

DOF-5 Dover Objective Focusing Stage

Microscope Nanopositioning Stage

The new Dover Objective Focusing (DOF) stage is a low-cost, high-performance nanopositioning stage optimized for optical imaging applications. When compared to piezo flexure stages typically used for focusing, the DOF-5 offers greater travel (5 mm) and higher bandwidth (> 225 Hz), providing fast step and settle while maintaining image stability.



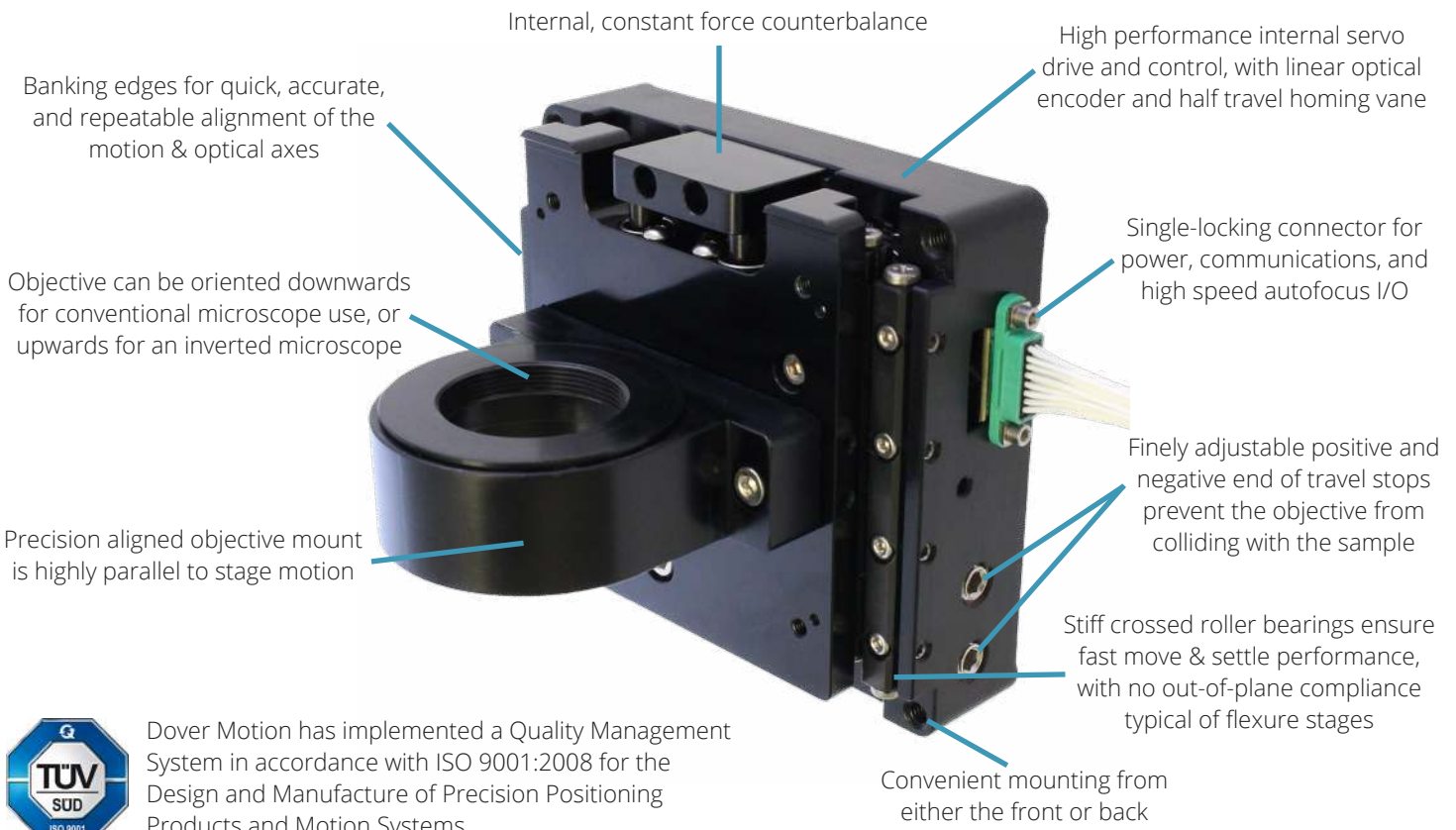
Overview

Nanopositioning stages with piezoelectric motors and flexure bearings have been the industry standard for focusing for too long. They are expensive, have restricted travel, and stiffness issues. The new DOF-5 Objective Focusing Stage has been engineered to overcome these performance drawbacks, offering greater travel (5 mm) and higher bandwidth (> 225 Hz) at a fraction of the cost. By embedding the servo drive and motion controller within the stage, we have removed complex cabling and reduced the overall system cost to typically 50-60% less than competing offerings, while still maintaining equivalent or better performance. In addition, the DOF-5 can be connected directly to an Autofocus system for easy integration.

With > 5 mm of travel, the DOF-5 provides more engineering flexibility. The restricted travel of piezo systems (typically 100 to 300 microns) often leads to compromises in system performance. Attempts to extend the travel, such as employing lever amplification, dramatically decrease the focus stage's resonant frequency and stiffness. The DOF-5's increased travel removes the need for additional coarse positioning axes.

