ALV-Technical Documentation

Document : Technical Data, (WWW Version)
ALV-CGS-5022F & ALV-CGS-5050F

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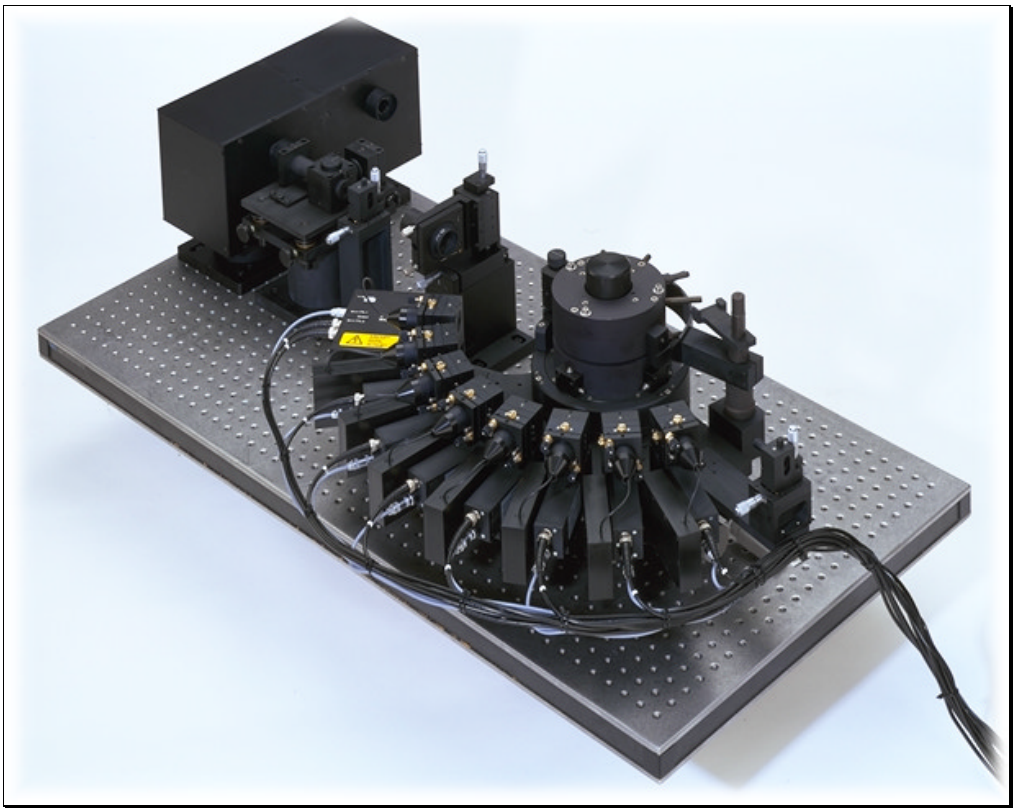

Important Note : This version of the document is reduced in content and detail to allow general www-distribution. Specifically, details about the technologies used within the ALV-CGS Series and the resulting specifications are omitted. A more detailed version of this document can be requested for at ALV directly.

ALV-CGS-5022F, ALV-CGS-5050F & ALV-CGS-5000F, General Data

Size and Weight	
Bread board Size (not part of the delivery) ***An additional Anti-Vibration Table is not required !***	900 mm (w) x 1800 mm (l), 25 mm x 25 mm, thickness 2“, better 3“, M6 threaded mounting hole grid.
Total Weight of Goniometer without bread board	approx. 80 kg
Adjustment Tools and Recommendations	
Double Needle Unit and Centricity/Height Needle Cell Housing Alignment Tool Dual Dial Gauge Indicator for Cell Housing and Index Macthing Vat Alignment 0°-Projection Optics	yes yes yes yes
Recommended Projection Length 0° projection Recommended Projection Length with 90° folding	a projection length of 3 m is recommended a projection length of 3 m is recommended
Software [(2)]	
ALV-Correlator for WINDOWS Software	yes
ALV-Fit & Plot Software	yes
ALV-WinAlign Alignment Software	yes
Computer Requirements	
Computer (not part of delivery)	PC or compatible computer with ≥ 133 MHz PENTIUM® CPU fully compatible PCI bus with 1 free slot ≥ 32 Mbyte RAM ≥ 10 Mbyte free hard disk memory 1024 x 768 graphics resolution or better CD-ROM and 3.5“ diskette Printer
Monitor (not part of the delivery)	ALV recommends the use of 17“or larger CRTs
Operating System (not part of the delivery)	WINDOWS®-95 WINDOWS®-98 WINDOWS®-NT 4.0
Room Requirements	
Room Light Level	the light level in the room should be reducable (e.g. via blinds) to near dark room condition for adjustement procedures.
Thermal Requirements	the room temperature should be stable to +/- 1.5°C within 24 h. Direct air blow onto the goniometer system must be avoided.
Clean Room Requirements	None, the goniometer system can be operated in a standard room, however, care must be taken to avoid dust contamination of the to be measured samples.

