CORNING

Varioptic® Lenses

Marketing Datasheet

Corning® Varioptic® V-PE-80R0 Series Variable Focus and Astigmatism Lens

Overview

V-PE-80R0 Series is based on Corning® Varioptic® liquid lens providing variable focus tilt and astigmatism. It is provided with a complete calibration of the spherical and cylindrical power.

Ordering Information

- **Corning® Varioptic® V-PE-80R0-07 variable focus and astigmatism lens:** Packaged liquid lens with electronic board and 8-pin, 0.5 mm pitch straight flex cable with on-flex thermistor

Performance Summary

- 24 diopters of sphere optical power range
- 5 diopters of cylinder optical power range
- Embeds liquid lens driver, temperature sensor and microcontroller
- Integrates individual lens calibration parameters
- I²C / RS 232 interface

Contents

ESD

Opto-electrical specifications

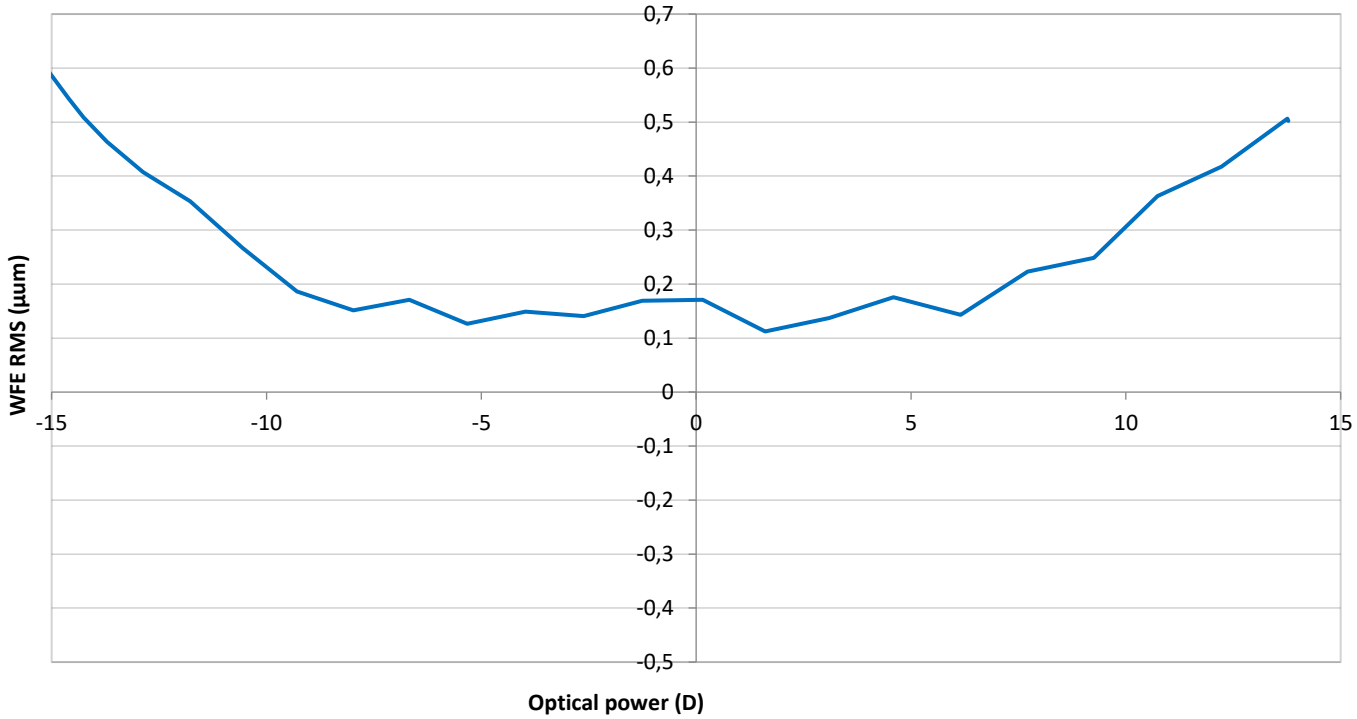
@25°C, @635 nm unless otherwise stated

Parameter	*Unit*	*Symbol*	*Min*	*Typ*	*Max*	*Notes*
Aperture size	mm	$Ø_e$		8		(1)
Sphere only optical power range	m^{-1}	PS_L / PS_H	-12		+12	(2)
Sphere optical power range using cylinder	m^{-1}	PSC_L / PSC_H	-6		+6	(3)
Cylinder optical power range	m^{-1}	PC_L / PC_H	-5		0	(3)
Sphere and cylinder optical power accuracy on full range	m^{-1}			0.17		
