, operator registration, pilot competency, flight height, distance from people and geographical zones.

3.3 Camera and operator registration

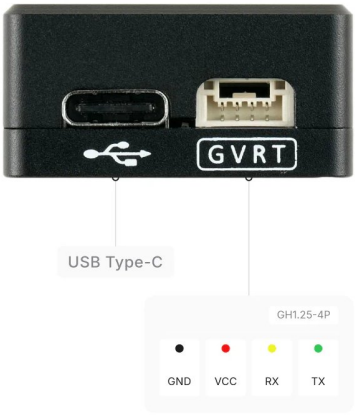
Under Article 14(5) of Regulation (EU) 2019/947, a drone operator must register if the drone has a maximum take-off mass of 250 g or more, or if it carries a sensor able to capture personal data – regardless of mass. The MicoVIO module contains a camera that neither stores nor transmits images and serves only for positioning. No unambiguous interpretation is available in the EU as to whether such a camera triggers the registration obligation for drones under 250 g. We recommend registering as an operator or checking the procedure with the civil aviation authority (in the Czech Republic, registration on the ÚCL portal).

4. Installation and wiring

4.1 What else you need

- A flight controller (FC) with **ArduPilot firmware version 4.5.2 or later**, or with **PX4** firmware, and a free serial port (UART) with a 5 V supply.
- Flight controllers based on an F405 MCU (with less than 2 MB of flash) generally do not support external vision in the default ArduPilot firmware.
- A computer with an up-to-date Chrome or Edge browser and a USB-C data cable for testing and setting up the module in MicoAssistant.
- A ground control station (Mission Planner, QGroundControl) or MicoConfigurator for configuring the flight controller.

4.2 Interface and pinout



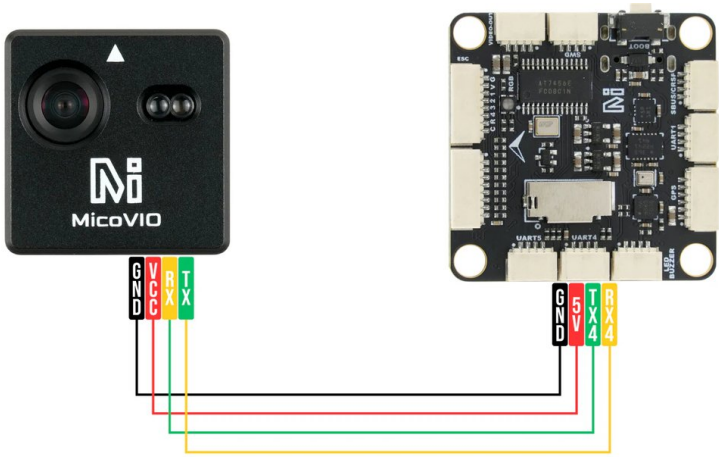
Module connectors: USB-C and GH1.25-4P (GVRT)

Pin	Function	Connect on the flight controller to
GND	ground	GND
VCC	5 V supply	5 V
RX	module data input	TX of the selected UART
TX	module data output	RX of the selected UART

The USB-C port is used to connect the module to a computer for testing and setup. In flight, the module is powered and communicates through the GH1.25-4P connector.

4.3 Connecting to the flight controller

Connect the module to a free UART port of the flight controller. The RX and TX lines are **crossed**: module RX to flight controller TX and module TX to flight controller RX. GND and 5 V are connected directly.



Wiring example: MicoVIO module (left) connected to the UART4 port of a flight controller (right)

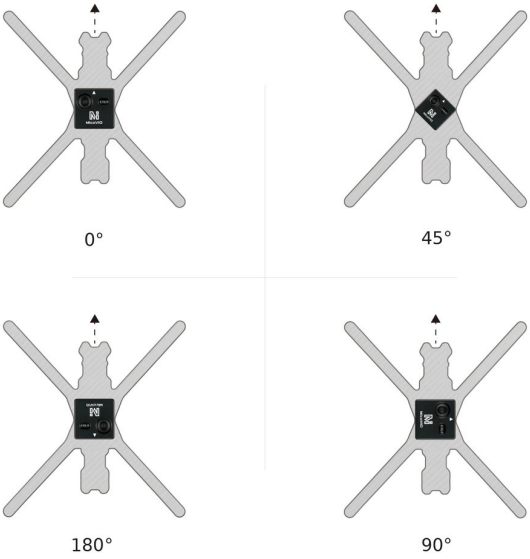
Flight controller	Cable from the package
MicoAir743	GH1.25-4P → SH1.0-4P
Pixhawk 1 / Pixhawk 2	GH1.25-4P → MX1.25-6P
Pixhawk 4 / 5 / 6	GH1.25-4P → GH1.25-6P

The port number (n) you will enter during setup in Chapter 5 can be found in the flight controller manual (mapping of physical ports to serial port numbers) or on the *Port Settings* page in MicoConfigurator.