Goniometer Mechanics, Technical Data

Angular Range of Goniometer [(1)]	
Goniometer Angular Range	10° ... 155° scattering angle
Goniometer Angular Resolution and Angular Encoder	0.003° or 400 steps per °, absolute encoder is part of the deilivery
Goniometer Angular Travel Speed	user selectable, min. 0.7° / s, max. 18° / s
Min./Max Angle Limit Switches	two adjustable Hall-effect based limit switches
Turntable	
Max. Allowed Load	800 Nm
Cell Housing	
Accuracy of Centricity	better than +/- 5 µm in plane of rotation
Accuracy of Orthogonality	better than +/- 10 µm resdiual tilt
Index Matching Vat	
Index Matching Vat Size and Material	quartz glass, 80 mm outer diameter with two plan-parallel quartz glass windows at 0° and 180°, anti-reflection coated
Accuracy of Centricity	better than +/- 5 µm in center of rotation
Accuracy of Orthogonality	better than +/- 10 µm residual tilt

Laser Illumination, Technical Data

Laser Type and Output Power	
For ALV-CGS-5022F Goniometer System	HeNe @ λ = 632,8 nm, 22 mW output power power stability better +/- 1% over 24 h after at least 1 h warm-up time
For ALV-CGS-5050F Goniometer System	NdYAG @ λ = 532 nm, 50 mW output power power stability better +/- 1% over 24 h after at least 20 min warm-up time
For ALV-CGS-5000F Goniometer System	***Laser is not part of the delivery !***
Laser Beam Folding Unit	two fully shielded mirrors with > 95% reflection. Both mounted in fully orthogonal mirror adjusters (X/Y and tilt/turn), thermally decoupled from environment.
Laser Beam Attenuation	
Optical Attenuator (standard) Optical Attenuator (optional)	compensated optical attenuator with < 1% ... 100% transmission range, manual operation. stepper motor driven optical attenuator with 100%, 30%, 10%, 3%, 1%, 0.3%, 0.1% and 0% transmission steps
Laser Beam Monitorisation	
Monitor Diode Unit	high linearity 4-quadrant optical diode, allows beam stability & intensity monitorisation, used to compensate for the actual laser beam attenuation.
Laser Focusing	
Laser Focusing Optics	achromatic lens system mounted in X-Y & tilt/turn adjustable holder with focal length = 300 mm or focal length = 400 mm (optional).
Laser Safety Class [(1)]	
Laser Safety Measures	fully tubed laser beam, stray light shielding for small scattering angles, beam trap at 0° scattering angle
Applicable Laser Safety Class, operation mode Applicable Laser Safety Class, adjustment mode	**Laser Class 1, EN 60825-1:94** **Laser Class 3B, EN 60825-1:94**

(1) Please note : Both goniometer systems are Class 1 Laser Products in operation mode. However, during the alignment procedure, the laser must be aligned to the goniometer, which requires the removal of all of the several laser beam tubings etc. While being aligned, the goniometer system does no longer correspond to a Class 1 Laser product, but must be treated as corresponding to a Class 3B Laser Product. **Special regulations may apply in your country for handling Class 3B Laser Products.**