Sphere and cylinder optical power accuracy on reduced range	m^{-1}			0.07		(4)
Astigmatism angle accuracy	°			4		
Wave Front Error, rms (on 8mm aperture)	nm	WFE_{rms}		300		(2)(5)
Optical transmission @587nm	%	T_{587}	92	95		

Notes:

(1) Pupil size at the lens' smallest aperture. For more details, please refer to 'Optical Design Information' and 'Cosmetic Specifications'.

(2) The graph below shows an example of the RMS wave front error in µm as a function of the optical power of the multi-electrode lens. Measurement is done on an 8mm pupil.



(3) The low cylinder optical power PCL is available on the PSCL/PSCH range of the sphere. See “Sphere and cylinder range and typical accuracy” for more details.
(4) Reduced range corresponds to spherical optical power within the range of [-4D/+4D] and cylinder optical power within the range of [0D/-4D].
(5) The wave-front error of the liquid lens is induced at the interface between the two liquids and mainly due to random astigmatism.

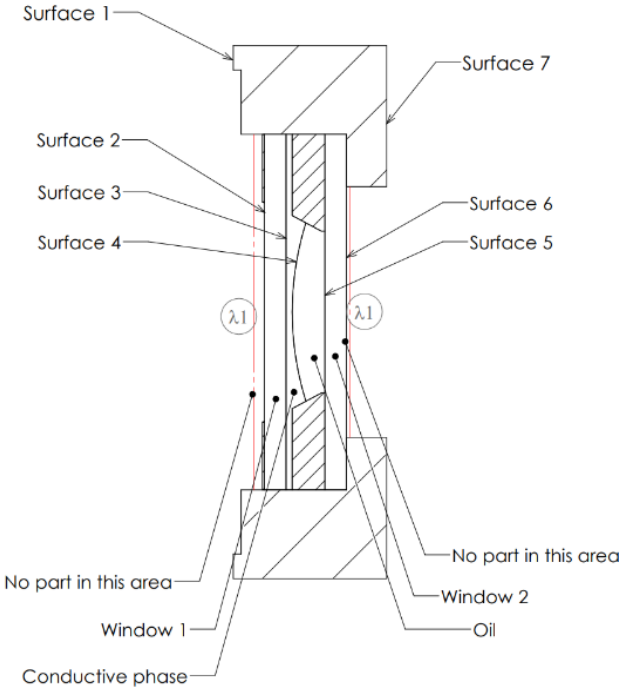
Optical design information

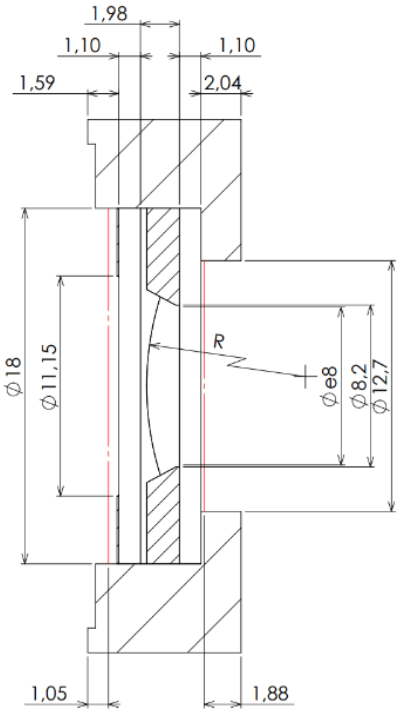
The information in this section is mainly for optical design. A Zemax model is available upon request.

