varioptic
dynamic lens

Liquid Lens Actuators

Variable Focus

January 2017

What do we do ?

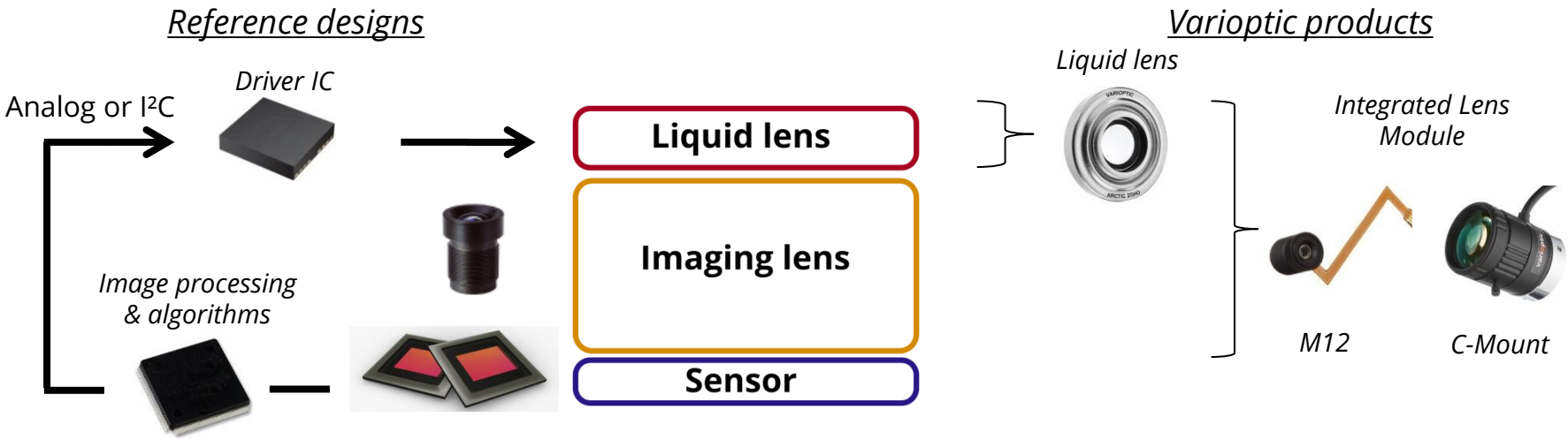
Varioptic is a component manufacturer for:

- Imaging applications
- Laser applications

What do we do ?

For imaging applications, Varioptic provides:

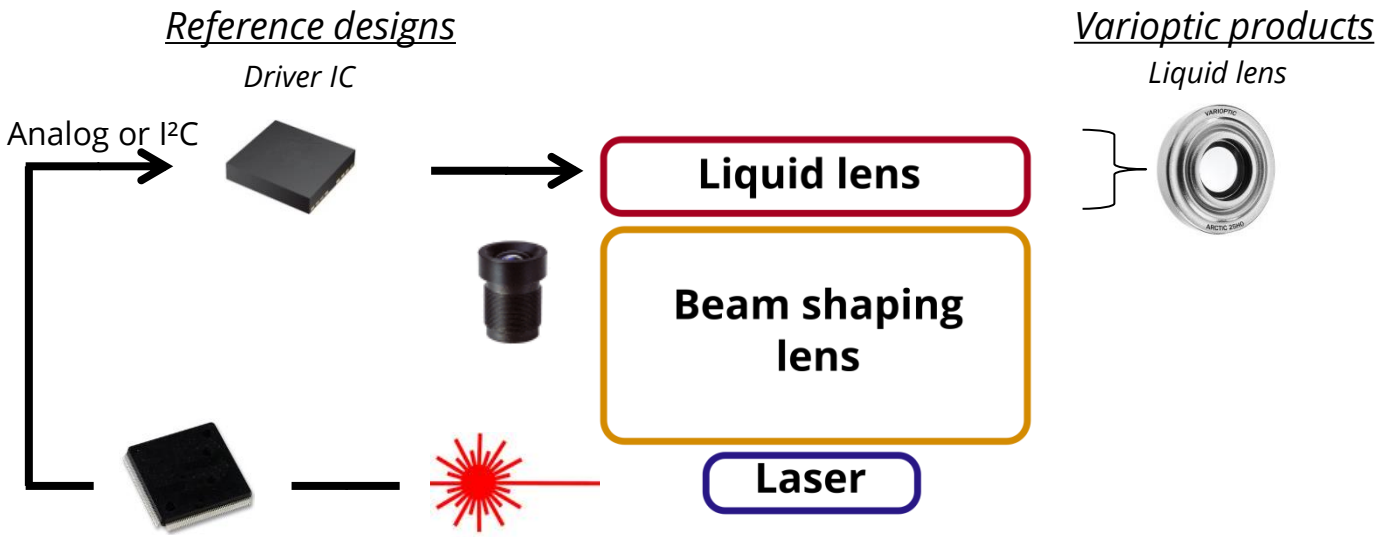
- Variable focus, AutoFocus,
- Continuous AutoFocus