Optical Detection, Technical Data

Optical Detection Unit	
Optical Detection Unit	special optical fiber based optical detector including ALV-Static & Dynamic Enhancer, orthognal adjustment mount (X/Y, tilt&turn)
Max. Number of Parallel Detectors (1)	from 1 (standard) up to 8 parallel detectors, type ALV-Static & Dynamic Enhancer, attachable in steps of 17° scattering angle
Fast Detector Removal / Reassembly	special ultra-high precision detector mount allows removal and reassembly of any of the detectors, while keeping the full alignment of the goniometer system
Optical Detection Details	
Detection Characteristics	near single mode detection characteristics, no „interferometer effects“
Detection Volume	approximately 0.3 mm³ (1 x 1 x 0.3 mm) at 90° scattering angle
Max. q²-Range for ALV-CGS-5022F Max. q²-Range for ALV-CGS-5050F	5.3 x 10^{12}... 6.7 x 10^{14} [1/m²] (water as solvent) 7.5 x 10^{12}... 9.4 x 10^{14} [1/m²] (water as solvent)
Depolarized Light Scattering (2)	
Laser Beam Polarizor (optional) Detection Beam Analyzor (optional)	Laser polarizor prism (Glan) with better 10^5 polarisation ratio in special adjustment holder. Analyzer prism (Glan Thomson) with better 10^5 extinction ratio in a fully compensated rotatable holder.

(1) The ALV-CGS-5022F, ALV-CGS-5050F and ALV-CGS-5000F allow the use of up to 8 parallel optical detectors. However, more than one optical detector is optional at corresponding surcharge. For each additional optical detector, a single photon detector and an additional correlator resource is required.

(2) Depolarized light scattering requires that the light is analyzed for the depolarized light amount at highest accuracy (and thus again polarization ratio). The ALV-Goniometer Systems have provison to insert a Glan prism in the laser beam and a Glan-Thomson Prism in front of the optical detector as analyzer in a fully compensated rotation holder. This allows depolarization as well as polarized light scattering being performed.

Single Photon Detection, Technical Data

ALV-High Q.E. Avalanche Photo Diode	
Max. Quantum Efficiency Max. Count Rate for 1% Linearity Max. Peak Count Rate Max. Dark Counts Overload Protection Min. Accessible Correlation Lagtime	> 50% Q.E. at 633 nm > 500 kCps > 10 MCps (protected at 8 MCps) < 250 Cps ALV-Overload Protection Unit approx. 1 µs at 20 kCps or more
ALV-SIPC-II	
Max. Quantum Efficiency Max. Count Rate for 1% Linearity Max. Peak Count Rate Max. Dark Counts Min Accesible Correlation Lagtime	> 7% Q.E. at 633 nm, > 9% at 532 nm >1 MCps > 20 MCps (protected at 10 MCps) < 250 Cps approx. 1 µs at 20 kCps or more
ALV / SO-SIPD-II	
Number of PMTs and splitter technology Max. Quantum Efficiency Max. Count Rate for 1% Linearity Max. Peak Count Rate Max. Dark Counts Min. Accesible Correlation Lagtime	Dual PMT unit with fiber optical beam splitter to allow „Pseudo Cross Correlation“ > 10 % at 532 nm > 2 MCps > 40 MCps < 200 Cps per PMT < 20 ns at 1 kCps or more
ALV / DUAL-APD	
Number of APDs and splitter technology Max. Quantum Efficiency Max. Count Rate for 1% Linearity Max. Peak Count Rate Max. Dark Counts Overload Protection Min. Accesible Correlation Lagtime	Dual APD unit with fiber optical beam splitter to allow „Pseudo Cross Correlation“ > 50 % at 633 nm > 1 MCps > 20 MCps (> protected at 8 MCps per APD) < 250 Cps per APD Dual ALV-Overload Protection Unit < 20 ns at 1 kCps or more

	ALV-High Q.E. APD	**ALV-SIPC-II**	**ALV / SO-SIPD-II**	**ALV / DUAL-APD**
ALV-CGS-5022F	STANDARD	not recommended	not recommended	OPTIONAL
ALV-CGS-5050F **ALV-CGS-5000F**	OPTIONAL (multi-angle)	OPTIONAL (multi-angle)	STANDARD	OPTIONAL

