

# TESTING TELESCOPES

## INTRODUCTION

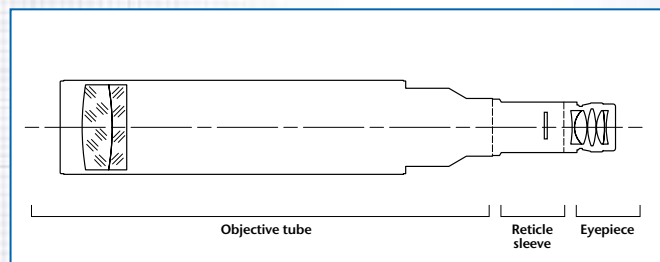
### Layout and principle of operation

A testing telescope provides a magnified real image of a distant object. Usually the object is at infinity at a wavelength of 546 nm. The main components of a testing telescope are:

- objective tube with objective
- reticle sleeve with reticle
- eyepiece

The following figure shows the principle set-up of a testing telescope with straight viewing adjusted to infinity. The reticle is positioned at the rear focal plane of the objective. Due to this configuration all objects at infinity are imaged into the reticle plane. The reticle plane is viewed through the eyepiece. Due to this set-up the image in the eyepiece is rotated by 180°.

Mechanical and optical axes of testing telescopes with focal length  $f \leq 300$  mm are adjusted with an accuracy of  $\pm 30 \mu\text{m}/f$ .



Testing telescopes form with collimators a measuring system for direction and angle testing of optical elements or optical systems in transmission.

### Calculation of the angles

The angles ( $\alpha_x$  and  $\alpha_y$ ) can be calculated from the distances  $\Delta x$  or  $\Delta y$  of the image of the collimator reticle to zero position of the eyepiece reticle as follows:

$$\alpha_x = \arctan\left(\frac{\Delta x}{f}\right) \approx \frac{\Delta x}{f}$$

$$\alpha_y = \arctan\left(\frac{\Delta y}{f}\right) \approx \frac{\Delta y}{f}$$

$f$ : focal length of the telescope objective

### Numerical example:

A displacement of 3 mm measured with a testing telescope with 300 mm focal length corresponds to an angle of:

$$\alpha \approx 3/300 \text{ rad} = 10 \cdot 10^{-3} \text{ rad} = 0,5730^\circ = 34'23''.$$

A point at a distance of  $10 \mu\text{m}$  to the centre of the eyepiece reticle corresponds to an angle of the parallel beam to the optical axis of the telescope as follows:

Focal length	Angle
50 mm	41"
90 mm	23"
140 mm	15"
200 mm	10"
300 mm	6,9"
500 mm	4,1"
600 mm	3,4"
1100 mm	1,9"

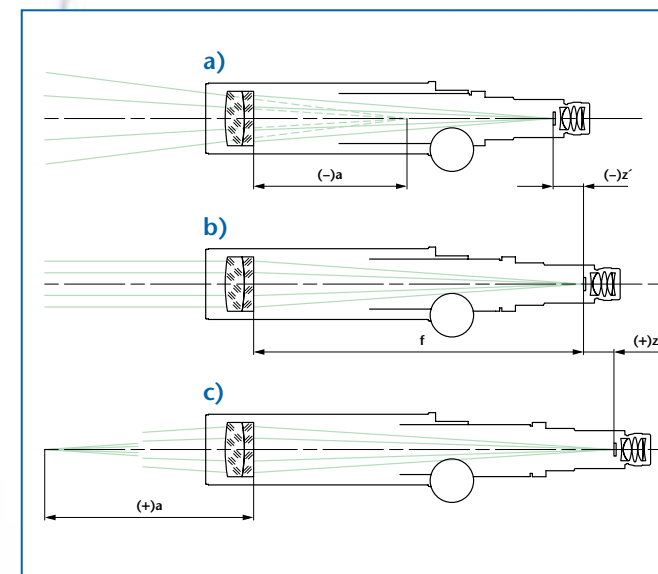
### Adjustable Focus

Besides testing telescopes with fixed distance between reticle and objective telescopes with adjustable focus are available. With these telescopes the distance between reticle and objective is adjustable. If the reticle is displaced out of the focal plane by a distance  $z'$ , then the telescope is focused at a distance  $a$  according to:

$$a = \frac{f^2 + z'f}{z'}$$

$z' < 0$  corresponds to a decrease of the distance between objective and reticle. The resulting image distance is negative (virtual object position) (a).

$z' > 0$  corresponds to a real image with positive object distance (c).  $z' = 0$  produces an image at infinite distance (b).



### Selection criteria

#### Long or short focal length?

Depending on the magnification of the instrument a longer focal length leads to a greater measuring sensitivity and measurement accuracy. As the focal length increases, the measuring range (FOV) decreases proportionally. Additionally, the intensity of the light bundle received by the telescope decreases with increased focal length. A longer focal length affects the mechanical extension of the tube, as well.

#### Small or large objective aperture?

Light conditions are more favourable when large apertures are used, and the evaluation of the results is easier and more accurate. A long distance between test specimen and telescope demands a relatively large free aperture (or aperture ratio). For these measurements a relatively large aperture diameter should be used.

#### Fixed or variable distance setting?

Fixed, infinity focus testing telescopes are generally the best choice when testing systems adjusted to infinity. Fixed focus tubes set at other than infinity can be ordered.

For measurement tasks requiring an adjustable focal distance like adjustment at different wavelengths or to different distances, focusable testing telescopes with objective tube with tube extensions are used.

#### Eyepiece focal length?

Usually eyepieces with  $f=14,7$  mm are used. Eyepieces with  $f=10$  mm give greater magnification but less field angle. Eyepieces with  $f=25$  mm give larger field of view but less magnification. For eyepieces with  $f=14,7$  mm and  $f=25$  mm a C-Mount Camera adapter is available.

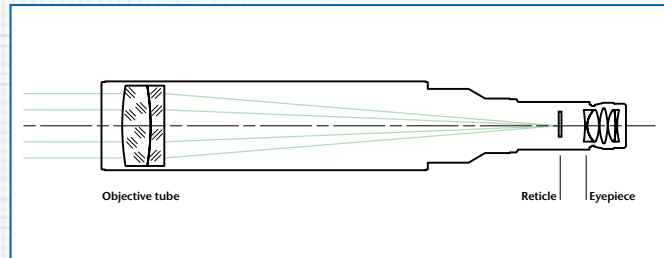


# TESTING TELESCOPES

## STRAIGHT VIEWING

### Description:

For a general description of the operating principle of testing telescopes see page 20.



### Application examples

(additional collimator required):

- Measurement of angular displacement
- Parallelism measurement of uncoated flats
- Testing of the imaging properties of optical elements and systems

### Notes on ordering:

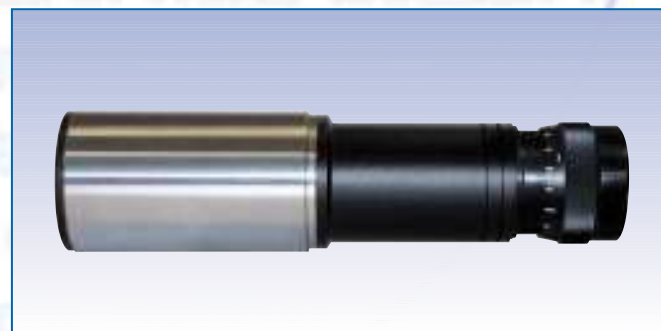
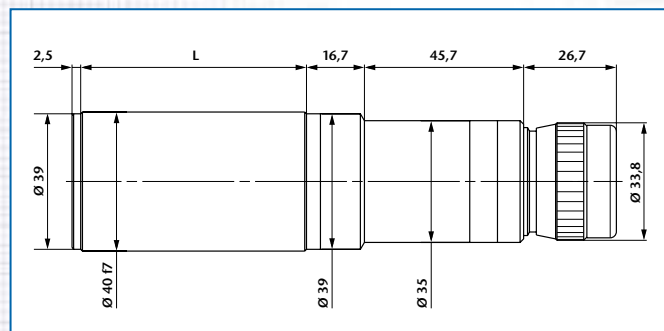
- Testing telescope eyepiece is commonly  $f=14,7$  mm but can be equipped with eyepieces  $f=25$  mm or  $f=10$  mm on request.
- One reticle and one eyepiece are included in the standard instrument.
- If not specified otherwise, the testing telescope is adjusted to infinity at 546 nm wavelength. Adjustment to other distances or wavelengths is also possible on demand.
- The nomenclature of the testing telescopes with straight viewing is as follows:

Example: F G 50/ 40/ 14,7

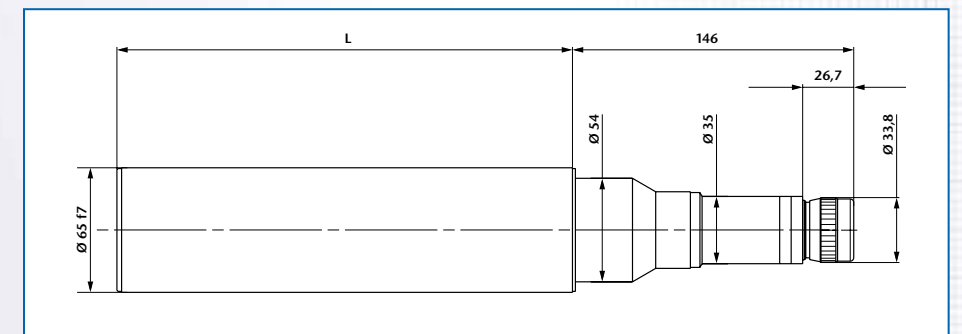
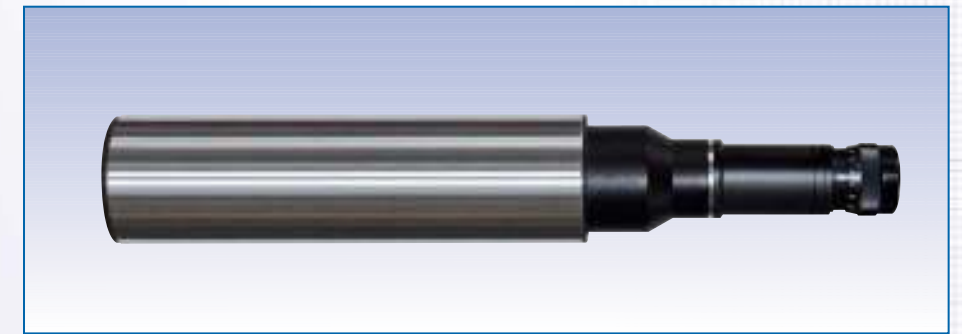
Testing telescope  
Straight viewing  
Focal length  
Tube diameter  
Eyepiece focal length

### Important:

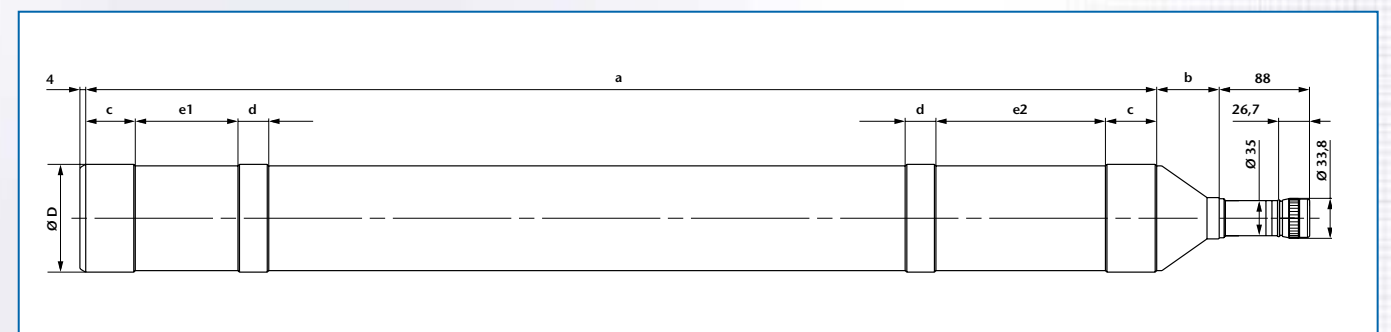
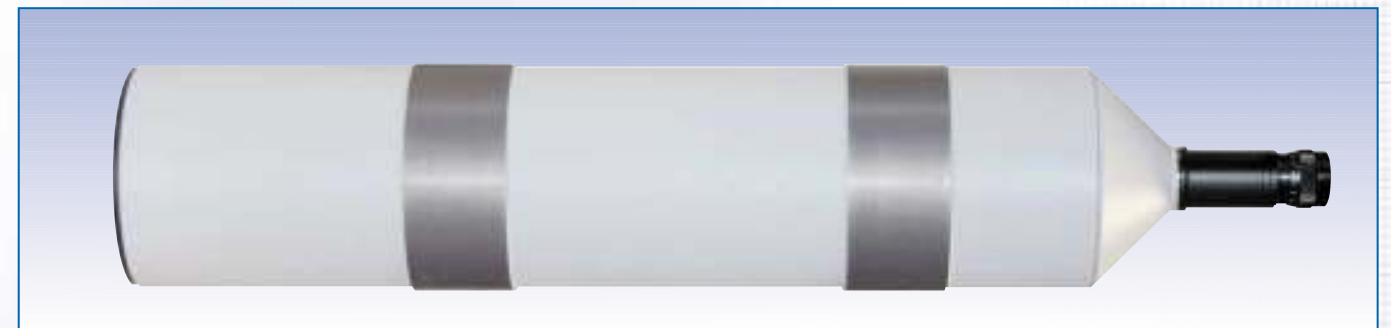
Please specify reticle (see page 82) when ordering.