4.4 Mounting on the drone

- The module supports **downward-facing installation only** and is typically mounted on the underside of the airframe.
- The arrow ③ on the module must point **toward the nose** of the drone.
- Secure the module firmly so that it cannot move relative to the frame. Make sure that landing gear legs, cables or other parts of the drone do not protrude into the lens field of view or in front of the rangefinder window.

If the module cannot be mounted with the arrow facing forward, its mounting orientation (Yaw) can be adjusted in MicoAssistant in clockwise 45° increments when viewed from below.



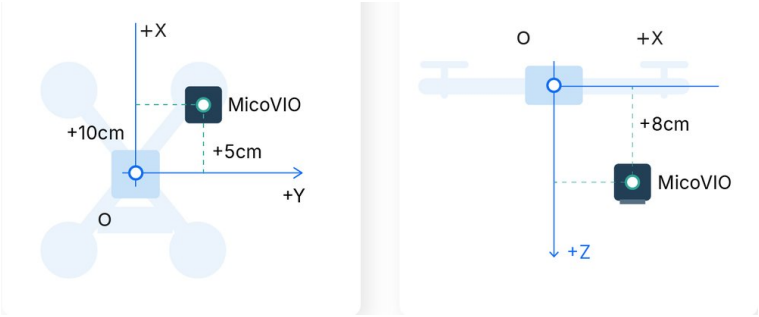
Module orientation viewed from below – 0° (default), 45°, 90° and 180° clockwise; the arrow at the top indicates the nose



Example of the module mounted on the underside of the frame

4.5 Module offset from the drone's centre

If the module is not installed at the drone's centre of rotation, configure its X, Y and Z position offsets in the flight controller. Incorrect or missing offsets affect flight stability and positioning accuracy during dynamic manoeuvres – in particular, when the drone rotates in place it may drift or circle around its intended centre of rotation.



Measuring the offsets: top view (X and Y axes) and side view (Z axis); O = reference origin

- **+X** forward, **+Y** to the right, **+Z** down. Values are entered in metres.
- **ArduPilot**: when no IMU offset is set, the origin is the position of the flight controller's IMU; with the IMU offset set, the origin is the vehicle's centre of gravity.
- **PX4**: the origin is the vehicle's centre of gravity. The flight controller's IMU offset must be configured correctly in a separate step.

Example: module 10 cm forward, 5 cm right and 8 cm below the origin

ArduPilot	Value	PX4	Value
VISO_POS_X	+0.10	EKF2_EV_POS_X	+0.10
VISO_POS_Y	+0.05	EKF2_EV_POS_Y	+0.05
VISO_POS_Z	+0.08	EKF2_EV_POS_Z	+0.08

The positions in the example are illustrative – enter the values measured on your drone.

5. Commissioning and setup

5.1 Testing and setup in MicoAssistant

MicoAssistant is the manufacturer's web tool that runs in the Chrome or Edge browser – nothing needs to be installed. Driver installation is generally unnecessary.

① Connect the module to the computer with a USB-C data cable.

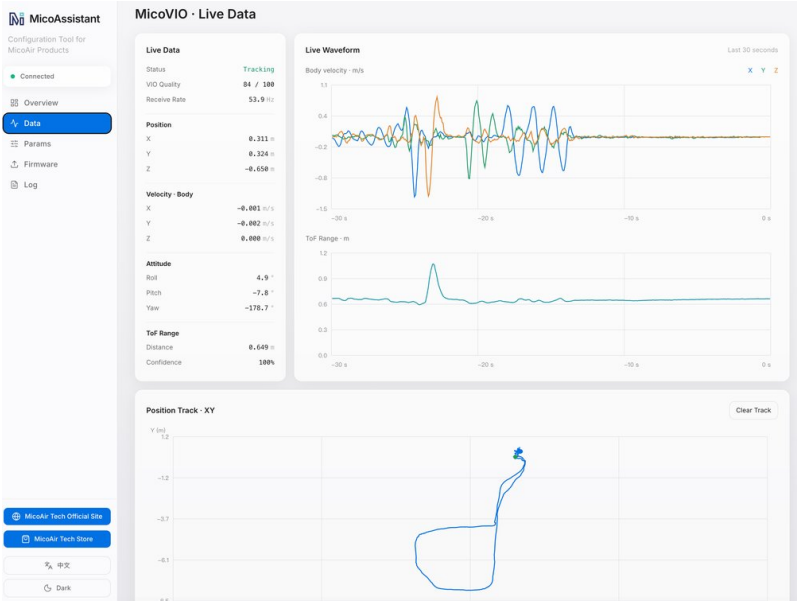
② Open micoair.com/assistant.