Thermal Control, Technical Data

Standard Cell Housing	
Cell Housing Material	aluminum cell housing with stainless steel (black) heat exchanger ensuring min. thermal gradient in the sample cuvette
External Waterbatch Circulator based Thermostatisation	via external waterbath circulator (**not part of the delivery !**), control via secondary Pt-100 probe
Operation Temperature Range (1)	-6°C ... +50°C, fully keeping the alignment
High Temperature Cell Housing (optional)	
Cell Housing Material	insulating special compound material with stainless steel (black) heat exchanger ensuring min. thermal gradient in the sample cuvette
Thermostatisation	via external waterbath or oil circulator, control via secondary Pt-100 probe
Operation Temperature Range (1)	-12°... + 140°C, fully keeping the alignment
Temperature Measurement / Control Range	
Primary Temperature Probe	Pt-100 based probe measures in index matching fluid, -20°C ... +175°C measurement range
Temperature Measurement Accuracy	+/- 0.1 °C absolute (not certified, but by design) +/- 0.01 °C relative
Temperature Control Accuracy	depending on the waterbath circulator used, typ. +/- 0.05°C.
Measurements Below Dew Point	both cell housings have provisions to blow dry air/nitrogen against the index matching vat, fully avoiding condensation problems.

(1) The temperature range given above is the allowed temperature range for which the ALV-Goniometer System will keep it's alignment to the required precision. For the High Temperature Cell Housing, special fluids for the waterbath circulator must be used (e.g. Glycole or mineral oils). Sillicone oils must never be used as circulator fluids any time !

Digital Correlator, Technical Data

	ALV-5000/EPP (standard)	ALV-6010-160 (optional)	ALV-6010-200 (optional)	ALV-6000 (optional)
Auto/Cross Correlation Modes	Yes			
SINGLE Mode, 100% Real Time Efficiency	Yes, 125 ns Initial Sampling Time			
DUAL Mode (1), 100% Real Time Efficiency	Yes, 250 ns Initial Sampling Time			
FAST Mode (2) with 100% Real Time Efficiency	No	Yes, 6,25 ns Initial STC	Yes, 5 ns Initial STC	Yes, 25 ns Initial STC
Max Number of Channels	288	328	328	312
Max. Number of Parallel Sampling Times	35	40	40	38
Max. Sampling Time Range	125 ns ... 2147 s	5 ns ... 2749 s	6,25 ns ...3435 s	25 ns ... 3435 s
Max. Lag Time Range	1 : 2,75 x 10^{11}	1 : 8,8 x 10^{12}	1 : 8,8 x 10^{12}	1 : 2,2x10^{12}
Correlation Channel Structure	ALV-16 / 8 Channel Multiple Tau Structure			
Max. Input Count Rate SINGLE / DUAL Mode(3)	up to 80 MHz using Random Scaling Techniques (either automatic or user controlable) sustained 2,5 MHz / 1,25 MHz without any Random Scaling Techniques used			
Max. Input Count Rate in FAST Mode	n.a.	max. 31,25 MHz 200 MHz peak	max. 25 MHz 160 MHz peak	

(1) The DUAL Mode computes either two independent Auto Correlation functions or both Cross Correlation functions, namely IN0 / IN1 and IN1 / IN0. The later mode can be used to slightly decrease the shot noise on the cross correlation function by computing the average of the IN0 / IN1 and the IN1 / IN0 correlation function. While the shot noise reduction usually is very small only in comparison to the total noise on the correlation function (namely shot noise and signal noise), care must be taken to use this scheme for input signals with Gaussian or at least very near Gaussian statistics only.

(2) The FAST Mode is by definition a Cross Correlation or Pseudo Cross Correlation Mode only. Auto Correlation is not supported in FAST Mode ! For Auto Correlation, the SINGLE Mode or DUAL Mode should be used. In combination with the ALV-CGS, it can only be used in combination with „pseudo“ cross correlation detectors, such as the ALV/SO-SIPD-II or the ALV-DUAL High Q.E. APD.