Ord.-No.	Description	Focal length	Free aperture	Field of view	L
227 004	FG 50/40/14,7	50	10	10,0°	65
227 005	FG 90/40/14,7	90	16	6,0°	65
227 006	FG 140/40/14,7	140	28	4,0°	118
227 007	FG 200/40/14,7	200	28	3,0°	173
227 008	FG 300/40/14,7	300	28	2,0°	274
227 009	FG 500/40/14,7	500	28	1,0°	474



Ord.-No.	Description	Focal length	Free aperture	Field of view	L
227 010	FG 300/65/14,7	300	50	2,0°	233
227 011	FG 500/65/14,7	500	50	1,0°	415
227 012	FG 500T/65/14,7	500	50	1,0°	233



Ord.-No.	Description	Focal length	Free aperture	Field of view	D	a	b	c	d	e1	e2
227 015	FG 600/128/14,7	600	100	0,8°	Ø 128 f7	530	46	-	58	154	78
227 016	FG 1100/105/14,7	1100	80	0,5°	Ø 105 f7	1045	66	50	30	165	100

# TESTING TELESCOPES

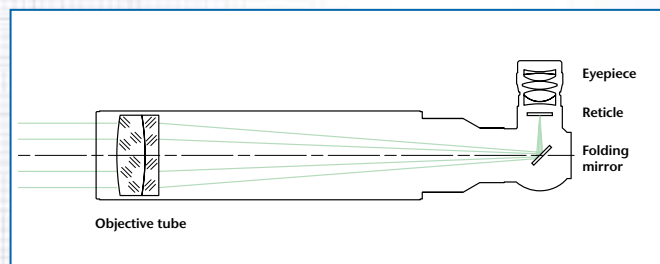
## 90°-VIEWING

### Description:

For a general description of the operating principle of testing telescopes see page 20.

The basic function and design of testing telescopes with 90° viewing is the same as of testing telescopes with straight viewing.

The testing telescopes with 90° viewing contain an additional folding mirror. This kind of testing telescope is used for vertical set-ups or for set-ups on optical tables where straight viewing is not practical from point of view of ergonomics and space.



### Notes on ordering:

- Testing telescope eyepiece is commonly  $f=14,7$  mm but can be equipped with eyepieces  $f=25$  mm or  $f=10$  mm on request.
- One reticle and one eyepiece are included in the standard instrument.
- If not specified otherwise, the testing telescope is adjusted to infinity at 546 nm wavelength. Adjustment to other distances or wavelengths is also possible on demand.
- The nomenclature of the testing telescopes with 90°-viewing is as follows:

Example: F R 50/ 40/ 14,7

Testing telescope  
90° viewing  
Focal length  
Tube diameter  
Eyepiece focal length

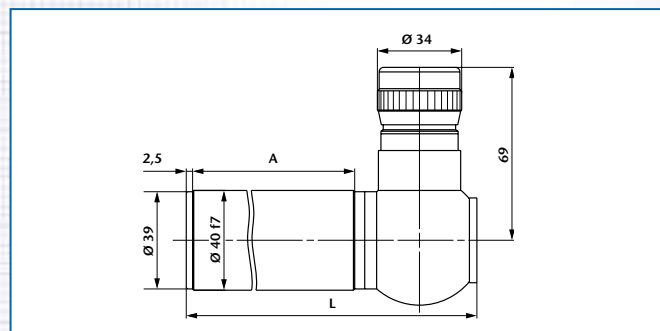
### Important:

Please specify reticle (see page 82) when ordering. Please specify direction of use if reticles with lettering (e.g. co-ordinate division etc.) are used so that the lettering will be right-side-up.

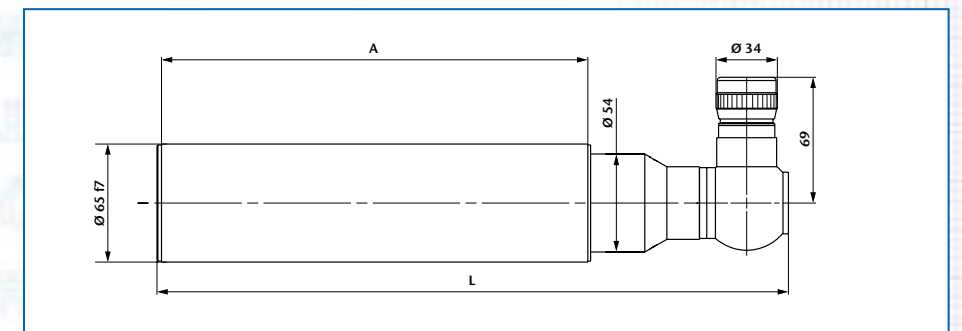
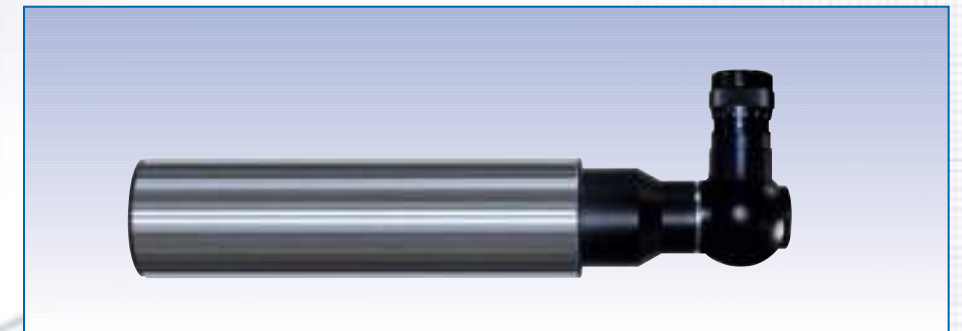
### Application examples

(additional collimator required):

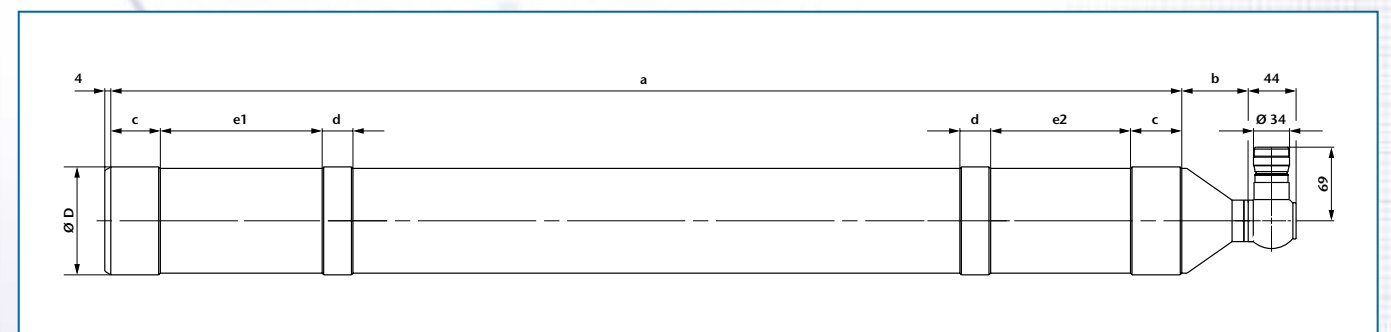
- Measurement of angular displacement
- Parallelism measurement of uncoated flats
- Testing of the imaging properties of optical elements and systems
- Measurement of the focal length of negative optical systems/ elements (additional attachment achromat required)



Ord.-No.	Description	Focal length	Free aperture	Field of view	A	L
227 041	FR 50/40/14,7	50	10	10,0°	65	116,5
227 042	FR 90/40/14,7	90	16	6,0°	65	116,5
227 043	FR 140/40/14,7	140	28	4,0°	118	169,5
227 044	FR 200/40/14,7	200	28	3,0°	173	224,5
227 045	FR 300/40/14,7	300	28	2,0°	274	325,5
227 046	FR 500/40/14,7	500	28	1,0°	474	525,5



Ord.-No.	Description	Focal length	Free aperture	Field of view	A	L
227 047	FR 300/65/14,7	300	50	2,0°	233	346,0
227 048	FR 500/65/14,7	500	50	1,0°	415	528,0
227 049	FR 500T/65/14,7	500	50	1,0°	233	346,0



Ord.-No.	Description	Focal length	Free aperture	Field of view	D	a	b	c	d	e1	e2
227 052	FR 600/128/14,7	600	100	0,8°	Ø 128 f7	530	46	-	58	154	78
227 053	FR 1100/105/14,7	1100	78	0,5°	Ø 105 f7	1045	66	50	30	165	100



# TESTING TELESCOPES

## 60°-VIEWING/60°-VIEWING WITH DOUBLE MICROMETER

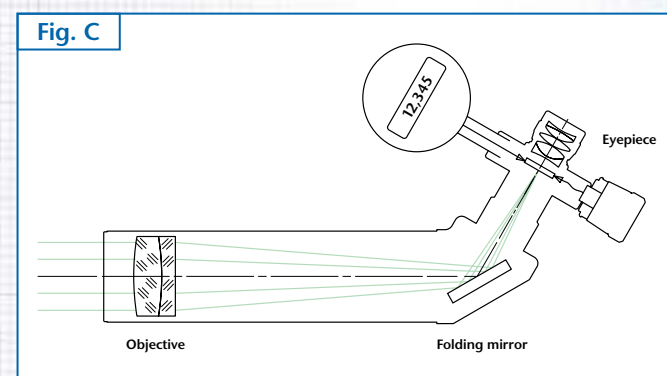
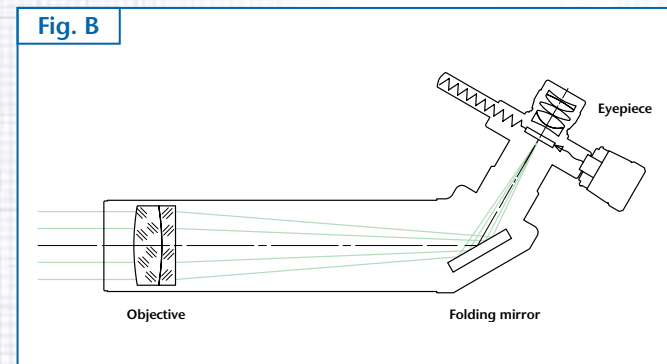
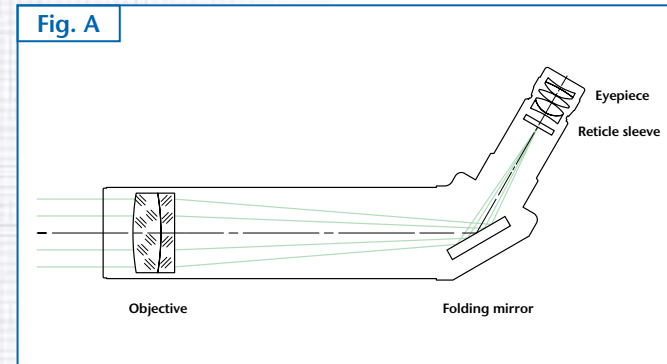
### Description:

For a general description of the operating principle of testing telescopes see page 20.

The basic function and design of testing telescopes with 60°-viewing is the same as of testing telescopes with 90°-viewing. The testing telescopes with 60° viewing contain a folding mirror (see following figure). The image appears upright but laterally reversed. This kind of testing telescopes is used for horizontally set-ups because the 60°-viewing is more ergonomic.

The testing telescopes with 60° viewing (figure A) are available also with mechanical micrometer (figure B) and digital double micrometers (figure C).

The scale division (SD) of the mechanical micrometer drum is 5 μm. For a general description of the operating principle of testing telescopes with double micrometers see page 28 and 30 respectively.