Variation of index of refraction with wavelength is given in the following table (@20°C):

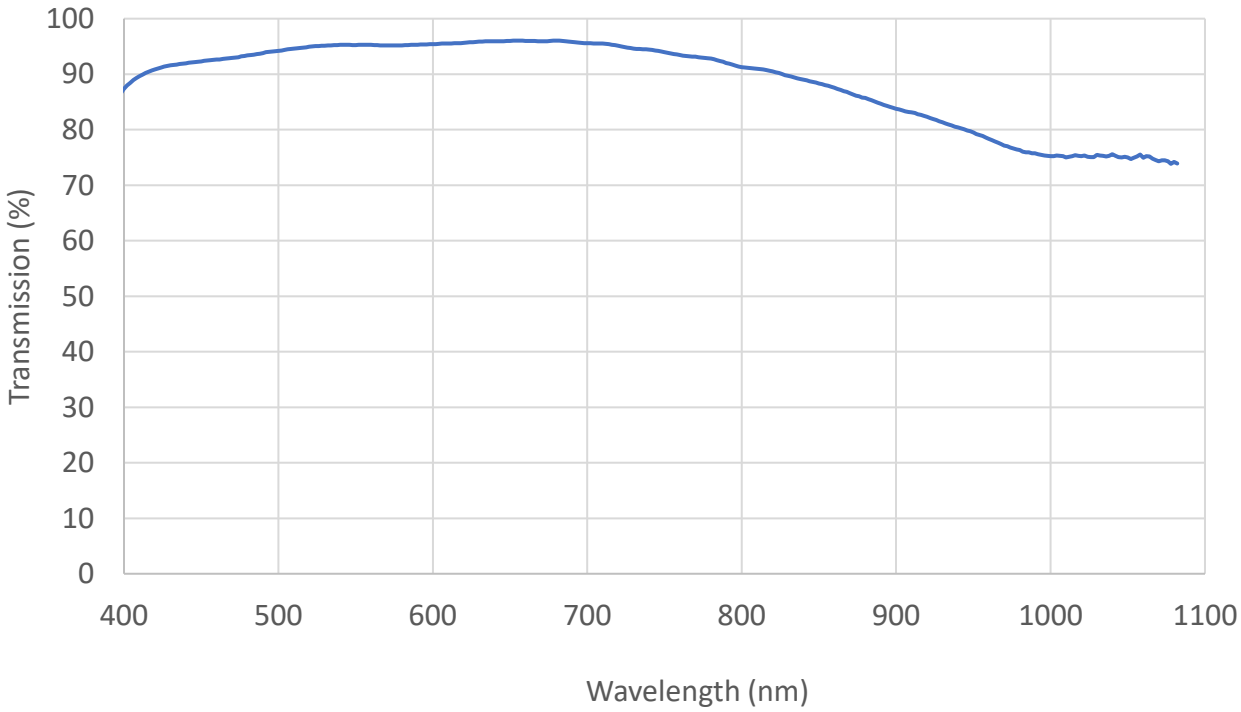
Wavelength	*Oil Phase*	*Conductive phase*
400 nm	1.56430	1.41524
448 nm	1.54976	1.41057
489 nm	1.54099	1.40774
541 nm	1.53365	1.40503
589.3 nm	1.52849	1.40311
654.6 nm	1.52380	1.40109
703 nm	1.52115	1.40005
Abbe number	29.7	58.7

The thicknesses of the different optical materials are detailed in the drawing below. Red lines represent virtual surfaces beyond which no optical or mechanical components should be placed.





Transmission curve



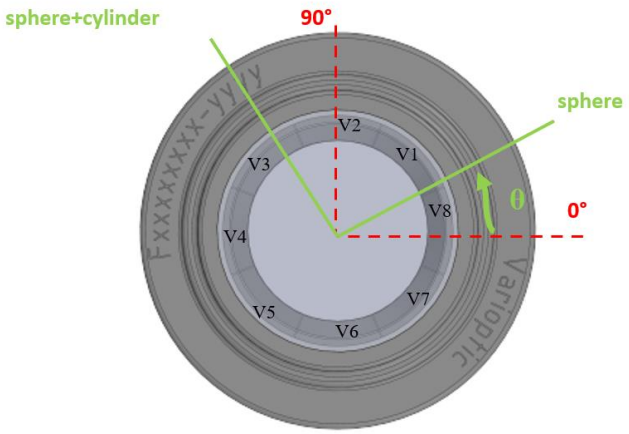
Optical convention

The multi-electrode lens is controlled with respective V1, V2, V3, V4, V5, V6, V7, V8 voltages.