③ Click *Select Port* and choose the module's port. Any baud rate can be used.

④ Click *Connect* and wait until MicoAssistant identifies the module. After power-on it takes approx. 12 s before the module starts outputting data.

⑤ On the *Data* page, check the tracking status, VIO quality, position, velocity, attitude and rangefinder distance.

⑥ If the module is mounted other than with the arrow toward the nose, set the orientation (Yaw) – see Chapter 4.4.



MicoAssistant – Data page with live module data

※ Only one application can use a port at a time. Before connecting, close Mission Planner, QGroundControl and any other application that might be using the port.

5.2 ArduPilot setup

ArduPilot version 4.5.2 or later is required. For graphical configuration the manufacturer recommends MicoConfigurator. Replace **n** with the number of the serial port to which the module is connected (Chapter 4.3).

▶ Serial port

Parameter	Value
SERIALn_BAUD	921 (921600 Bd)
SERIALn_PROTOCOL	2
SERIALn_OPTIONS	1024 (versions before 4.7)
MAVn_OPTIONS	2 (from version 4.7)

▶ Visual sensor

Parameter	Value
VISO_TYPE	3
VISO_YAW_M_NSE	0.1

Leave all other settings at their defaults. Restart the flight controller to apply the changes.

▶ Rangefinder

Parameter	Value
RNGFND1_TYPE	10
RNGFND1_MAX_CM	1200
RNGFND1_MIN_CM	1
RNGFND1_ORIENT	25

After setting RNGFND1_TYPE, restart the flight controller or refresh the parameters so that the remaining rangefinder parameters appear. From version 4.7.0 the distances are entered in metres – i.e. a maximum of 12 m and a minimum of 0.01 m.

▶ EKF3 sources

Parameter	Value
EK3_SRC1_POSXY	6 – ExternalNav
EK3_SRC1_POSZ	2 – RangeFinder
EK3_SRC1_VELXY	6 – ExternalNav
EK3_SRC1_VELZ	6 – ExternalNav
EK3_SRC1_YAW	6 – ExternalNav

EK3_SRC1_YAW can alternatively be set to 1 – Compass; in that case VISO_TYPE must still remain 3.

5.3 PX4 setup

Replace **n** with the number of the TELEM port to which the module is connected.

▶ **Serial port**

Parameter	Value
MAV_1_CONFIG	TELEM n – then restart the flight controller
MAV_1_MODE	Onboard
MAV_1_FORWARD	Disabled
SER_TELn_BAUD	921600 8N1

▶ **EKF2**

Parameter	Value
EKF2_EV_CTRL	9
EKF2_HGT_REF	2 – Range sensor

5.4 Checks before the first flight

- Do not forget to enter the module offsets (Chapter 4.5).
- Without propellers, check in the ground control station that the flight controller receives data from the module and that the position changes in the corresponding direction and by the corresponding amount when you move the drone by hand.
- When you rotate the drone by hand around its vertical axis, the position estimate must not change significantly. If it does, check the module orientation and offsets.

6. Flying

6.1 Pre-flight check

- The module is firmly attached and arrow ③ points toward the nose (or the orientation is set in MicoAssistant).
- The camera lens and the rangefinder window are clean and unobstructed.
- The connector is plugged in, the wires are undamaged and cannot get into the propellers.
- After powering on the drone, wait approx. 12 s until the module starts outputting data, and check in the ground control station or on the OSD that the flight controller is receiving the position.
- The propellers are in good condition and correctly mounted, the drone's battery is fully charged.

6.2 First flight

- Fly in a safe open area or in a sufficiently large room without people.
- Take off in a mode that does not use position (in ArduPilot e.g. *Stabilize* or *AltHold*, in PX4 *Stabilized* or *Altitude*), and only at low height switch to a position-hold mode (*Loiter* or *Position* respectively).
- If the drone starts to drift or oscillate, immediately switch back to a mode without positioning and land.
- After landing, Disarm (switch off the motors) before approaching the drone.

6.3 Operating limits

Quantity	Limit
Max. VIO operating height	30 m
ToF rangefinder range	0.02–12 m, approx. 8 m in bright sunlight
Max. tilt angle	60°
Max. angular rate	300 °/s
Tracking speed	typically up to 15 m/s at 2 m
Illumination	> 1 lx; in complete darkness with supplemental lighting

The values given are typical. Actual limits depend on surface texture and reflectance, lighting and the motion of the drone.

7. Maintenance and troubleshooting

7.1 Maintenance

- Clean the lens and the rangefinder window with a soft, dry optical cloth. Do not use solvents.
- Regularly check the connector and cable, especially after a hard landing or crash.
- Store the module in a dry, dust-free place away from direct sunlight.
- The module firmware is uploaded in MicoAssistant if the manufacturer releases an update.