### Notes on ordering:

- Testing telescope eyepiece is commonly  $f=14,7$  mm but can be equipped with eyepieces  $f=25$  mm or  $f=10$  mm on request.
- One reticle and one eyepiece are included in the standard instrument.
- If not specified otherwise, the testing telescope is adjusted to infinity at 546 nm wavelength. Adjustment to other distances or wavelengths is also possible on demand.
- When ordering a telescope with digital double micrometer please specify the unit of display of the digital gauges (mm, arcsec, milliradians).
- The nomenclature of the testing telescopes with 60°-viewing and 60° viewing with double micrometer respectively is as follows:

Example: F W 300/ 65/ 14,7 MD

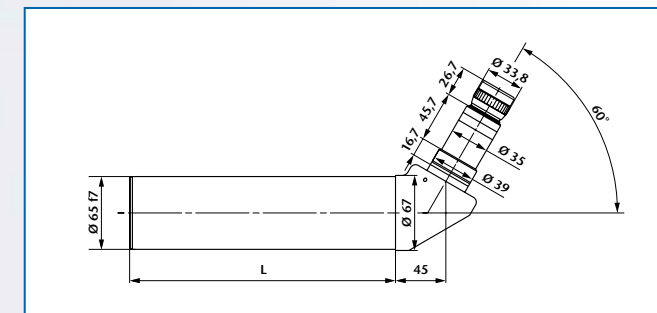
MDD

- Testing telescope
- 60° viewing
- Focal length
- Tube diameter
- Eyepiece focal length
- Double micrometer
- Digital double micrometer

### Important:

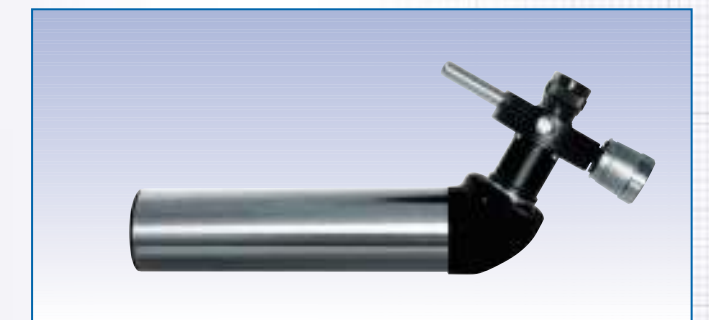
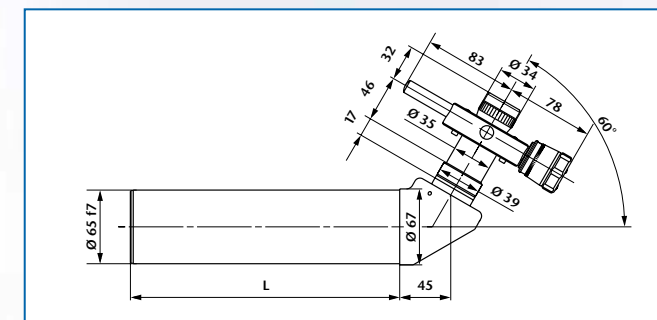
Please specify reticle (see page 82) when ordering.

## 60°-VIEWING

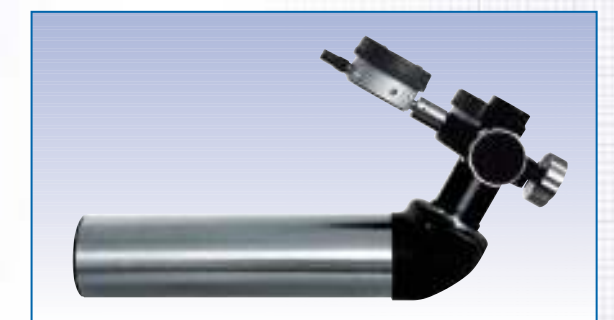
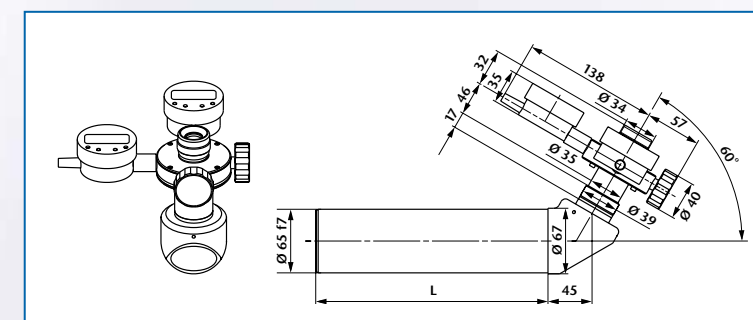


Ord.-No.	Description	Focal length	Free aperture	Field of view	L
227 067	FW 300/65/14,7	300	50	2,0°	233
227 068	FW 500/65/14,7	500	50	1,0°	415
227 069	FW 500T/65/14,7	500	50	1,0°	233

## 60°-VIEWING WITH DOUBLE MICROMETER



Ord.-No.	Description	Focal length	Free aperture	Meas. range	SD	L
227 177	FW 300/65/14,7 MD	300	50	0,6°	3,5"	233
227 178	FW 500/65/14,7 MD	500	50	0,4°	2,0"	415
227 179	FW 500T/65/14,7 MD	500	50	0,4°	2,0"	233



Ord.-No.	Description	Focal length	Free aperture	Meas. range	Resolution	L
227 217	FW 300/65/14,7 MDD	300	50	0,6°	1,0"	233
227 218	FW 500/65/14,7 MDD	500	50	0,4°	0,5"	415
227 219	FW 500T/65/14,7 MDD	500	50	0,4°	0,5"	233

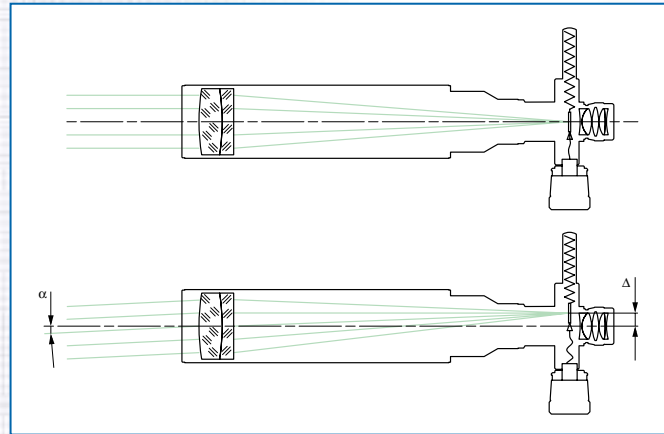
# TESTING TELESCOPES

## STRAIGHT VIEWING – WITH DOUBLE MICROMETER

### Description:

For a general description of the operating principle of testing telescopes see page 20.

Testing telescopes with mechanical double micrometer allow the measurement of deflection angles in two directions. The movement of the eyepiece reticle in x- and y-direction in the image plane can be read from the scale of the micrometer drums. The scale division (SD) is 5  $\mu\text{m}$ .



### Notes on ordering:

- Testing telescope eyepiece is commonly  $f=14,7$  mm but can be equipped with eyepieces  $f=25$  mm or  $f=10$  mm on request.
- One reticle and one eyepiece are included in the standard instrument.
- If not specified otherwise, the testing telescope is adjusted to infinity at 546 nm wavelength. Adjustment to other distances or wavelengths is also possible on demand.
- The nomenclature of the testing telescopes with straight viewing and mechanical double micrometer is as follows:

Example: F G 50/ 40/ 14,7 MD

Testing telescope  
Straight viewing  
Focal length  
Tube diameter  
Eyepiece focal length  
Double micrometer

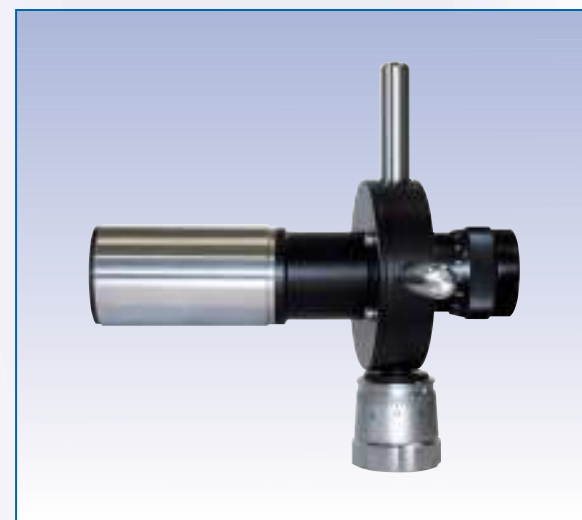
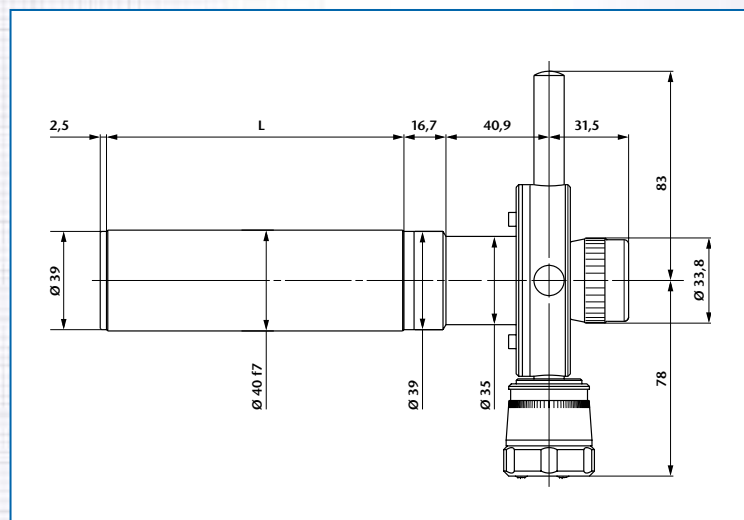
### Important:

Please specify reticle (see page 82) when ordering.

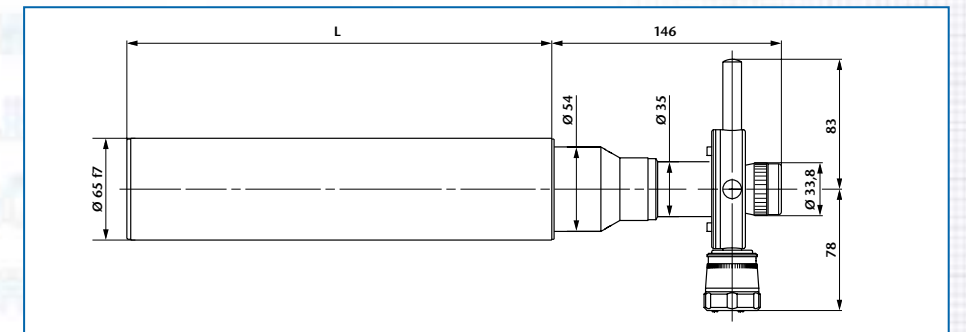
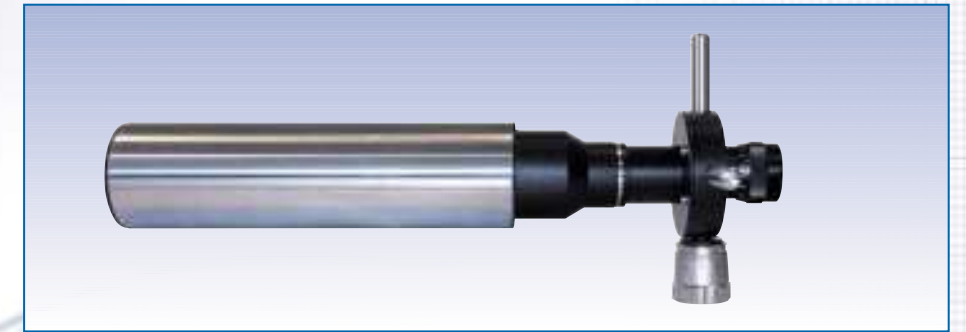
### Application examples

(additional collimator required):

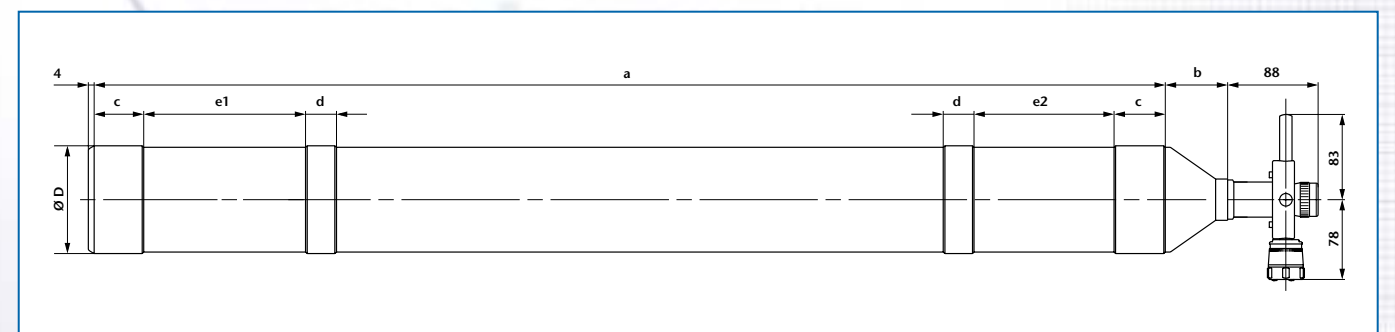
- Measurement of deflection angles
- Parallelism measurement of uncoated flats



Ord.-No.	Description	Focal length	Free aperture	Meas. range	SD	L
227 161	FG 50/40/14,7 MD	50	10	3,2°	20,0"	65
227 162	FG 90/40/14,7 MD	90	16	2,0°	11,5"	65
227 163	FG 140/40/14,7 MD	140	28	1,2°	7,5"	118
227 164	FG 200/40/14,7 MD	200	28	0,8°	5,0"	173
227 165	FG 300/40/14,7 MD	300	28	0,6°	3,5"	274
227 166	FG 500/40/14,7 MD	500	28	0,4°	2,0"	474