Piezo nanopositioning stages are difficult to tune because the flexure-style bearing is susceptible to off-axis noise and the piezo motor is lower bandwidth. The DOF-5 includes stiff crossed roller bearings and brushless linear servo motor actuation, providing higher servo bandwidth and a better response for optical microscopy. The DOF-5 design is covered under U.S. Patent 10,367,436.

Additional DOF-5 Features:



Dover Motion has implemented a Quality Management System in accordance with ISO 9001:2008 for the Design and Manufacture of Precision Positioning Products and Motion Systems

DOF-5 Specifications

Parameter	Specification	
	Units	Tolerance
Total Travel	mm	≥ 5
Payload Mass ¹	g	0 - 900 ¹
Full Travel Accuracy (2σ) ^{2,3}	μm	5
Full Travel Bi-directional Repeatability (2σ) ^{2,3}	μm	1
Bi-directional Repeatability, 500nm move(2σ) ^{2,3}	nm	≤ 25
Home Repeatability (2σ)	μm	≤ 1
Minimum Move	nm	15
Servo Bandwidth ³	Hz	> 225
Move and Settle (100nm step, ±15nm) ³	ms	≤ 15
Move and Settle (250nm step, ±15nm) ³	ms	≤ 15
Servo Stability	nm (rms)	≤ 5
Max Velocity (1.25nm feedback resolution)	mm/s	30
Max Velocity (5nm feedback resolution)	mm/s	125
Max Acceleration with 1kg Payload	m/s ²	6
Dimensions (excluding objective mount)	mm	77H x 82W x 30D
Typical Total Mass (includes objective mount)	kg	0.5
Communications Options: RS232, RS485, CAN, Step & Direction)		

¹ Other loads can be supported, for info contact Dover Motion.

² Tested according to ISO 230-2 standard.

³ Specifications based on a 250g payload.

Moving Mass of Table

Table only, no objective mount	174g ± 10g
Table with standard objective mount	220g ± 10g

Note: mass is provided as a range due to variations in mass based on exact counterbalance and adapter chosen.