(3) Random Scaling Techniques allow the use of very high count rates with virtually no decrease in the noise performance of the correlation function accumulation. Such Random Scaling Techniques are used in the ALV-5000/EPP, ALV-60X0, either automatically selected in „strength“ depending on the actual input signal or manually selected by the user through the control software.

Measurement & Sensitivity, Technical Data

Count Rates for a Toluene Standard at 90° Scattering Angle using the ALV-Static & Dynamic Enhancer allowing simultaneous Static and Dynamic Light Scattering (for laser focusing lens with 300 mm focal length) :

Illumination/Detection Effeciency	**Toluene Scattering, 90° Scattering Angle**
ALV-CGS-5022F, ALV-HIGH Q.E. APD	> 19.000 Counts/s
ALV-CGS-5050F, ALV-DUAL APD	> 40.000 Counts/s
ALV-CGS-5050F, ALV / SO-SIPD-II or ALV-SIPC-II	> 8.000 Counts/s

Residual Systematic Errors over the entire Scattering Angle Range (17° ... 155°) for a Toluene Standard using the ALV-Static & Dynamic Enhancer allowing simultaneous Static and Dynamic Light Scattering (either 300 mm or 400 mm laser focus lens) :

Residual Systematic Errors	**For Scattering Angle Range of 17° ... 155°**
ALV-5022F Goniometer System	< +/-0.5% absolute
ALV-5050F Goniometer System	< +/-0.5% absolute

Minimum determinable ***Molecular Weight*** assuming different sample concentrations, 10% Excess Scattering and a dn/dc of 0.2 mg/ml.

Excess Scattering = 10%, dn/dc = 0.2 ml/g	
Sample Concentration	**Min. Molecular Weight**
0.01 mg/ml	360000 dalton
0.1 mg/ml	36000 dalton
1 mg/ml	3600 dalton
10 mg/ml	360 dalton

Minimum determinable ***Molecular Weight*** assuming different sample concentrations, 100% Excess Scattering and a dn/dc of 0.2 mg/ml.

Excess Scattering = 100%, dn/dc = 0.2 ml/g	
Sample Concentration	**Min. Molecular Weight**
0.01 mg/ml	3600000 dalton
0.1 mg/ml	360000 dalton
1 mg/ml	36000 dalton
10 mg/ml	3600 dalton

Minimum determinable ***Radius of Gyration*** assuming 0.3% total slope over Scattering Angle Range from 17° ... 155° and 2nd Virial Coefficient

Min. Determinable Radius of Gyration 0.3% slope over Scattering Angle Range of 17° ... 155°	
ALV-5022F Goniometer System	min. Radius of Gyration approx. 5 nm
ALV-5050F Goniometer System	min. Radius of Gyration approx. 5 nm

Min. Determinable 2nd Virial Coefficient depending on actual sample concentrations used	
ALV-5022F Goniometer System	min. Virial Coefficient approx. 10^{-7} mol dm³ / g²
ALV-5050F Goniometer System	min. Virial Coefficient approx. 10^{-7} mol dm³ / g²

Particle Size Range for DLS	
ALV-5022F Goniometer System	< 1 nm Diameter ... > 5 µm Diameter
ALV-5050F Goniometer System	< 1 nm Diameter ... > 5 µm Diameter

The Long Time Count Rate Stability of the Entire Goniometer System

Using the ALV-Static & Dynamic Enhancer and any of the ALV-Single Photon Detectors, the ALV-Goniometer Systems long time count rate stability (24 hours and longer) can be shown to be solely limited by the long time stability of the laser source (which is approx +/- 1% or better over 24 h). The laser source intensity changes are fully compensated for in Static Light Scattering measurements via the Monitor Diode Unit and can be compensated for in Dynamic Light Scattering by measuring the Laser Illumination Correlation Function as well (optional).

The alignment of the ALV-Goniometer System usually is stable for more than 6 month in the sense that no significant change in the 1/sin(Θ) law can be detected. However, this requires that the room the ALV-Goniometer is operated in is air-conditioned and does not show temperature fluctuations larger than +/- 1.5 °C over 24 h.

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