7.2 Troubleshooting

Problem	Possible cause and solution
The browser lists no port	Use an up-to-date Chrome or Edge, not an Incognito/InPrivate window. Check in Device Manager that the port appears and allow the browser to access serial ports. Try another data cable or USB port.
The port cannot be opened or is busy	Close other applications using the port (Mission Planner, QGroundControl, serial terminal) and reconnect the module.
MicoAssistant shows no data	Wait approx. 12 s after power-on. Check the cable and power supply, disconnect and reconnect the module.
The flight controller receives no data	Check that RX/TX are crossed, the 5 V supply, the port number n, the baud rate 921600 Bd and the protocol (SERIALn_PROTOCOL = 2). Restart the flight controller after changing parameters.
External vision cannot be set up in ArduPilot	Flight controllers with an F405 MCU (less than 2 MB of flash) generally do not support it. Also check the firmware version (4.5.2 or later).
The drone drifts or circles when rotating in place	The module offsets are missing or incorrect (Chapter 4.5).
The position drifts in a different direction than the drone moves	The arrow does not point toward the nose and the orientation (Yaw) is not set in MicoAssistant.
Height is wrong or jumps	The rangefinder window is dirty, the drone is out of the rangefinder's range, or the surface is glossy, dark or inclined. The range is shorter in bright sunlight.
Loss of tracking, low VIO quality	Poor lighting (below 1 lx), dirty lens or a surface with little texture. Fly lower or over a surface with more distinct texture.

8. Information for the EU and Czech Market

8.1 Importer and responsible person in the EU

The product is placed on the European Union market by the importer stated below, who is at the same time the responsible person within the meaning of Article 16 of Regulation (EU) 2023/988 of the European Parliament and of the Council on general product safety (GPSR).

Importer / responsible person in the EU	Rotorama, s.r.o.
Company ID (IČO)	051 57 692
VAT ID (DIČ)	CZ05157692
Registered office	Okrajová 1351, 674 01 Třebíč, Czech Republic
E-mail	info@rotorama.cz
Phone	+420 252 252 098
Website	www.rotorama.com

8.2 Product conformity

CE

- The product bears the **CE** marking and complies with the requirements of the applicable European Union harmonisation legislation.
- A copy of the **EU Declaration of Conformity** is available from the importer at the address stated above or at the e-mail address info@rotorama.cz.
- **Product identification:** the type designation (MicoVIO) is marked on the bottom (sensing) side of the module.

8.3 Disposal of electrical equipment



- The crossed-out wheeled bin symbol on the product, its packaging or in the documentation means that at the end of its service life the product **must not be disposed of together with mixed municipal waste**.
- Hand it over at a take-back point for electrical equipment – at a collection yard, at a take-back point of a collective system, or at the retailer when purchasing a new equivalent product. Take-back is free of charge for the end user.
- The obligations under Act No. 542/2020 Coll., on end-of-life products, are fulfilled by the importer through a collective take-back system.
- Proper disposal helps prevent negative impacts on the environment and human health and contributes to the reuse of secondary raw materials.

Through its contractual partner **ASEKOL a.s.**, the company ensures the take-back of waste electrical equipment from households and the separate collection of waste electrical equipment, batteries and accumulators in accordance with the applicable legislation. The customer is entitled to hand over old electrical equipment or a battery or accumulator at any collection point of the above contractual partner. The addresses of these take-back points are listed at www.asekol.cz, www.ecobat.cz and also https://visoh2.mzp.cz/RegistrMistZO/RegistrMistZOPublic/MapaMistZpetOdberu.

9. Warranty and rights arising from defective performance

Rights of the buyer under Czech law

The rights and obligations of the contracting parties are governed by Czech law, in particular by Act No. 89/2012 Coll., the Civil Code, and Act No. 634/1992 Coll., on consumer protection.

- The seller is liable to the buyer for the product being free of defects on receipt. If the buyer is a consumer, a defect may be notified **within two years of receipt** of the product (Section 2165 of the Civil Code).
- If a defect appears within **one year** of receipt, the product is deemed to have been defective already at the time of receipt (Section 2161(5) of the Civil Code).
- When purchasing online, a consumer has the right to **withdraw from the contract within 14 days** of receiving the goods without giving a reason (Section 1829 of the Civil Code).
- Claims should be made with the retailer from whom you purchased the product. The importer's contact details are given in Chapter 8.1.
- The competent body for out-of-court settlement of consumer disputes is the **Czech Trade Inspection Authority**, Štěpánská 796/44, 110 00 Prague 1, www.coi.cz.