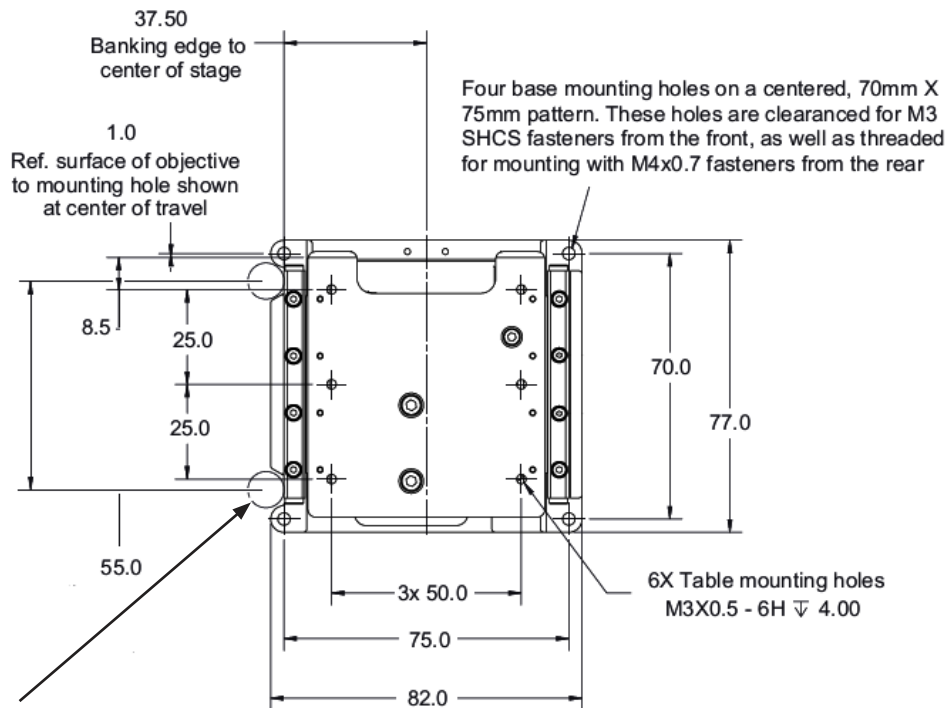
Electrical Power Specifications

Recommended Voltage (Logic and Motor Bus)	24 VDC ± 10%
Logic Power	2 W Peak, 1.5 W Typical
Motor Bus Power	25 W Peak
Current (Nominal Voltage, 24 VDC)	Max = 1.125 A Typical = 0.200 A



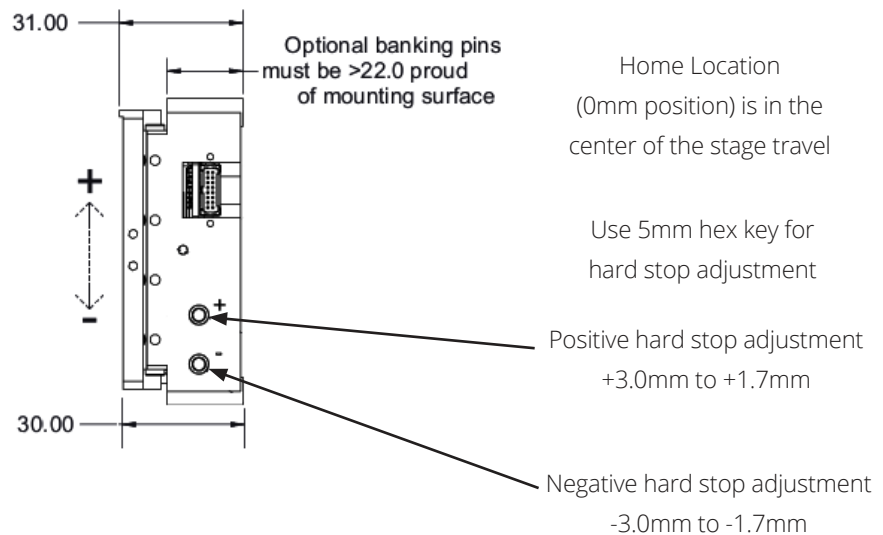
DOF-5 Dimensional Drawings

DOF-5 Front View



Optional banking pins:
use 2 pins with diameter
in range of: 5 - 10 mm

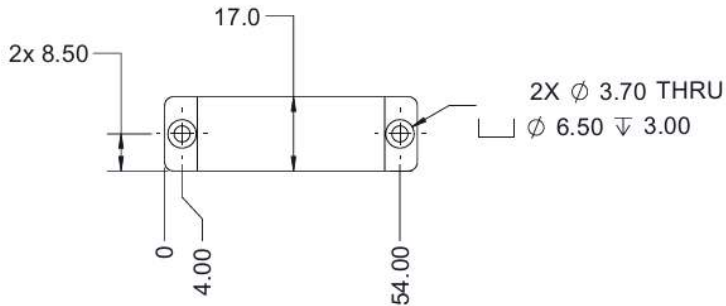
DOF-5 Side View



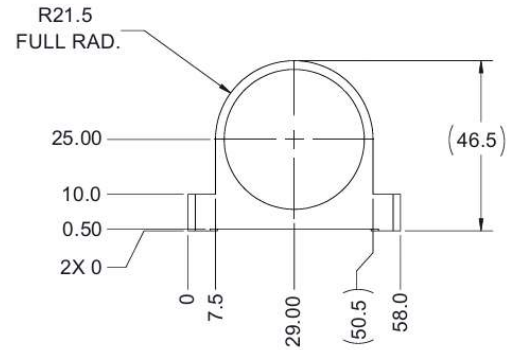
Note: Objective Mount and Adapter not shown, see additional sections for more information.