Each voltage is calculated with sphere, cylinder and axis defined according to **optometric referential**.

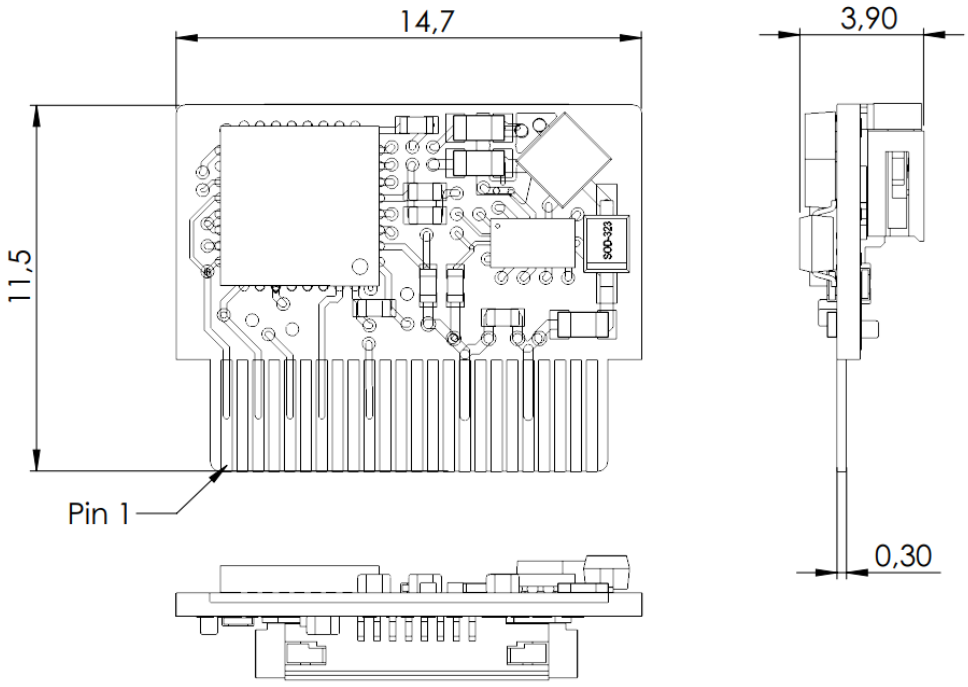
Sphere, cylinder and axis are expressed in negative referential: cylinder is negatively signed.

A negative θ oriented cylinder is equivalent to a positive (θ+90°) oriented cylinder.