What do we do ?

For Laser applications, Varioptic provides:

- Variable focus



About Varioptic and Invenios

varioptic dynamic lens

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- Founded by Bruno Berge in 2002.
- First shipments of products started in 2007.
- Varioptic is acquired by Invenios end 2016.
- Varioptic is the world leader in Liquid Lens Technology.

invenios

- Founded by Ray Karam in 2002.
- Located in Santa Barbara, California
- Core expertise: glass structuring and glass bonding
- Invenios acquired Optilux, Varipotic's licensee for mobile phones in 2013.

How does it work?
Variable Focus Lens – Arctic Family

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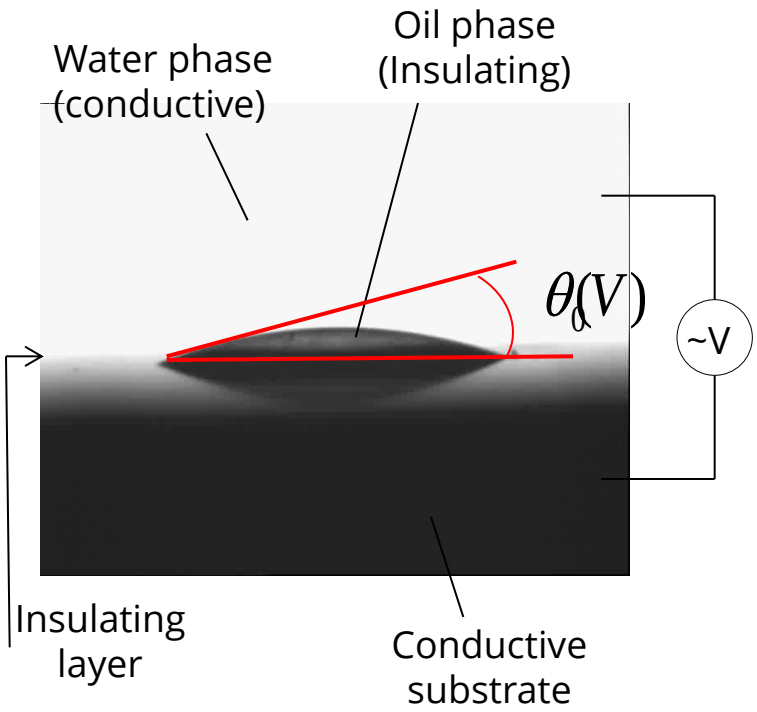
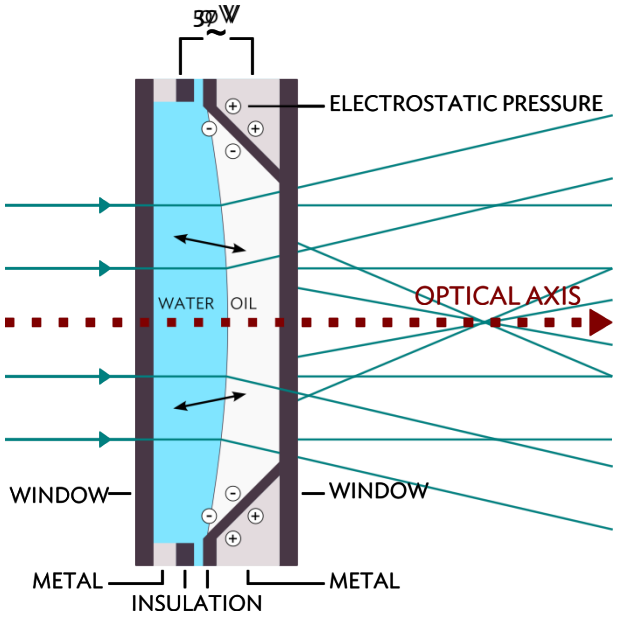
Key principle: Electrowetting