Ord.-No.	Description	Focal length	Free aperture	Meas. range	SD	L
227 167	FG 300/65/14,7 MD	300	50	0,6°	3,5"	233
227 168	FG 500/65/14,7 MD	500	50	0,4°	2,0"	415
227 169	FG 500T/65/14,7 MD	500	50	0,4°	2,0"	233



Ord.-No.	Description	Focal length	Free aperture	Meas. range	SD	D	a	b	c	d	e1	e2
227 172	FG 600/128/14,7 MD	600	100	0,30°	1,7"	$\varnothing$ 128 f7	530	46	-	58	154	78
227 173	FG 1100/105/14,7 MD	1100	78	0,16°	1,0"	$\varnothing$ 105 f7	1045	66	50	30	165	100

INTRODUCTION COLLIMATORS TESTING TELESCOPES AUTOCOLLIMATORS MODULES RETICLES ALIGNMENT SYSTEMS OTHER INSTRUMENTS ACCESSORIES

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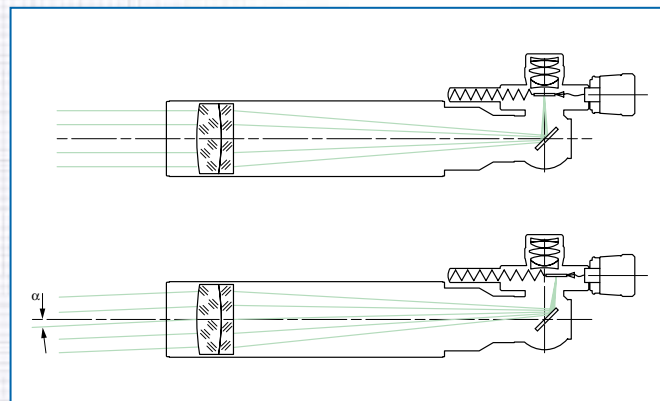
# TESTING TELESCOPES

## 90°-VIEWING – WITH DOUBLE MICROMETER

### Description:

For a general description of the operating principle of testing telescopes see page 20.

Testing telescopes with mechanical double micrometer allow the measurement of deflection angles in two directions. The movement of the eyepiece reticle in x- and y-direction in the image plane can be read from the scale of the micrometer drums. The scale division (SD) is 5 μm. The following figure shows the set-up of a testing telescope with 90° viewing. In contrast to a testing telescope with straight viewing the image appears upright and laterally reversed.



### Application examples

(additional collimator required):

- Measurement of deflection angles
- Parallelism measurement of uncoated flats

### Notes on ordering:

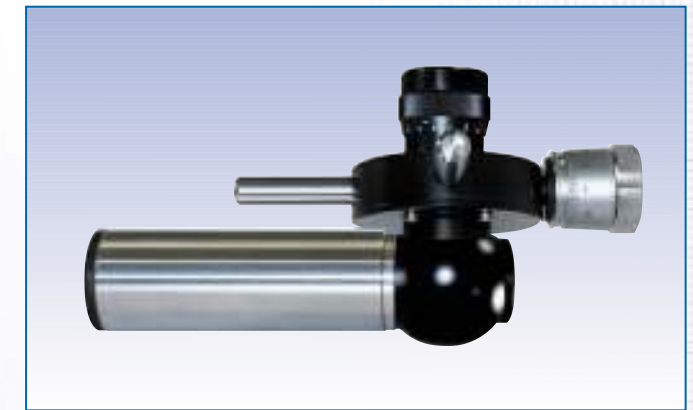
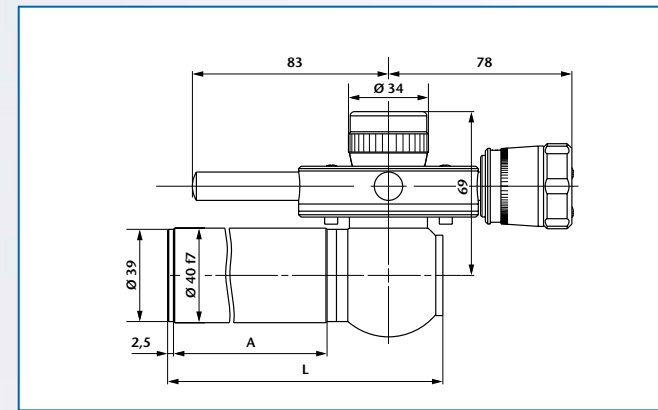
- Testing telescope eyepiece is commonly f=14,7 mm but can be equipped with eyepieces f=25 mm or f=10 mm on request.
- One reticle and one eyepiece are included in the standard instrument.
- If not specified otherwise, the testing telescope is adjusted to infinity at 546 nm wavelength. Adjustment to other distances or wavelengths is also possible on demand.
- The nomenclature of the testing telescopes with 90°-viewing and mechanical double micrometer is as follows:

Example: F R 50/ 40/ 14,7 MD

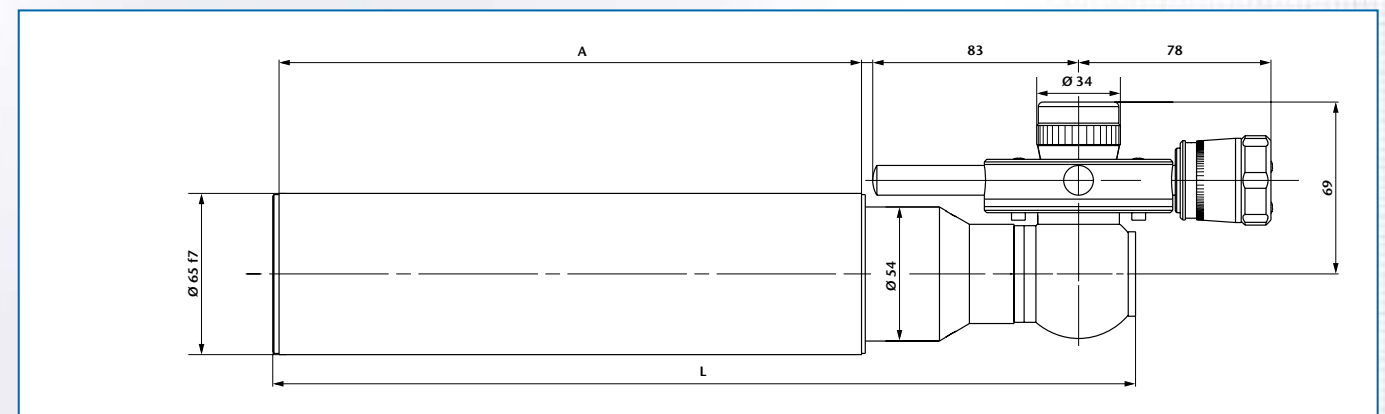
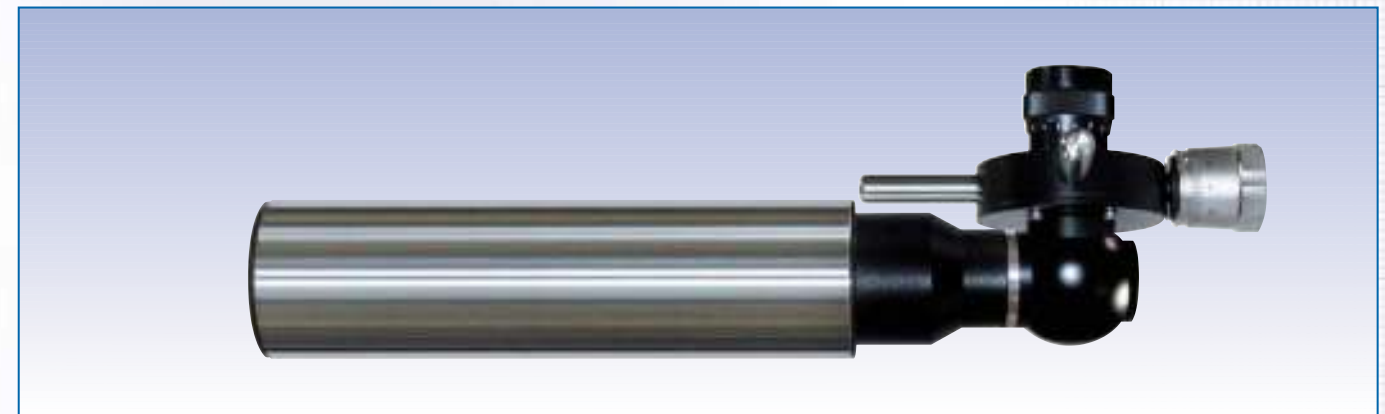
- Testing telescope
- 90° viewing
- Focal length
- Tube diameter
- Eyepiece focal length
- Double micrometer

### Important:

Please specify reticle (see page 82) when ordering. Please specify direction of use if reticles with lettering (e.g. co-ordinate division etc.) are used so that the lettering will be right-side-up.



Ord.-No.	Description	Focal length	Free aperture	Meas. range	SD	A	L
227 181	FR 50/40/14,7 MD	50	10	3,2°	20,0"	65	116,5
227 182	FR 90/40/14,7 MD	90	18	2,0°	11,5"	65	116,5
227 183	FR 140/40/14,7 MD	140	28	1,2°	7,5"	118	169,5
227 184	FR 200/40/14,7 MD	200	28	0,8°	5,0"	173	224,5
227 185	FR 300/40/14,7 MD	300	28	0,6°	3,5"	274	325,5
227 186	FR 500/40/14,7 MD	500	28	0,4°	2,0"	474	525,5



Ord.-No.	Description	Focal length	Free aperture	Meas. range	SD	A	L
227 187	FR 300/65/14,7 MD	300	50	0,6°	3,5"	233	346,0
227 188	FR 500/65/14,7 MD	500	50	0,4°	2,0"	415	528,0
227 189	FR 500T/65/14,7 MD	500	50	0,4°	2,0"	233	346,0

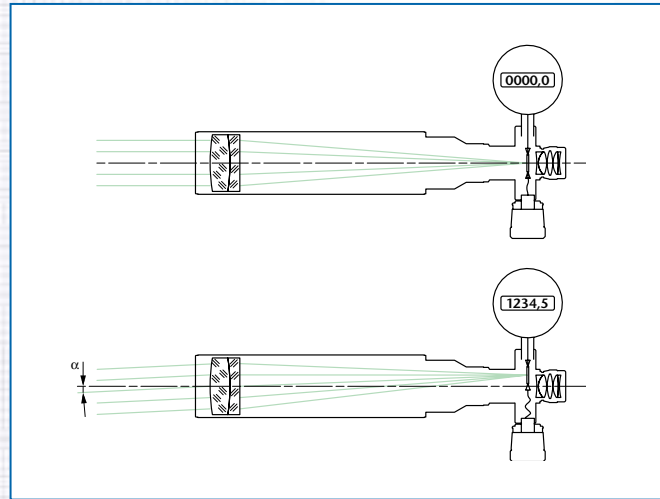
# TESTING TELESCOPES

## STRAIGHT VIEWING – WITH DIGITAL DOUBLE MICROMETER

### Description:

For a general description of the operating principle of testing telescopes see page 20.

Testing telescopes with digital double micrometer allow the measurement of deflection angles in two directions. The programmable measuring gauges allow the operator to read the angular displacement in arcsec or mrad.



### Notes on ordering:

- Testing telescope eyepiece is commonly  $f=14,7$  mm but can be equipped with eyepieces  $f=25$  mm or  $f=10$  mm on request.
- One reticle and one eyepiece are included in the standard instrument.
- If not specified otherwise, the testing telescope is adjusted to infinity at 546 nm wavelength. Adjustment to other distances or wavelengths is also possible on demand.
- Please specify the unit of reading (mm or arcsec or mrad) when ordering.
- The nomenclature of the testing telescopes with straight-viewing and digital double micrometer is as follows:

Example: F G 50/ 40/ 14,7 MDD

Testing telescope  
Straight viewing  
Focal length  
Tube diameter  
Eyepiece focal length  
Digital double micrometer

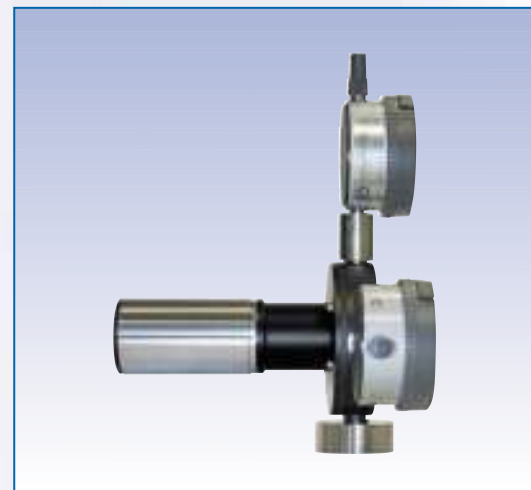
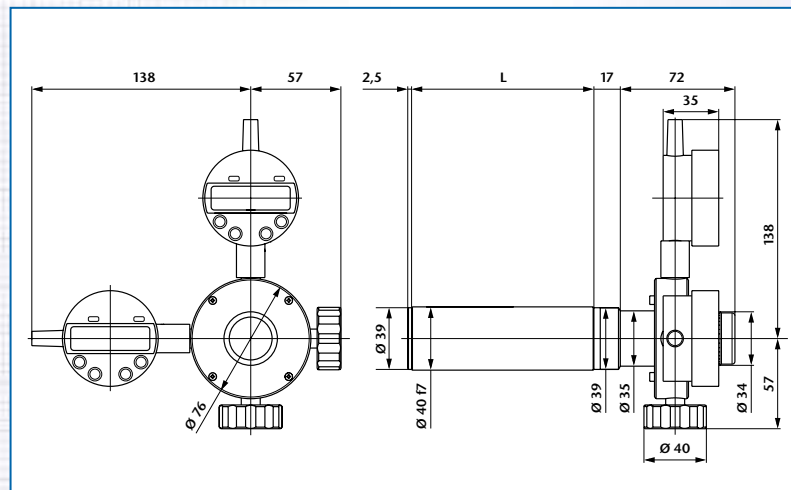
### Important:

Please specify reticle (see page 82) when ordering.