Objective Mount and Adapter

Objective Mount Front View



Objective Mount Top View



Note: Threaded adapter not shown, for threaded adapter information, see downloadable CAD on the dovermotion.com website

The DOF-5 is orderable with a precision aligned objective bracket with commonly used thread options. The standard thread options are:

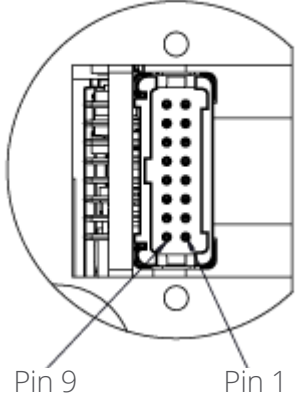
- M25 x 0.75
- M26 x 0.706
- M27 x 0.75
- SM1
- RMS
- M32 x 0.75

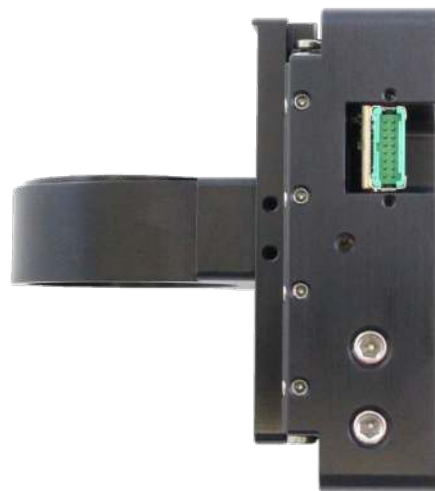
The DOF-5 is also offered with no objective bracket. See the configurator for ordering code.



Connector Pinout

DOF-5 Stage Pinout

Pin Number	Function			Pinout Diagram
	RS-232	RS-485	CAN	
1	Factory Use Only			
2	Factory Use Only			
3	NC	Z TxD-	NC	
4	TX	Y TxD+	NC	
5	NC	B RxD-	CANH	
6	RX	A RxD+	CANL	
7	Supply Return			
8	Motor Bus Supply			
9	Factory Use Only			
10	Factory Use Only			
11	Digital Input A (Step)			
12	Digital Input B (Direction)			
13	Digital Output			
14	Digital Return			
15	Supply Return			
16	Logic Supply			
DOF-5 Connector: Harwin G125-MH11605L7P Mating Connector: Harwin G125-2241696F1				



Objective Orientation

The DOF-5 can be used in a horizontal or vertical orientation. The orientation and placement location of the adapter must be specified when ordering. For vertical applications, the gravity counterbalance force will be setup with the ordered payload for either a “regular” or “inverted” configuration. In a “regular” orientation, the counterbalance force is set with a slight upwards bias so that the stage moves to the upper (positive) hard stop upon power off. In an “inverted” orientation, the counterbalance force is set with a slight downwards bias so that the stage moves to the lower (negative) hard stop when power is off. For horizontal applications, the counterbalance is not provided. The objective adapter can be mounted in three possible locations on the moving table. The DOF-5 is also offered with no objective bracket. See the Configurator section for ordering codes.