$$\cos\theta = \cos\theta_0 + \frac{\varepsilon\varepsilon_0}{2e\gamma} V^2$$



Key features :

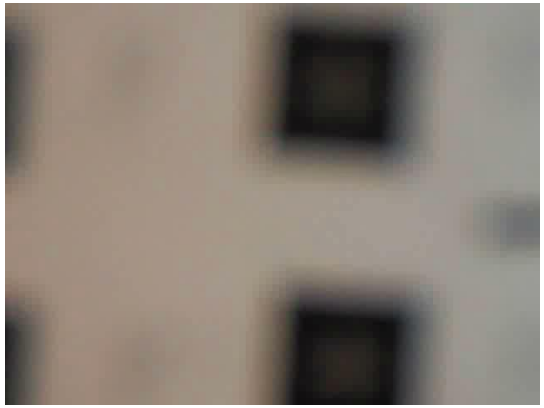
- Electrowetting
- Iso-density
- Drop centering
- Refractive index difference

Why use Arctic variable focus lenses ?

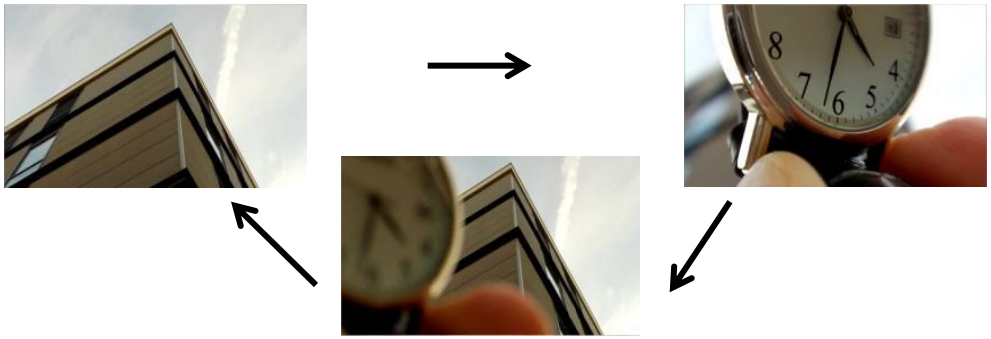
- Still pictures : Sharp images, whatever the distance : from infinity to Macro Mode

5 cm macro

Infinity focus



- Video mode : continuous & smooth AutoFocus allows sharp pictures even if the object distance is changing



Why use Liquid Lenses ?
Technical advantages

VARIOPTIC TECHNOLOGY GETS RID OF ANY MOVING PART

=> BRINGS UNIQUE COMPETITIVE ADVANTAGE

- **No wear** – Tested over 500 millions of cycles !
- **Fast**
  - ~10 frames to be in focus in Closed loop mode
  - <50ms in Open Loop mode
- **Robust** – unmatched mechanical shock resistance
  Lens withstands: 2000g / 0.25ms / 100 times (x2 directions) !
- **Close Focus Ability** – below 5cm focus ability
- **Accurate** – Low hysteresis
- **Easy to integrate** – add-on to fixed lens
- **Low Power** – <1 mW (~20 mW with driver)
- **Silent** – no crosstalk between motor and microphone

No Moving Parts – Nothing to wear out !