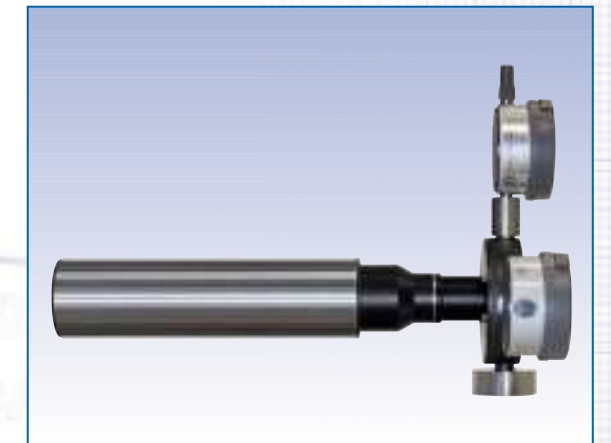
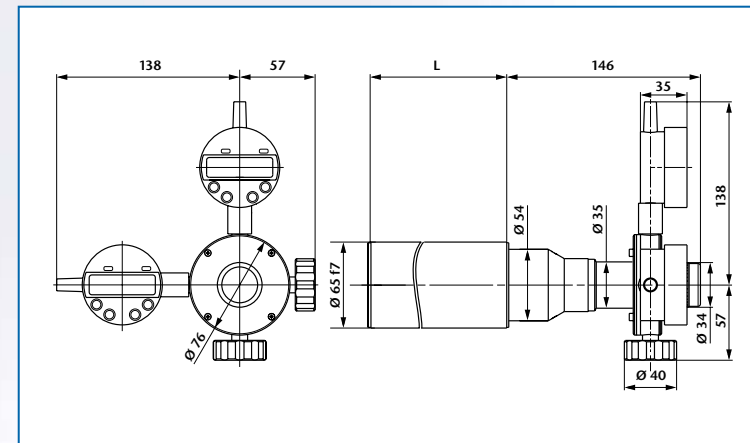
### Application examples

(additional collimator required):

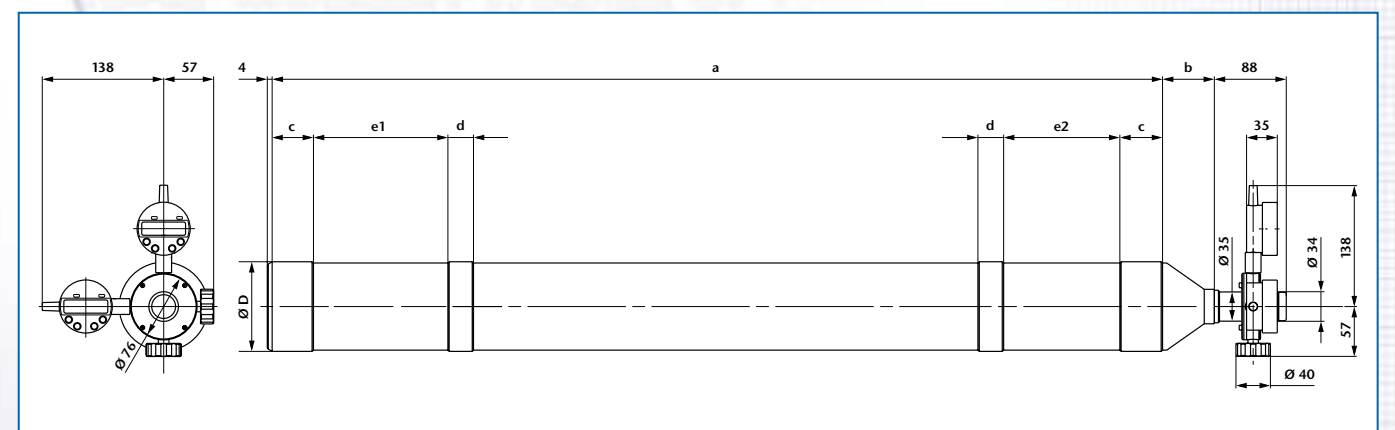
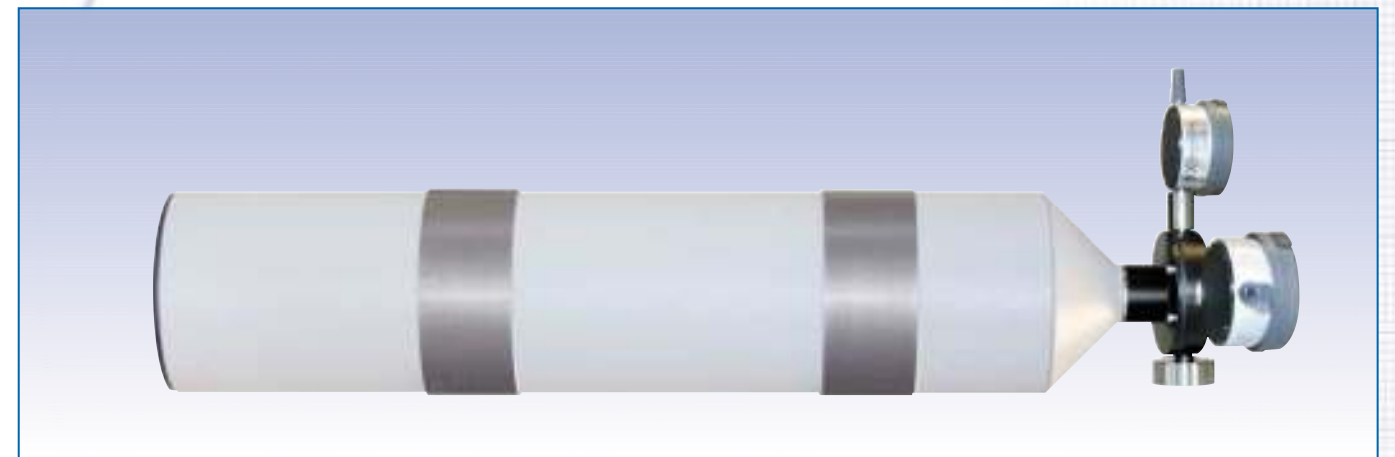
- Measurement of deflection angles
- Parallelism measurement of uncoated flats



Ord.-No.	Description	Focal length	Free aperture	Meas. range	Resolution	L
227 201	FG 50/40/14,7 MDD	50	10	5,6°	5,0"	65
227 202	FG 90/40/14,7 MDD	90	16	3,0°	5,0"	65
227 203	FG 140/40/14,7 MDD	140	28	2,0°	2,0"	118
227 204	FG 200/40/14,7 MDD	200	28	1,4°	2,0"	173
227 205	FG 300/40/14,7 MDD	300	28	1,0°	1,0"	274
227 206	FG 500/40/14,7 MDD	500	28	0,5°	0,5"	474



Ord.-No.	Description	Focal length	Free aperture	Meas. range	Resolution	L
227 207	FG 300/65/14,7 MDD	300	50	1,0°	1,0"	233
227 208	FG 500/65/14,7 MDD	500	50	0,5°	0,5"	415
227 209	FG 500T/65/14,7 MDD	500	50	0,5°	0,5"	233



Ord.-No.	Description	Focal length	Free aperture	Meas. range	Resolution	D	a	b	c	d	e1	e2
227 212	FG 600/128/14,7 MDD	600	100	0,40°	0,5"	Ø 128 f7	530	46	-	58	154	78
227 213	FG 1100/105/14,7 MDD	1100	78	0,24°	0,2"	Ø 105 f7	1045	66	50	30	165	100

INTRODUCTION COLLIMATORS TESTING TELESCOPES AUTOCOLLIMATORS MODULES RETICLES ALIGNMENT SYSTEMS OTHER INSTRUMENTS ACCESSORIES

INTRODUCTION COLLIMATORS TESTING TELESCOPES AUTOCOLLIMATORS MODULES RETICLES ALIGNMENT SYSTEMS OTHER INSTRUMENTS ACCESSORIES



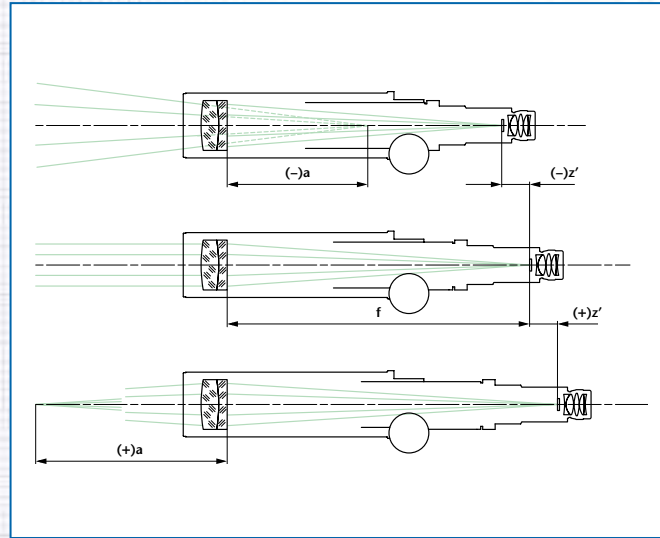
# TESTING TELESCOPES

## FOCUS ADJUSTABLE – WITH STRAIGHT VIEWING

### Description:

For a general description of the operating principle of testing telescopes see page 20.

An adjustable focus telescope allows the distance between reticle and telescope objective to be adjusted for measurements made at other than infinity. Additionally, infinity can be set for different wavelengths of light.



### Notes on ordering:

- Testing telescope eyepiece is commonly  $f=14,7$  mm but can be equipped with eyepieces  $f=25$  mm or  $f=10$  mm on request.
- One reticle and one eyepiece are included in the standard instrument.
- The nomenclature of the focus adjustable telescope with straight viewing is as follows:

Example: F G V 90/ 40/ 14,7 ±6

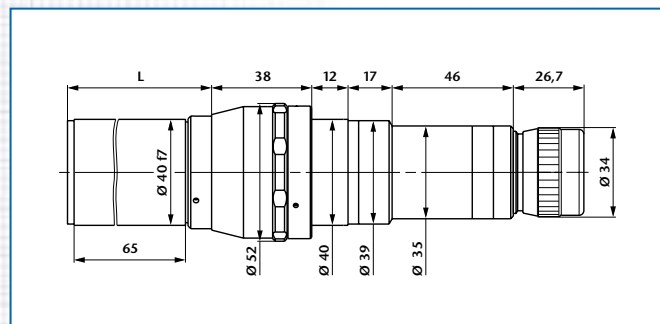
Testing telescope  
Straight viewing  
Variable  
Focal length  
Tube diameter  
Eyepiece focal length  
Tube extension in mm

### Important:

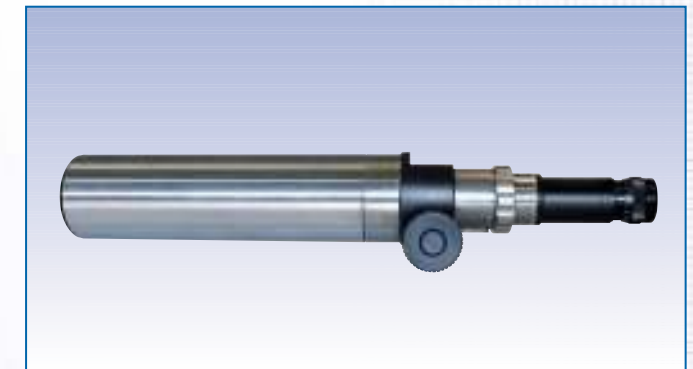
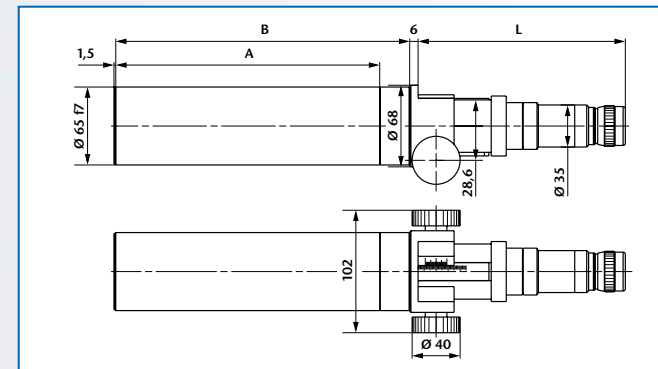
Please specify reticle (see page 82) when ordering.