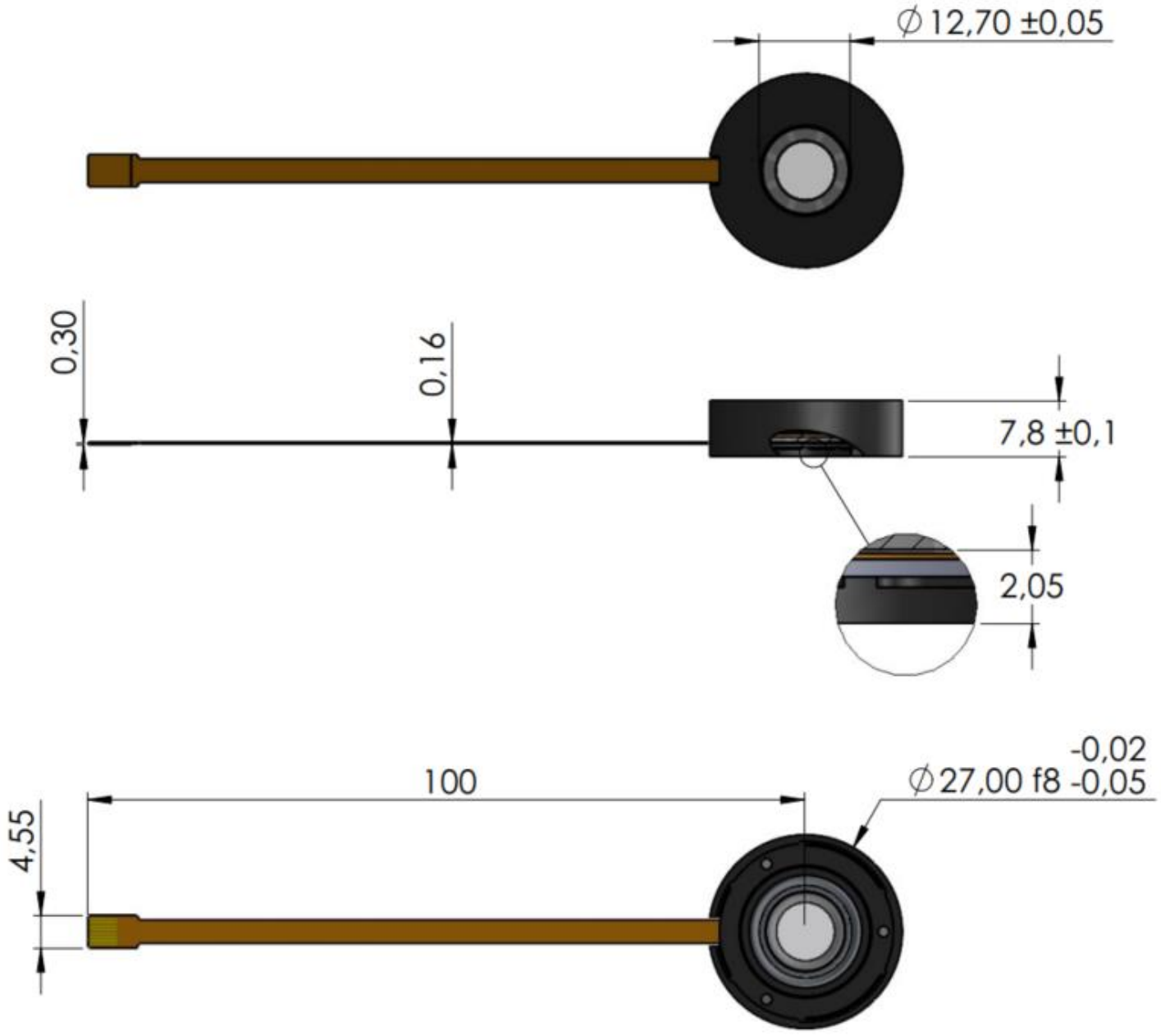


Mechanical Dimensions

Electronic board



Packaged Lens

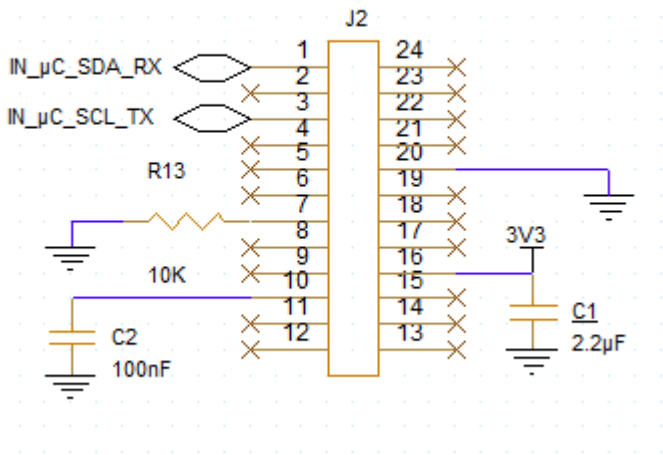


General Description Of The Board

The V-PE-80R0-07 electronic embeds a 32 bits microcontroller. The chip contains individual lens calibration parameters.

Connector Pinout

Pin Number	PCB I/O name
1	OUT_I2C_RS232_SDA_RX
2	NC
3	OUT_I2C_RS232_SCL_TX
4	NC
5	SWDIO
6	NC
7	BOOT0
8	NC
9	NC
10	NRST
11	NC
12	NC
13	NC
14	NC
15	NC
16	3,3V
17	NC
18	NC
19	NC
20	GND
21	NC
22	NC
23	NC
24	NC



Notes:

(1) The many unused pin on J2 connector are designed for improving PCB mechanical retention into the customer SMT connector.
(2) Recommended connector for A-PE Series board is 24 pins ZIF connector 24FLT-SM2-TB(LF)(SN) from JST
(3) IN_µC_SDA_RX/IN_µC_SCL_TX: Those pins can be used either in I2C or RS232, for I2C pull-ups are already present on the board.
(4) R13 pull down resistor on pin 7(BOOT0) and C2 decoupling capacitor on pin 10 (Reset) can be optional depending of EMC conditions.