How does it work ?
Example of closed loop AF system integration

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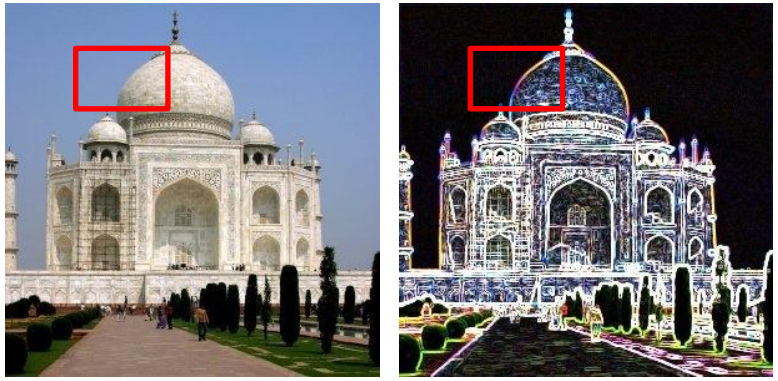
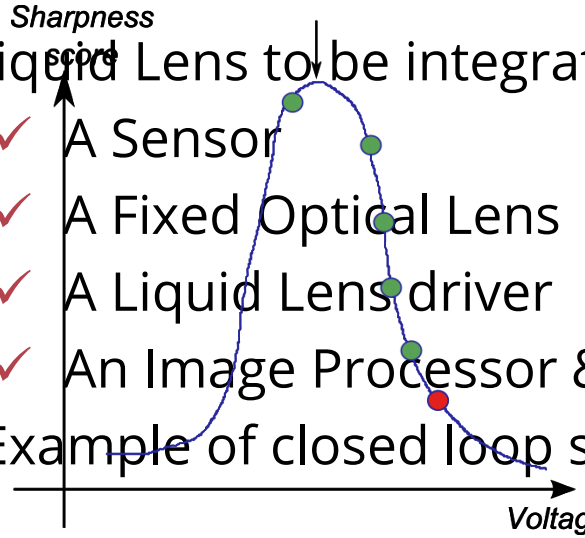
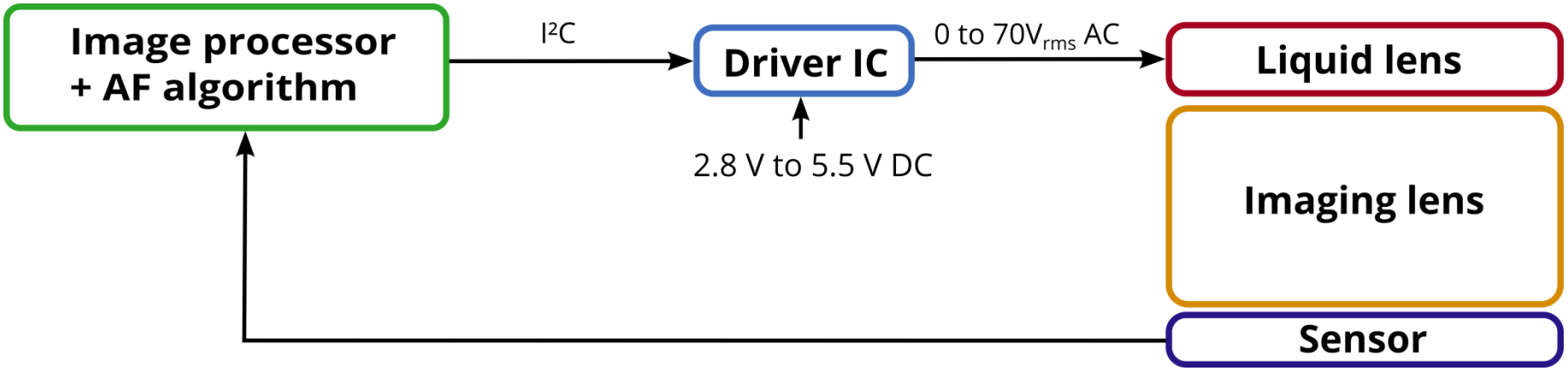