Inverted Objective Orientation



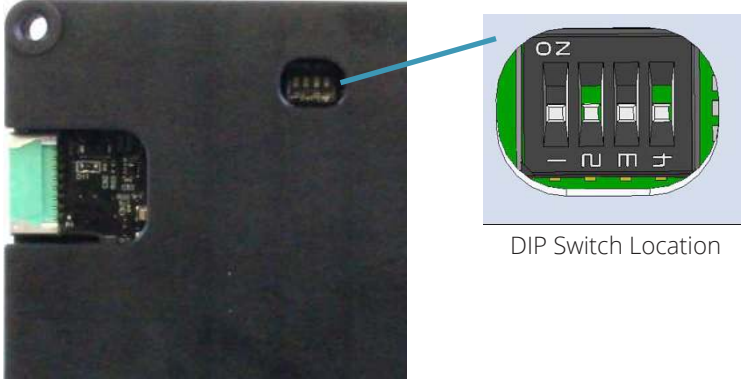
Regular Objective Orientation



Communications Options

Communications (RS-232, RS-485, and CAN) Setup

RS-232, RS-485, and CAN communication for the DOF-5 are DIP switch selectable. Communications DIP switches are accessible on the back of the DOF-5 stage and are preset at the factory. All communication signals are referenced to pin 14, digital return on the DOF controller connector.



DIP Switch Location

Switch	On	Off
1	Serial	CAN
2	RS232	RS485
3	High Z	Low Z
4	Full Duplex	

Note: High Z is 125K Ω termination resistance, and low Z is 120 Ω termination resistance (for RS-485 and CAN).

RS-232

To communicate to the stage using RS-232, set switches 1 and 2 to the "ON" state. Switches 3 and 4 are ignored and can be at any state. The DOF-5 can handle all voltage types of RS-232 communication. DOF-5 has a default baud rate of 57600 and maximum baud rate of 460,800.

RS-485

To communicate to the stage using RS-485, set switch 1 to the "ON" state and switch 2 to the "OFF" state. Switches 3 and 4 depend on your type of RS-485 communication. The baud rate default is 57600 and maximum baud rate is 460,800.

When communicating with a single axis, set the DOF-5 to low impedance. This can be done by setting pin 3 to the off position.

Multi-drop RS-485 communication allows serial commands to be sent by address. The on-board controller in the DOF-5 has a default address of 0. It is important to change the address of each DOF-5 to something unique or communication issues will arise. It is important that all of the DOF-5's, except the last stage in the network, have DIP switch 3 to the "ON" state to provide high impedance to the communication line. The last stage on the network should be set to the low impedance state.

CAN2.0B

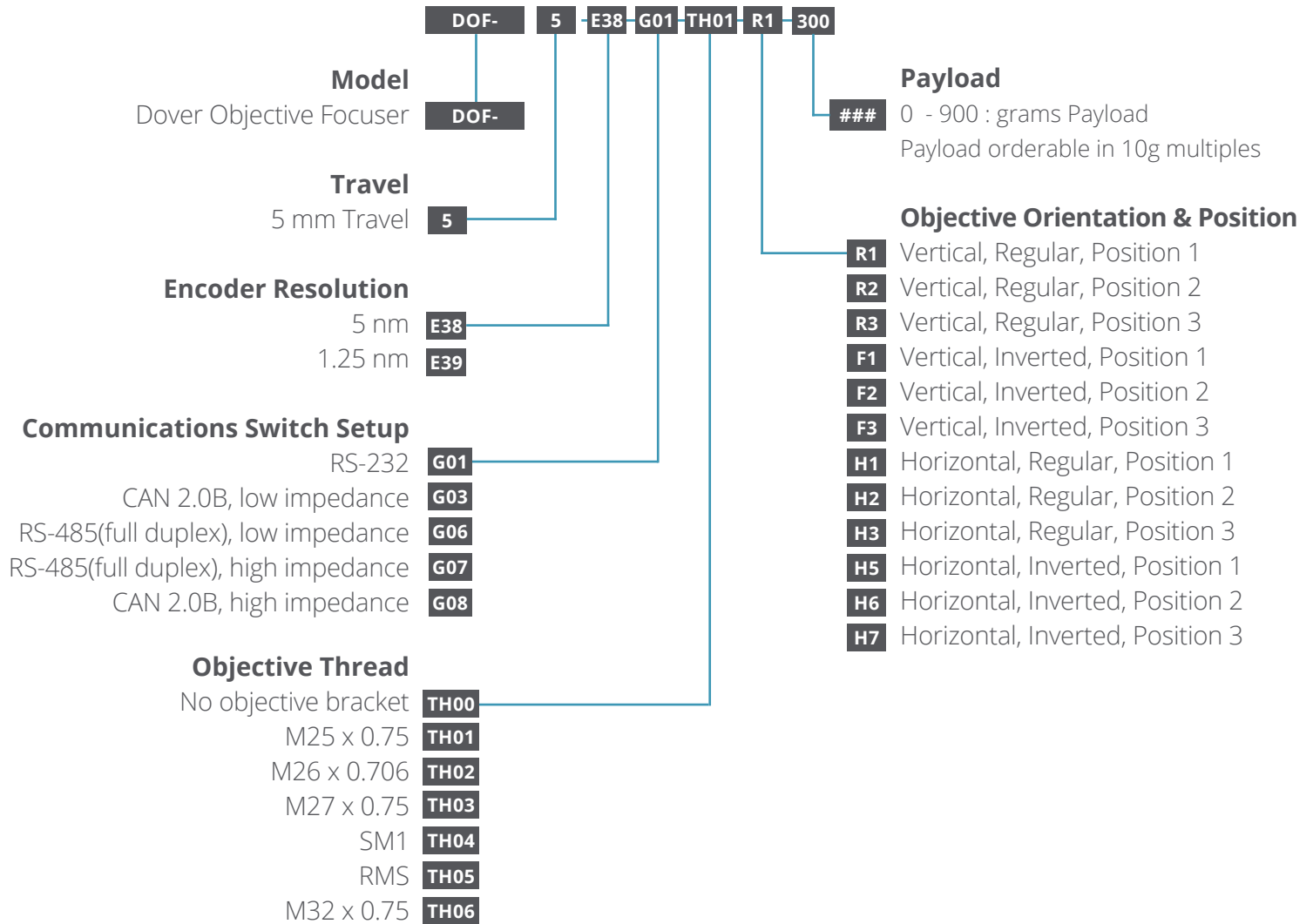
To communicate to the stage using CAN2.0B, set switch 1 to the "OFF" state. Switch 2 and 4 are ignored when in CAN mode and be set to any state. As with RS-485, only one DOF-5 on a communication network should have pin 3 set to the low impedance state to avoid communication confusion. It is recommended that the pin is set low for point to point communication to allow for all baud rates.