Absolute Maximum Ratings

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Operating Temperature	T	10	-	40	°C	
Storage Temperature	T_{stg}	-40	-	55	°C	

Important note:

Corning Varioptic Lenses and electronic boards are sensitive to electrostatic discharge (ESD). Use caution when handling (see chapter on ESD precautions below).

Electrical Specifications

Parameter	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Notes*
Power supply						
Input voltage	V_{cc}	3.2	3.3	3.4	V	

Precaution

FPC handling

To adjust the FPC shape to a given design, following rules should apply:

- Minimum bending radius: 2 mm
- Minimum cable length to perform a 180° torsion: 55 mm.
- For FPC with thermistor, flexion of the FPC in the thermistor area should be avoided as it can cause cracks in the soldering and/or FPC. If the customer design requires bending the FPC in the thermistor area, the radius of curvature of the bending should not be lower than 5 mm.

For additional information please refer to the document “MAAN - 190903 - FPC Installation Guidelines.pdf”.

ESD

Liquid lenses and embedded electronics are sensitive to electrostatic discharge (ESD). Users in contact with lenses or electronic boards should be grounded and should use soft-touch, ESD dissipative metal tweezers to avoid scratches. All materials directly in contact with the lenses should also be grounded (tables, benches, etc.) or antistatic/electrically dissipative materials (e.g. trays).

For additional information please refer to the document “MAAN - 200505 - Liquid Lens Handling, Cleaning and Storage.pdf”.

Safety precautions

In case the liquid lens is placed close to a human eye, we recommend adding a protective window between the user’s eye and the liquid lens with a minimum thickness of 1.5mm.

Register Definition

Field name	Bit	Type	Description
Lens Spherical power			address: 0x0707
SPHERE	[31:0]	Float	Lens spherical power (D)
SW Version			*address: 0x0004*
VER	[7:0]	Float	Software version: this register indicates the version of the module firmware.
Lens Cylinder power			*address: 0x0708*
CYLINDER	[31:0]	Float	Lens cylinder power (D)
Lens Axis			*address: 0x0706*
AXE	[31:0]	Float	Lens axis (°)

UART Protocol (RS232)

Hardware settings

Baud rate	57 600 Bds
Parity	No parity
Data length	32 bits
Number of stop bits	1 bit

Writing frame

STX	0x37	Add_LSB	Add_MSB	Nb_data	Data_1_1	Data_1_2	…	Data_2_1	…	Data_n	CRC

STX = 0x02

0x37 = Write command

Add_LSB

& Add_MSB = Address from first register to be written (if there are several data to write, the address will be automatically incremented).

Nb_data = Number of 32-bits words to be written

Data_1 to n = Registers value

CRC = 1 control byte calculated as follow:

Sum of all bytes (STX, CDE, ADD, NB_DATA, DATA)

Ex :

0x02	0x37	0x03	0x00	0x01	0x12	0x34	0x56	0x78	0x51

Response of the board if transmission is successful:

STX	0x37	ACK	CRC

With ACK = 0x06

Response of the board if transmission is not successful:

STX	0x37	NACK	CRC

With NACK = 0x15

In this case the application should send again the same frame.

Reading frame

STX	0x38	Add_LSB	Add_MSB	Nb_data	CRC

STX = 0x02

0x38 = Read command

Add_MSB

& Add_LSB = Address of the first register to be read (if more than one register, the address will be automatically incremented).