Edge filter (Sobel filter) + ROI

- Liquid Lens to be integrated with :
  - ✓ A Sensor
  - ✓ A Fixed Optical Lens
  - ✓ A Liquid Lens driver
  - ✓ An Image Processor & Algorithm
- Example of closed loop system :





How does it work?
Example of open-loop driving

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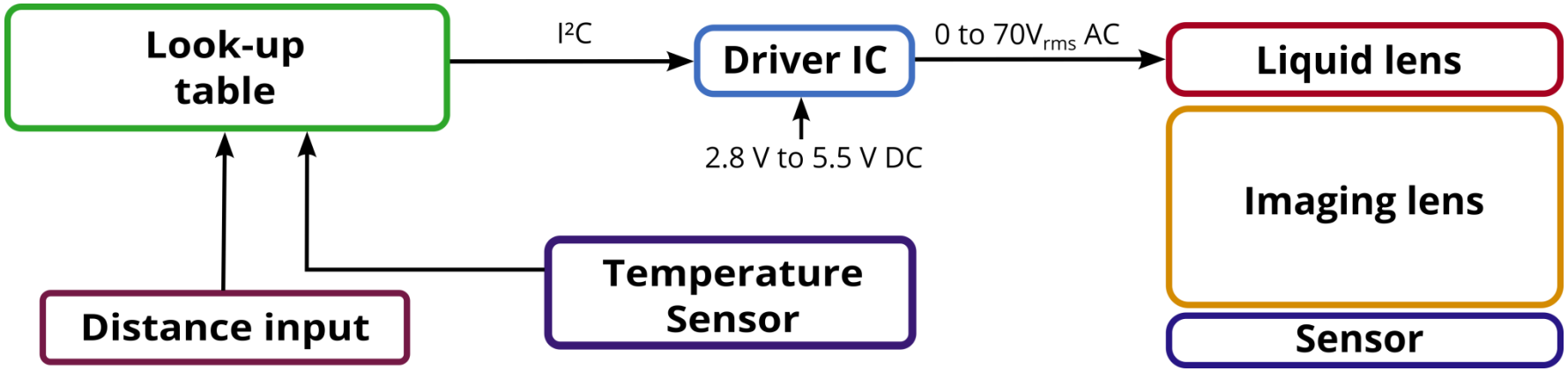
- Open loop system requires the knowledge of object distance and system temperature, and an accurate calibration.
- Open-loop (for coarse AF) and closed- loop (for fine search) need to be combined for optimum performances.



Arctic product family: Variable Focus Liquid Lenses

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	Arctic 16F0	Arctic 25H0	Arctic 39N0
Clear aperture, 0° FOV	1.6 mm	2.5 mm	3.9 mm
Clear aperture, 50° FOV	1.45 mm	2.5 mm	3.5 mm
External diameter	6.2 mm	7.75 mm	13 mm
Low optical power	-5 diopter	-5 diopter	-5 diopters
High optical power	+15 diopters	+13 diopters	+15 diopters
WFE rms, typical	25 nm	45 nm	50 nm
Response time, ms	30 ms	30 ms	60 ms
Operating temperature	-30°C..+85°C	-30°C..+85°C	-20°C..+60°C
Storage temperature	-40°C..+85°C		

** Not recommended for new design*

Arctic-P product family: Packaged Variable Focus Liquid Lenses

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A-25H0-P10 (with thermistor)