### Application examples:

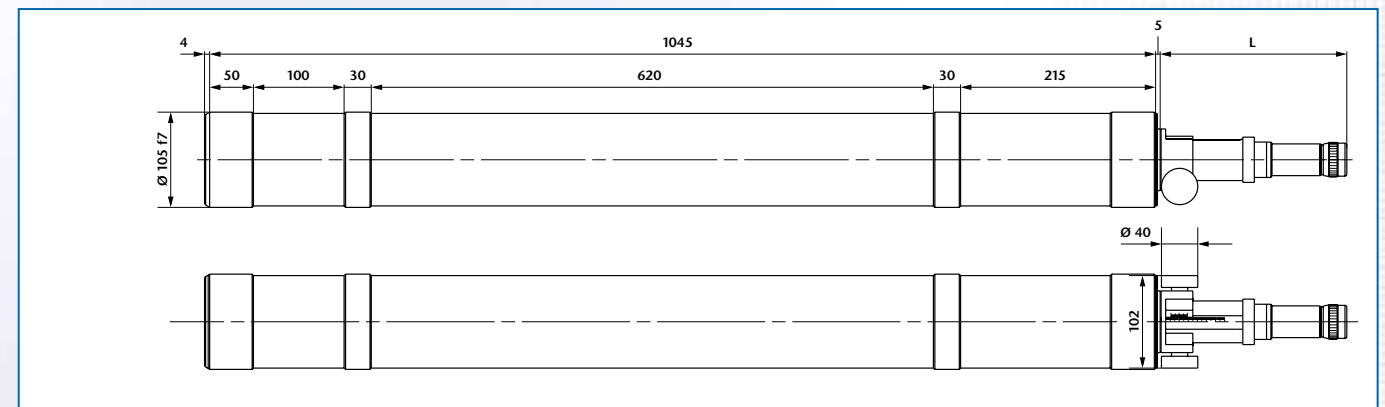
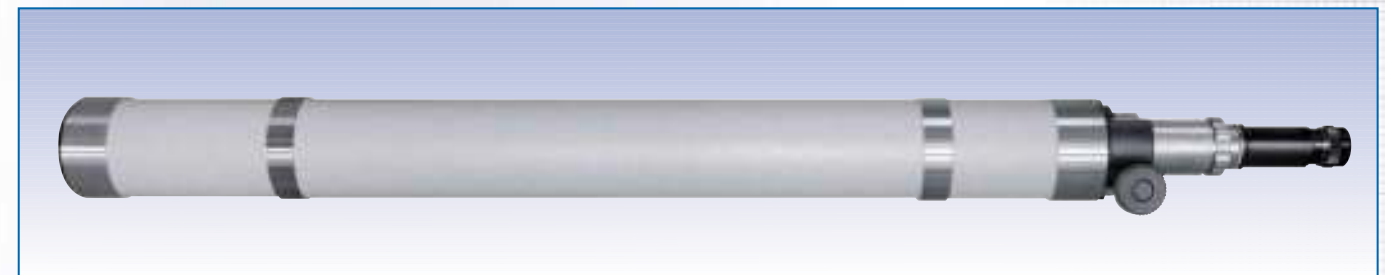
- Adjustment of optical and mechanical systems
- Qualitative testing of image quality of optical elements and systems (additional collimator required)
- Testing at different wavelengths of light



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Field of view	Distance range	L
227 501	FGV 90/40/14,7/±6	90	16	±6	6,0°	-∞...-1,25 m 1,40 m...+∞	77±6
227 502	FGV 90/40/14,7/+12	90	16	+12	6,0°	0,80 m...+∞	71 <sup>+12</sup>
227 503	FGV 90/40/14,7/-12	90	16	-12	6,0°	-∞...-0,60 m	83 <sup>-12</sup>
227 504	FGV 140/40/14,7/±6	140	28	±6	4,0°	-∞...-3,10 m 3,30 m...+∞	77±6
227 505	FGV 140/40/14,7/+12	140	28	+12	4,0°	1,70 m...+∞	71 <sup>+12</sup>
227 506	FGV 140/40/14,7/-12	140	28	-12	4,0°	-∞...-1,40 m	83 <sup>-12</sup>



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Field of view	Distance range	A	B	L
227 507	FGV 300/65/14,7/±25	300	50	±25	2,0°	-∞...-3,4 m 3,8 m...+∞	220	245	173±25
227 508	FGV 300/65/14,7/+50	300	50	+50	2,0°	2,1 m...+∞	220	270	148 <sup>+50</sup>
227 509	FGV 300/65/14,7/-50	300	50	-50	2,0°	-∞...-1,5 m	220	220	198 <sup>-50</sup>
227 510	FGV 500/65/14,7/±50	500	50	±50	1,0°	-∞...-4,5 m 5,4 m...+∞	310	360	198±50
227 511	FGV 500/65/14,7/+100	500	50	+100	1,0°	3,0 m...+∞	310	410	148 <sup>+100</sup>
227 512	FGV 500/65/14,7/-100	500	50	-100	1,0°	-∞...-1,5 m	310	310	248 <sup>-100</sup>



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Field of view	Distance range	L
227 516	FGV 1100/105/14,7/±50	1100	78	±50	0,5°	-∞...-23,70 m 25,80 m...+∞	202±50
227 517	FGV 1100/105/14,7/+100	1100	78	+100	0,5°	13,20 m...+∞	202 <sup>+100</sup>
227 518	FGV 1100/105/14,7/-100	1100	78	-100	0,5°	-∞...-12,00 m	202 <sup>-100</sup>



# TESTING TELESCOPES

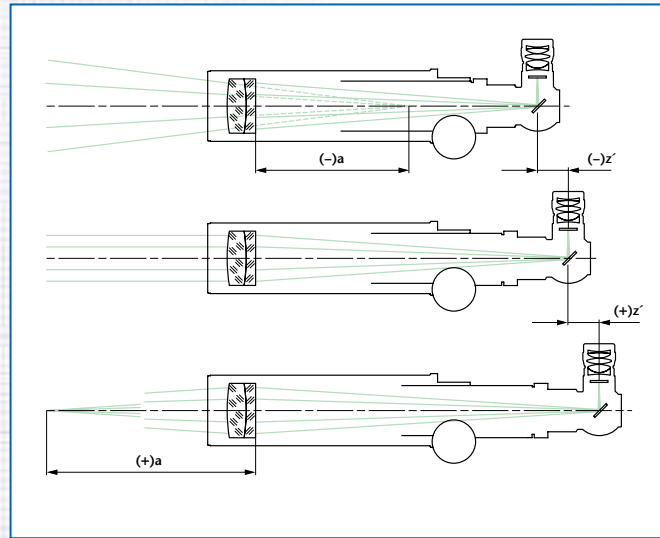
## FOCUS ADJUSTABLE – WITH 90°-VIEWING

### Description:

For a general description of the operating principle of testing telescopes see page 20.

An adjustable focus telescope allows the distance between reticle and telescope objective to be adjusted for measurements made at other than infinity. Additionally, infinity can be set for different wavelengths of light.

The following figure shows the set-up of a focusable telescope with 90° viewing. In contrast to a telescope with straight viewing the image appears upright and laterally reversed.



### Application examples:

- Adjustment of optical and mechanical systems
- Qualitative testing of image quality of optical elements and systems (additional collimator required)
- Testing at different wavelengths of light

### Notes on ordering:

- Telescope eyepiece is commonly  $f=14,7$  mm but can be equipped with eyepieces  $f=25$  mm or  $f=10$  mm on request.
- One reticle and one eyepiece are included in the instrument.
- The nomenclature of the focus adjustable testing telescopes with 90°-viewing is as follows:

Example: F R V 90/ 40/ 14,7 ±6

Testing telescope  
90° viewing

Variable

Focal length

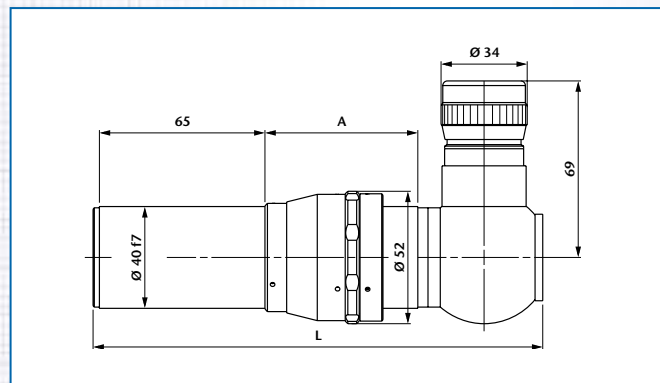
Tube diameter

Eyepiece focal length

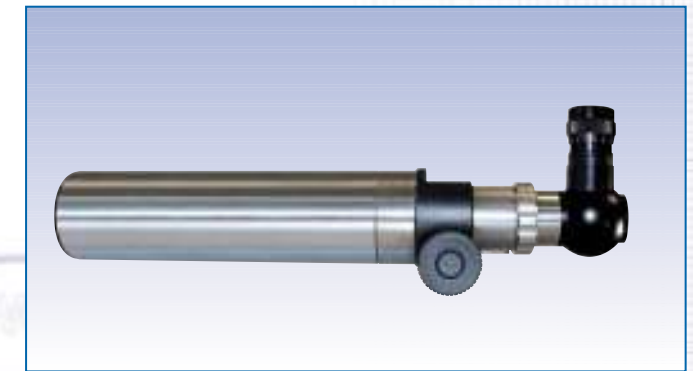
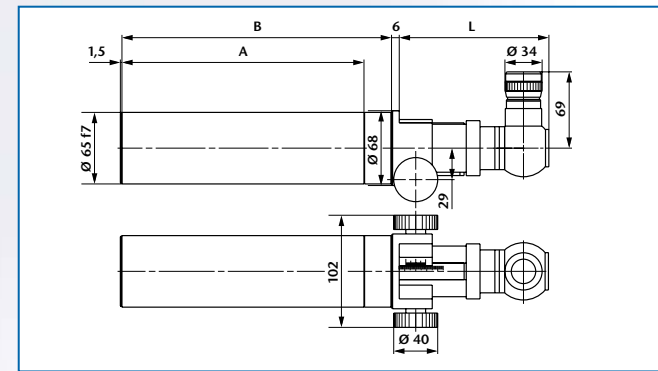
Tube extension in mm

### Important:

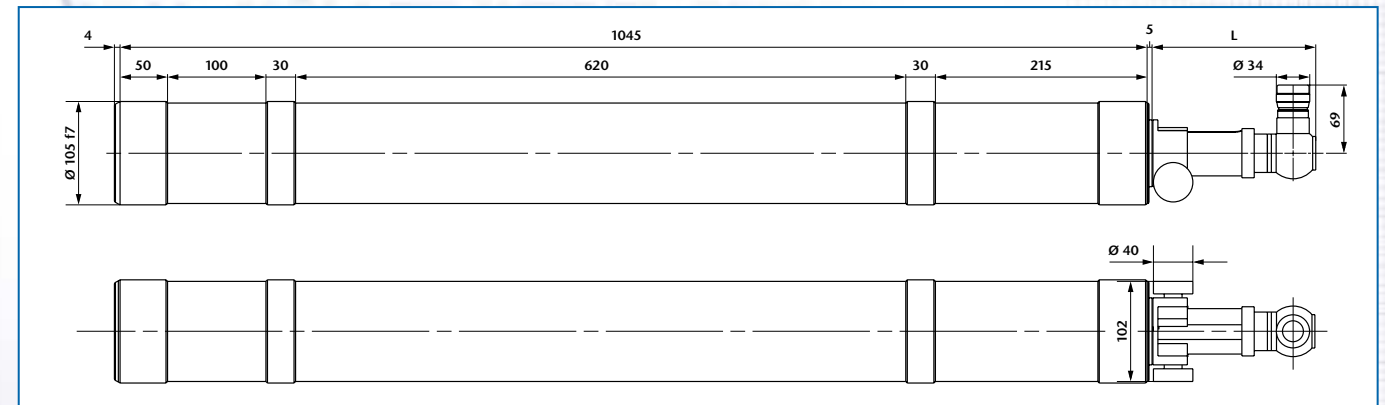
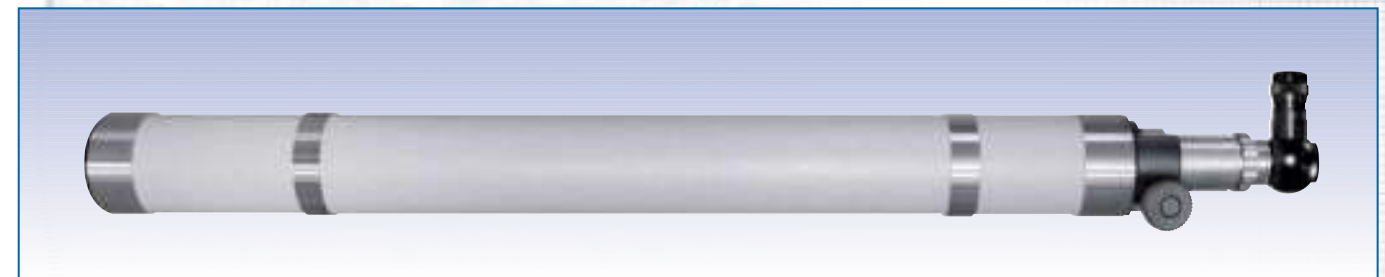
Please specify reticle (see page 82) when ordering.  
Please specify direction of use if reticles with lettering are used so that the lettering will be right-side-up.