The default settings on the DOF-5 revert to a baud rate of 1Mbaud and a Node ID of 0. CAN communications is the fastest communications speed option available. The maximum baud rate for CAN2.0B communication is 1,000,000.

Step & Direction Setup

The DOF-5 can be set up to receive pulse and direction inputs to control motion of the stage. See the DOF-5 Programming Guide, Electronic Gearing section, for more information on setting up the pulse and direction inputs. The step and direction input lines expect TTL signals from 3.3V to 5V. The maximum allowable frequency for the DOF-5 is 4.8MHz and that rate should not be exceeded.

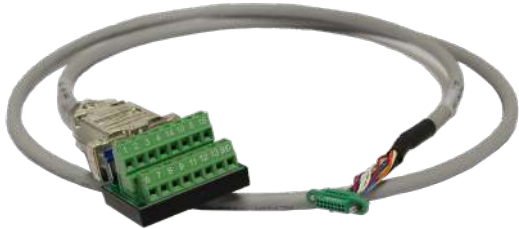
Configurator



Optional Accessory Cables

DOF to Breakout Cable (P/N: 36086-00)

- 1 meter long cable
- Standard DOF connector on one end
- Terminal block breakout on other end



Shown: DOF to Breakout Connector

DOF to RS-232 to USB (P/N: 36100-00)

- 1 meter long cable to terminal block
- Standard DOF connector to:
 - USB (includes RS-232 adapter)
 - Ferrules for connection to power supply
 - I/O accessible on terminal block

DOF to RS-485 to USB (P/N: 36101-00)

- 1 meter long cable to terminal block
- DOF connector to:
 - USB (includes RS-485 adapter)
 - Ferrules for connection to power supply
 - I/O accessible on terminal block



Shown: DOF RS-232 or RS-485 Kit

DOF to CAN to USB (P/N: 36102-00)

- 1 meter long cable to terminal block
- Standard DOF connector to:
 - USB (includes CAN 2.0B adapter)
 - Ferrules for connection to power supply
 - I/O accessible on terminal block
- Fastest communication speed option



Shown: DOF CAN Kit