A-25H0-P07

A-25H0-P06

A-39N0-P04

A-39N0-PW065

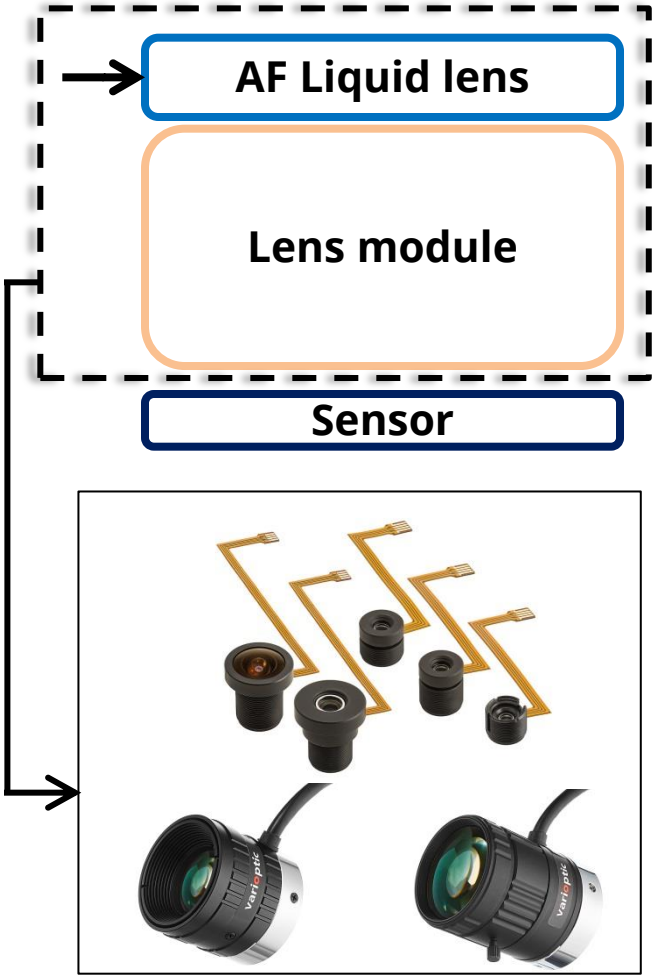
	A-25H0-PXX	A-39N0-PXX
External diameter	9.40 mm	15.5 mm
Thickness	3.5 mm	5.2 mm for –P 5.5 for -PW

Caspian Module: Easy integration!

varioptic dynamic lens

- Integration of an Arctic lens and a fixed lens, with FPC cable or connector
- **M12x0.5** or **C-Mount** format
- Available with or without IR cut filter for M12
- Other focal lengths available upon request

	Arctic 25H				Arctic 39N0		
Format	M12/S-Mount					C-Mount	
EFL (mm)	2.6	4.7	7.5	9.6	15.8	16	25
F#	2.5	2	2.9	3.7	4	2.8	4
Image circle (mm)	7.2	8	7.2	9.1	6	11	
Sensor compatibility	1/2.5”	1/2”	1/2.5”	1/1.8”	1/3”	2/3”	



C-Mount objective with Liquid Lens

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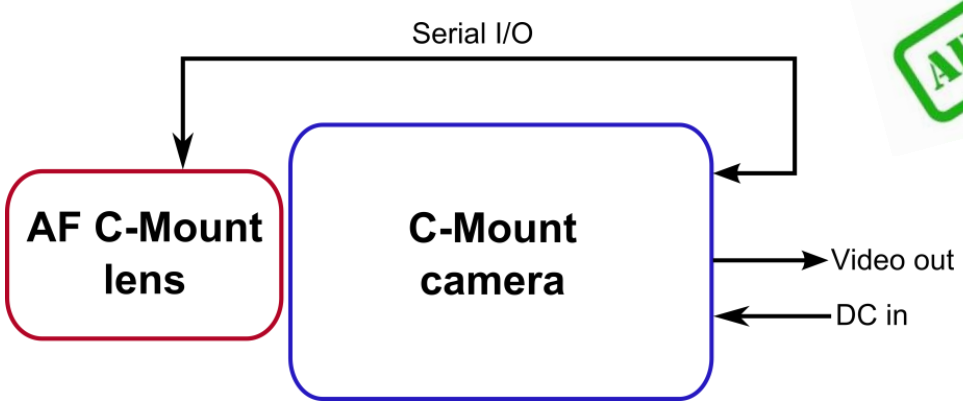
Power supply:

V_{DC} 3.3 to 24 V – ~25 to 100 mA

Simple Control of liquid Lens Voltage:

*C-C-39N0-XX0-**I2C** : I²C operation*
*C-C-39N0-XX0-**R33 :** RS232-3.3V operation*
*C-C-39N0-XX0-**R23 :** RS232-12 V operation*
*C-C-39N0-XX0-**SPI :** SPI operation*

All modules (except SPI) are compatible with Analog control.