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Field of view	Distance range	A	L
227 541	FRV 90/40/14,7/±6	90	16	±6	6,0°	-∞...-1,25 m 1,40 m...+∞	60±6	176,5±6
227 542	FRV 90/40/14,7/+12	90	16	+12	6,0°	0,80 m...+∞	54 <sup>+12</sup>	170,5 <sup>+12</sup>
227 543	FRV 90/40/14,7/-12	90	16	-12	6,0°	-∞...-0,60 m	66 <sup>-12</sup>	182,5 <sup>-12</sup>
227 544	FRV 140/40/14,7/±6	140	28	±6	4,0°	-∞...-3,10 m 3,30 m...+∞	60±6	176,5±6
227 545	FRV 140/40/14,7/+12	140	28	+12	4,0°	1,70 m...+∞	54 <sup>+12</sup>	170,5 <sup>+12</sup>
227 546	FRV 140/40/14,7/-12	140	28	-12	4,0°	-∞...-1,40 m	66 <sup>-12</sup>	182,5 <sup>-12</sup>



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Field of view	Distance range	A	B	L
227 547	FRV 300/65/14,7/±25	300	50	±25	2,0°	-∞...-3,4 m 3,8 m...+∞	220	245	140±25
227 548	FRV 300/65/14,7/+50	300	50	+50	2,0°	2,1 m...+∞	220	270	115 <sup>+50</sup>
227 549	FRV 300/65/14,7/-50	300	50	-50	2,0°	-∞...-1,5 m	220	220	165 <sup>-50</sup>
227 550	FRV 500/65/14,7/±50	500	50	±50	1,0°	-∞...-4,5 m 5,4 m...+∞	310	360	165±50
227 551	FRV 500/65/14,7/+100	500	50	+100	1,0°	3,0 m...+∞	310	410	115 <sup>+100</sup>
227 552	FRV 500/65/14,7/-100	500	50	-100	1,0°	-∞...-1,5 m	310	310	215 <sup>-100</sup>



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Field of view	Distance range	L
227 556	FRV 1100/105/14,7/±50	1100	78	±50	0,5°	-∞...-23,70m 25,80 m...+∞	161±50
227 557	FRV 1100/105/14,7/+100	1100	78	+100	0,5°	13,20 m...+∞	161 <sup>+100</sup>
227 558	FRV 1100/105/14,7/-100	1100	78	-100	0,5°	-∞...-12,00 m	161 <sup>-100</sup>

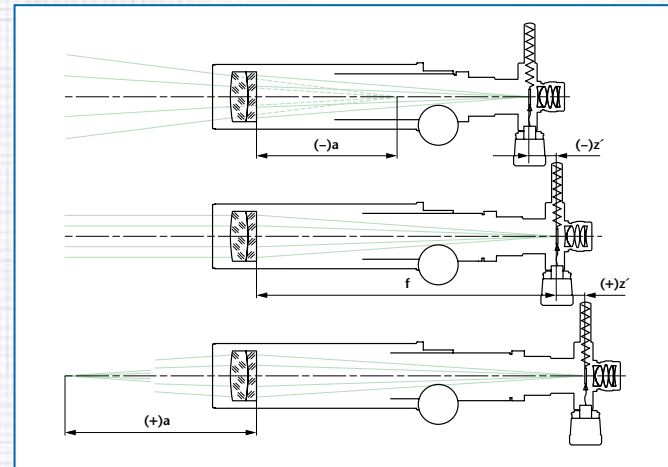
# TESTING TELESCOPES

## FOCUS ADJUSTABLE – STRAIGHT VIEWING WITH DOUBLE

### Description:

For a general description of the operating principle of testing telescopes see page 20.

An adjustable focus telescope with mechanical double micrometer allows the distance between reticle and telescope objective to be adjusted for measurements made at other than infinity. Additionally, infinity can be set for different wavelengths of light. The scale division (SD) of the micrometer drums is 5  $\mu\text{m}$ .



### Notes on ordering:

- Telescopes eyepiece is commonly  $f=14,7$  mm but can be equipped with eyepieces  $f=25$  mm or  $f=10$  mm on request.
- One reticle and one eyepiece are included in the instrument.
- The nomenclature of the focus adjustable testing telescopes with straight viewing and mechanical double micrometer is as follows:

Example: F G V 90/ 40/ 14,7  $\pm 6$  MD

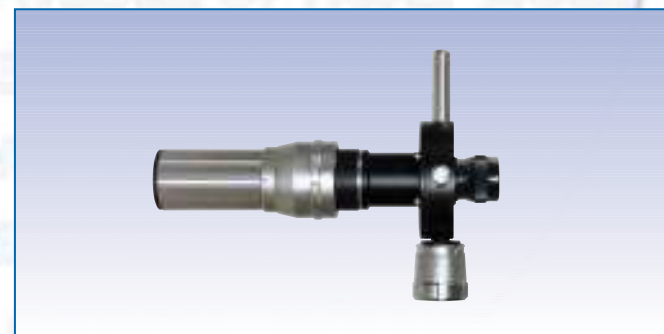
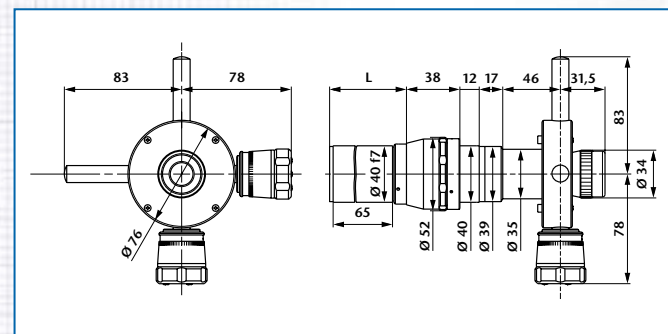
Testing telescope  
 Straight viewing  
 Variable  
 Focal length  
 Tube diameter  
 Eyepiece focal length  
 Tube extension in mm  
 Double micrometer

### Important:

Please specify reticle (see page 82) when ordering.

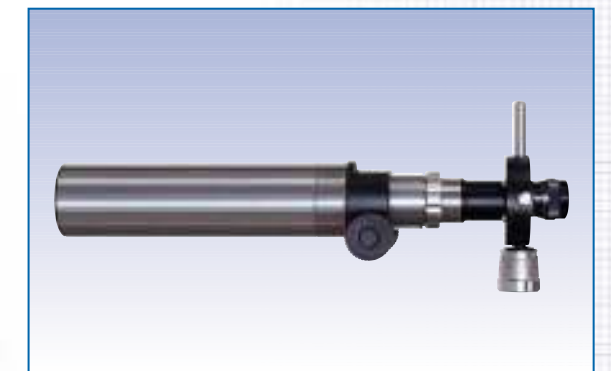
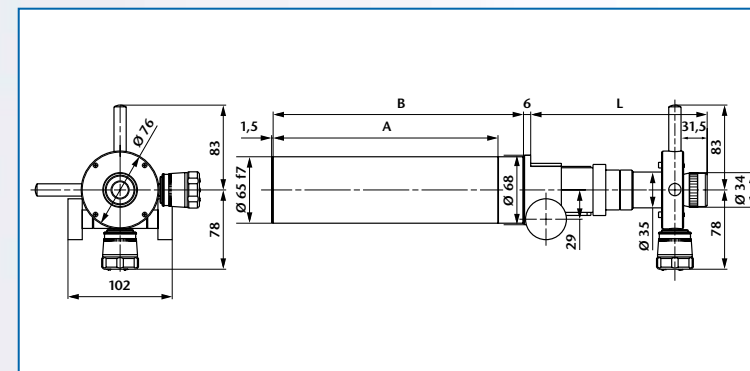
### Application examples:

- Adjustment of optical and mechanical systems
- Qualitative testing of image quality of optical elements and systems (additional collimator required)
- Testing at different wavelengths of light
- Measurement of deflection angles (add. collimator required)

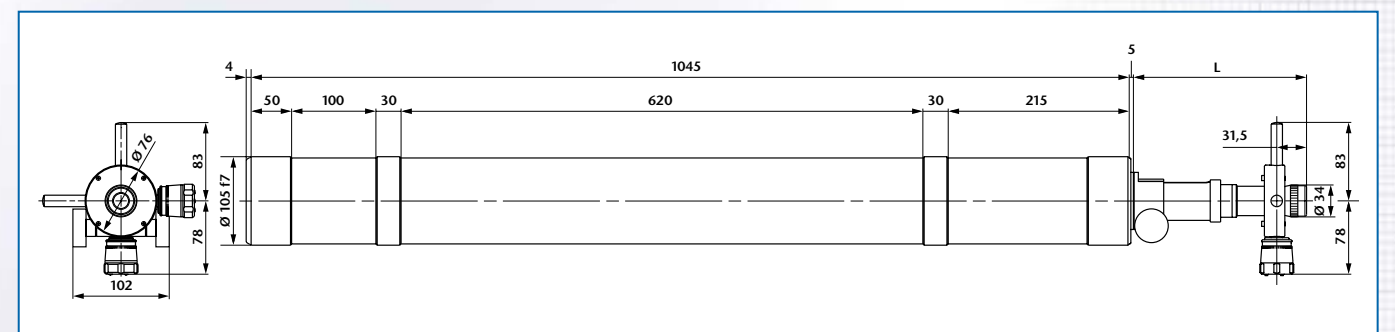
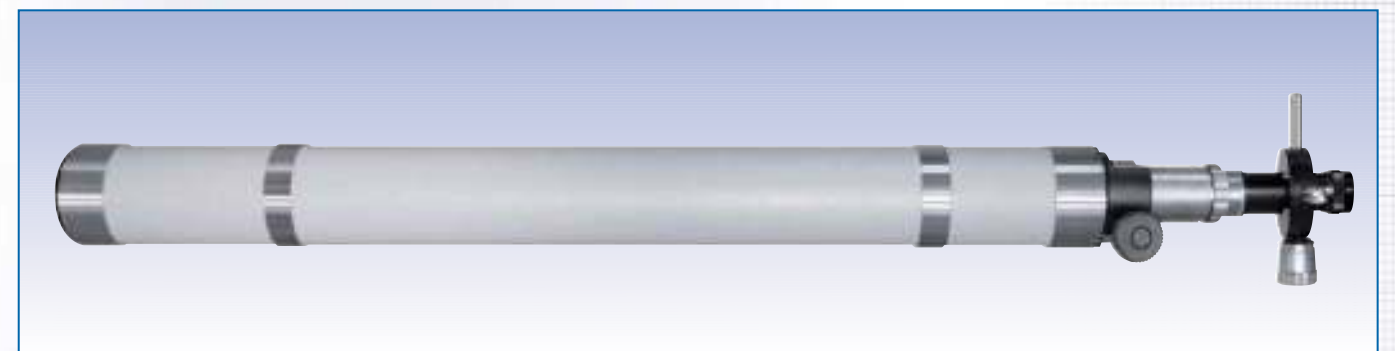


Ord.-No.	Description	Focal length	Free aperture	Tube extension	Meas. range	SD	Distance range	L
227 661	FGV 90/40/14,7/ $\pm 6$ MD	90	16	$\pm 6$	2,0°	11,5"	$-\infty \dots -1,25$ m 1,40 m... $+\infty$	77 $\pm 6$
227 662	FGV 90/40/14,7/+12 MD	90	16	+12	2,0°	11,5"	0,80 m... $+\infty$	71 $^{+12}$
227 663	FGV 90/40/14,7/-12 MD	90	16	-12	2,0°	11,5"	$-\infty \dots -0,60$ m	83 $_{-12}$
227 664	FGV 140/40/14,7/ $\pm 6$ MD	140	28	$\pm 6$	1,2°	7,5"	$-\infty \dots -3,10$ m 3,30 m... $+\infty$	77 $\pm 6$
227 665	FGV 140/40/14,7/+12 MD	140	28	+12	1,2°	7,5"	1,70 m... $+\infty$	71 $^{+12}$
227 666	FGV 140/40/14,7/-12 MD	140	28	-12	1,2°	7,5"	$-\infty \dots -1,40$ m	83 $_{-12}$