APPROVED

Compatible camera Manufacturers :

MATROX IMAGING

PixeLINK®

More to come !

Caspian for Microscopy: Caspian u-25H0-075

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- Based on a modified Caspian S-25H0-075

	Extension ring		
Magnification	**X2**	**X3**	**X5**
Working distance	7 mm	6 mm	5 mm
Focusing Range	± 0.85 mm	± 0.7 mm	± 0.65 mm
Back Focal	15 mm	22 mm	37 mm

Drivers for Liquid Lenses

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	Maxim MAX 14574	Supertex HV892
Max Voltage	70 V	60 V
Interface	I²C	I²C
Resolution	10 bits	8 bits
Size	1.6 mm x 2.6 mm	4 mm x 4 mm
Package	15 bump WLP	DFN
External components	5	2
Output waveform	PWM	Special square AM
Power consumption	40 mW	20 mW
Temperature measurement	Internal/External	No

With Whom?

Liquid Lens: Proven Performance for Demanding Applications

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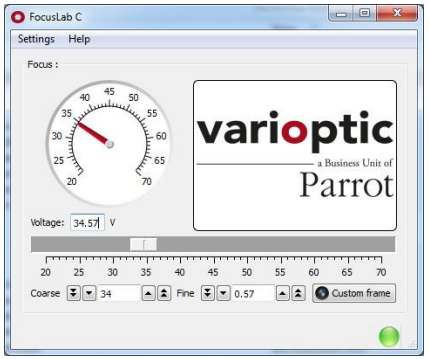
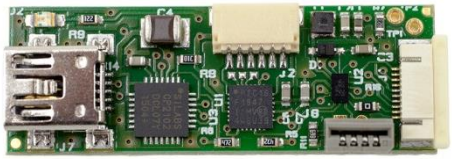
How to start ?
Arctic 25H Development kit

Arctic 25H DK	
A-25HX and A-25HX-P07	1 of each
USB-M drivboard and USB Cable	1
Lens Holder, VHD-07	1
Maxim drivboard	1
Microchip HV892 drivboard	1
Flex circuit FPC-A-3	1
FocusLab C Software	1
Development documentation	1

Development documentation



FocusLab C Software



USB-M Drivboard

VHD-0x lens holder

Arctic 25H0

FPC A-3 Circuit

Maxim drivboard

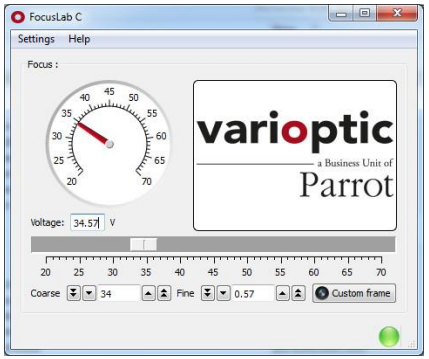
A-25H0-P07

Microchip HV 892 drivboard

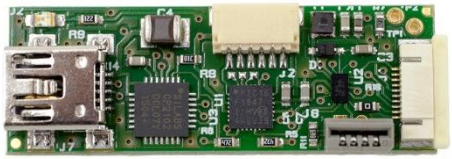
How to start ?
Arctic 39N Development kit

Arctic 39N DK	
A-39NX and A-39NX-P04	1 of each
USB-M drivboard and USB Cable	1
Lens Holder, VHD-06	1
Maxim drivboard	1
Microchip HV892 drivboard	1
Flex circuit FPC-A-4	1
FocusLab C Software	1
Development documentation	1

Development documentation



FocusLab C Software



USB-M Drivboard

VHD-0x lens holder

FPC A-4 Circuit

Maxim drivboard

A-39N0

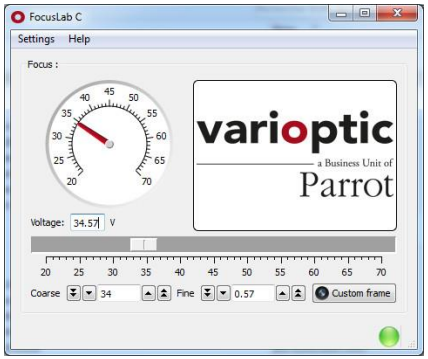
A-39N0-P04

Microchip HV 892 drivboard

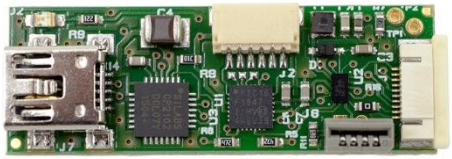
How to start ?
Caspian M12 Development kit

Caspian M12 DK	
Caspian Module	2
USB-M drivboard and USB Cable	1
Maxim drivboard	1
Microchip HV892 drivboard	1
FocusLab C Software	1
Development documentation	1

Development documentation



FocusLab C Software



USB-M Drivboard

Caspian Module

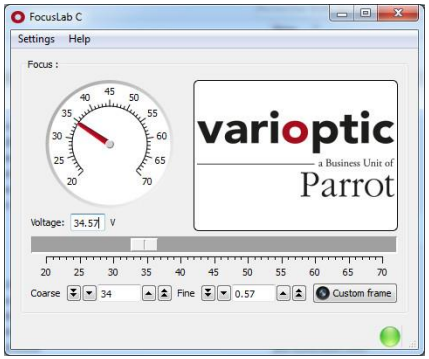
Maxim drivboard

Microchip HV 892 drivboard

How to start ?
Caspian Microscopy DK

Caspian Microscopy DK	
Caspian u-25H0-075-03	1
Caspian Microscopy Set	1
USB-M drivboard and USB Cable	1
Maxim drivboard	1
Microchip HV892 drivboard	1
FocusLab C Software	1
Development documentation	1

Development documentation



FocusLab C Software

USB-M Drivboard

Caspian u-25H0-075-03 Module

Caspian Microscopy Set

Microchip HV 892 drivboard

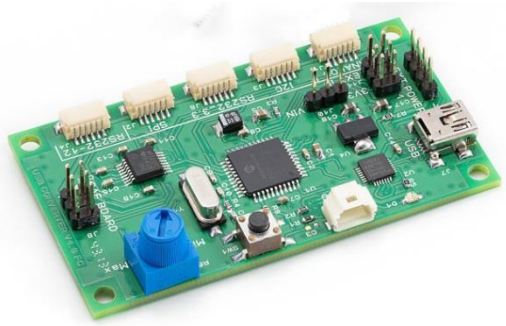
Maxim drivboard

How to start ?
C-Mount Development kit

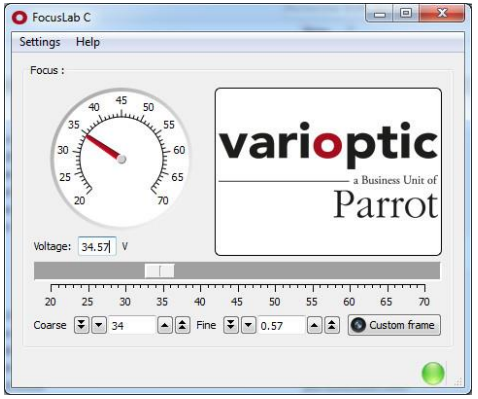
Caspian C-39N0-XX0 DK	
Caspian C-39N0-XX	1
Caspian C Com Board	1
FocusLab C Software	1
Development documentation	1

Development documentation

C-Mount Lens



Caspian C Com Board
(USB to I²C/RS232/SPI)



FocusLab C

Q & A