## MICROMETER



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Meas. range	SD	Distance range	A	B	L
227 667	FGV 300/65/14,7/ $\pm 25$ MD	300	50	$\pm 25$	0,6°	3,5"	$-\infty \dots -3,4$ m 3,8 m... $+\infty$	220	245	173 $\pm 25$
227 668	FGV 300/65/14,7/+50 MD	300	50	+50	0,6°	3,5"	2,1 m... $+\infty$	220	270	148 $^{+50}$
227 669	FGV 300/65/14,7/-50 MD	300	50	-50	0,6°	3,5"	$-\infty \dots -1,5$ m	220	220	198 $_{-50}$
227 670	FGV 500/65/14,7/ $\pm 50$ MD	500	50	$\pm 50$	0,4°	2,0"	$-\infty \dots -4,5$ m 5,4 m... $+\infty$	310	360	198 $\pm 50$
227 671	FGV 500/65/14,7/+100 MD	500	50	+100	0,4°	2,0"	3,0 m... $+\infty$	310	410	148 $^{+100}$
227 672	FGV 500/65/14,7/-100 MD	500	50	-100	0,4°	2,0"	$-\infty \dots -1,5$ m	310	310	248 $_{-100}$



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Meas. range	SD	Distance range	L
227 676	FGV 1100/105/ $\pm 50$ MD	1100	80	$\pm 50$	0,16°	1,0"	$-\infty \dots -23,70$ m 25,80 m... $+\infty$	202 $\pm 50$
227 677	FGV 1100/105/+100 MD	1100	80	+100	0,16°	1,0"	13,20 m... $+\infty$	202 $^{+100}$
227 678	FGV 1100/105/-100 MD	1100	80	-100	0,16°	1,0"	$-\infty \dots -12,00$ m	202 $_{-100}$

INTRODUCTION COLLIMATORS TESTING TELESCOPES AUTOCOLLIMATORS MODULES RETICLES ALIGNMENT SYSTEMS OTHER INSTRUMENTS ACCESSORIES

INTRODUCTION COLLIMATORS TESTING TELESCOPES AUTOCOLLIMATORS MODULES RETICLES ALIGNMENT SYSTEMS OTHER INSTRUMENTS ACCESSORIES



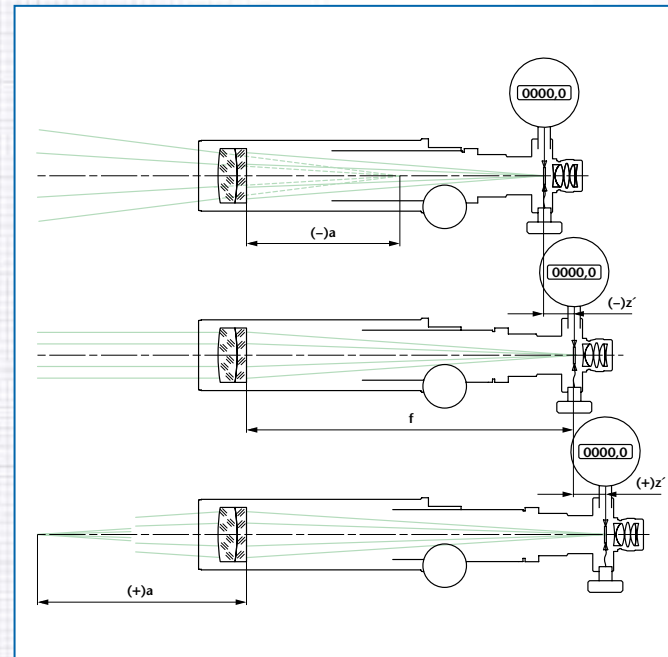
# TESTING TELESCOPES

## FOCUS ADJUSTABLE – STRAIGHT-VIEWING WITH DIGITAL DOUBLE

### Description:

For a general description of the operating principle of testing telescopes see page 20.

An adjustable focus telescope with digital double micrometer allows the distance between reticle and telescope objective to be adjusted for measurements made at other than infinity. Additionally, infinity can be set for different wavelengths of light. The programmable digital gauges of the telescope allow the operator to read directly angular displacement in arcsec or mrad.



### Application examples:

- Adjustment of optical and mechanical systems
- Measurement of big radii of curvature (additional collimator required)
- Adjustment for different wavelengths of light
- Measurement of deflection angles (additional collimator required)

### Notes on ordering:

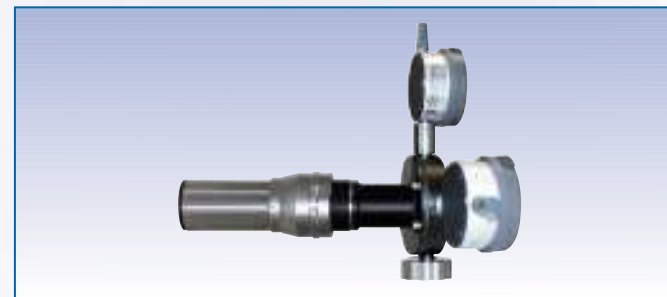
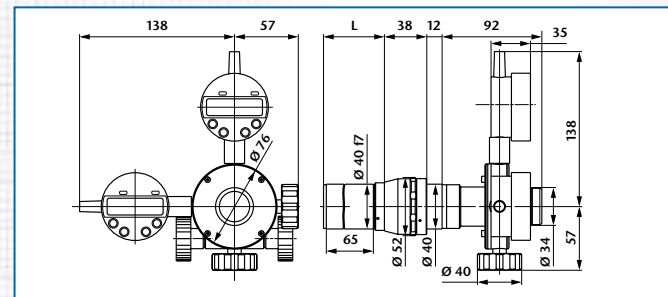
- Testing telescopes can be equipped with eyepieces  $f=25$  mm or  $f=10$  mm on request.
- One reticle and eyepiece are included in the instrument.
- Please specify the unit of reading (mm or arcsec or mrad) when ordering.
- The nomenclature of the adjustable testing telescopes with straight viewing and digital double micrometer is as follows:

Example: F G V 90/ 40/ 14,7 ±6 MDD

Testing telescope  
 Straight viewing  
 Variable  
 Focal length  
 Tube diameter  
 Eyepiece focal length  
 Tube extension in mm  
 Digital double micrometer

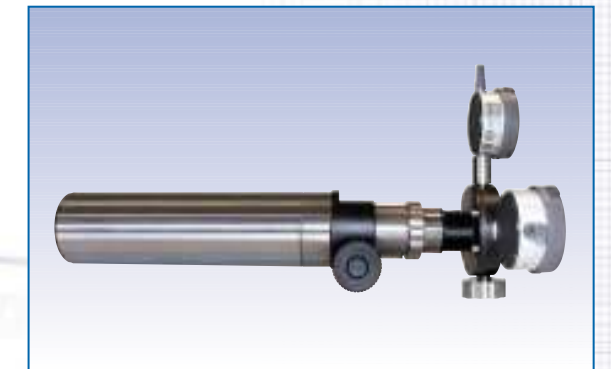
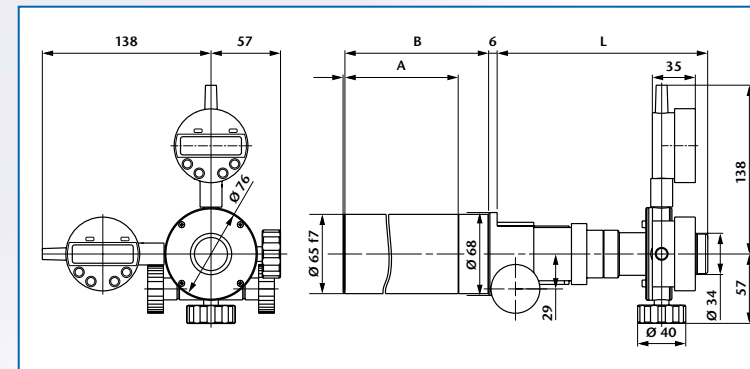
### Important:

Please specify reticle (see page 82) when ordering.

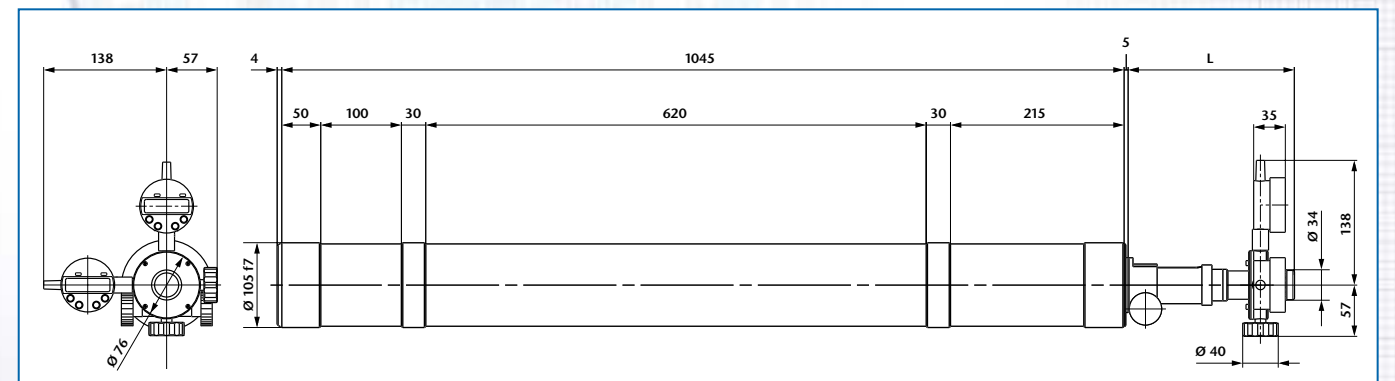
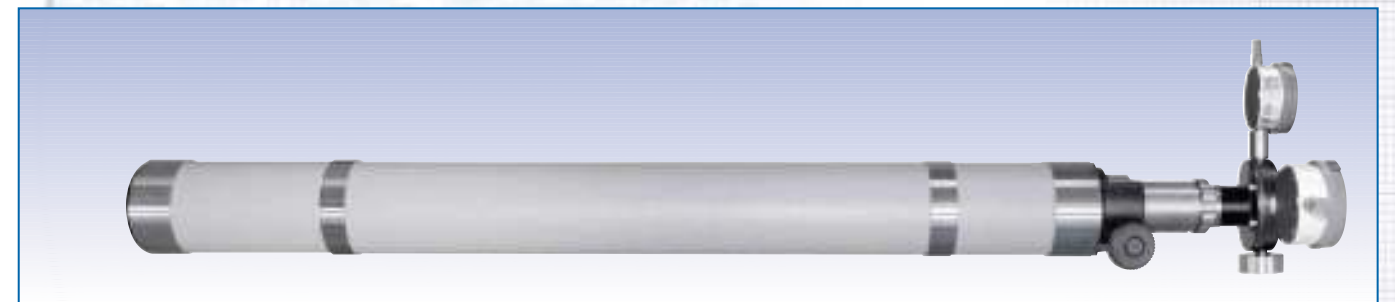


Ord.-No.	Description	Focal length	Free aperture	Tube extension	Meas. range	Resolution	Distance range	L
227 681	FGV 90/40/14,7/±6 MDD	90	16	±6	6,0°	5,0"	-∞...-1,25 m 1,40 m...+∞	77±6
227 682	FGV 90/40/14,7/+12 MDD	90	16	+12	6,0°	5,0"	0,80 m...+∞	71 <sup>+12</sup>
227 683	FGV 90/40/14,7/-12 MDD	90	16	-12	6,0°	5,0"	-∞...-0,60 m	83 <sup>-12</sup>
227 684	FGV 140/40/14,7/±6 MDD	140	28	±6	4,0°	2,0"	-∞...-3,10 m 3,30 m...+∞	77±6
227 685	FGV 140/40/14,7/+12 MDD	140	28	-12	4,0°	2,0"	1,70 m...+∞	71 <sup>-12</sup>
227 696	FGV 140/40/14,7/-12 MDD	140	28	-12	4,0°	2,0"	-∞...-1,40 m	83 <sup>-12</sup>

## MICROMETER



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Meas. range	Resolution	Distance range	A	B	L
227 697	FGV 300/65/14,7/±25 MDD	300	50	±25	1,0°	0,5"	-∞...-3,4 m 3,8 m...+∞	220	245	140±25
227 698	FGV 300/65/14,7/+50 MDD	300	50	+50	1,0°	0,5"	2,1 m...+∞	220	270	115 <sup>+50</sup>
227 689	FGV 300/65/14,7/-50 MDD	300	50	-50	1,0°	0,5"	-∞...-1,5 m	220	220	165 <sup>-50</sup>
227 690	FGV 500/65/14,7/±50 MDD	500	50	±50	0,5°	0,2"	-∞...-4,5 m 5,4 m...+∞	310	360	165±50
227 691	FGV 500/65/14,7/+100 MDD	500	50	+100	0,5°	0,2"	3,0 m...+∞	310	410	115 <sup>+100</sup>
227 692	FGV 500/65/14,7/-100 MDD	500	50	-100	0,5°	0,2"	-∞...-1,5 m	310	310	215 <sup>-100</sup>



Ord.-No.	Description	Focal length	Free aperture	Tube extension	Meas. range	Resolution	Distance range	L
227 686	FGV 1100/105/14,7/±50 MDD	1100	78	±50	0,5°	0,1"	-∞...-23,7 m 25,8 m...+∞	161±50
227 687	FGV 1100/105/14,7/+100 MDD	1100	78	+100	0,5°	0,1"	13,2 m...+∞	161 <sup>+100</sup>
227 688	FGV 1100/105/14,7/-100 MDD	1100	78	-100	0,5°	0,5"	-∞...-12,0 m	161 <sup>-100</sup>