Nb_data = Number of 32-bits word to be read

CRC = 1 control byte calculated as follow:

Sum of all bytes (STX, CDE, ADD, NB_DATA, DATA)

Ex:

0x02	0x38	0x03	0x00	0x01	0x3E

Response if transmission is successful:

STX	0x38	Data_1	Data_2	Data_3	Data_4	CRC

Response if transmission is not successful:

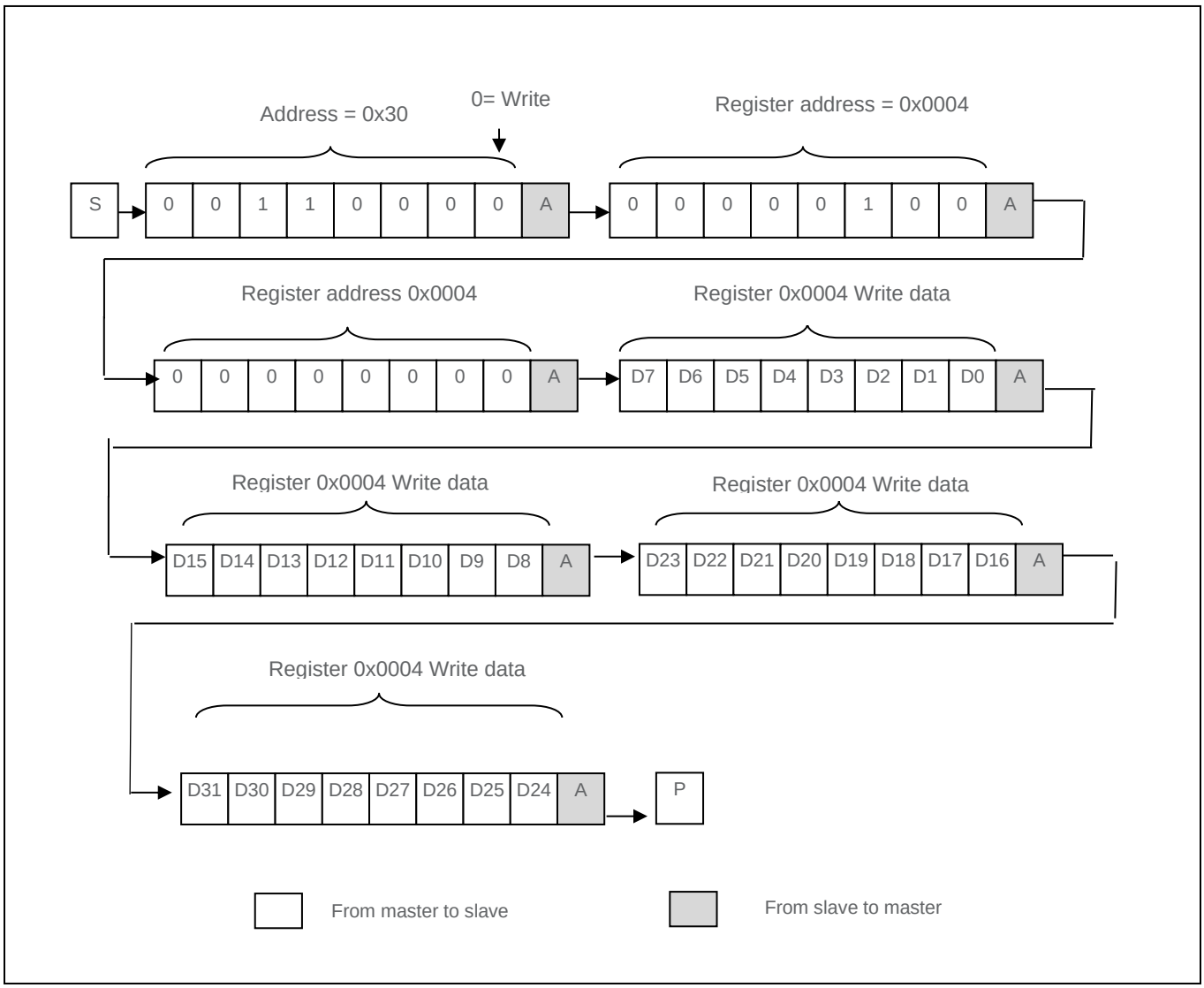
STX	0x38	NACK	0x15

I2C Protocol

Maximum frequency of SCL is 400 KHz.
The lens is a slave device, its address is 0x30 for writing and 0x31 for reading.

Writing frame

To write to the device, the master generates a START condition and then transmits the slave address with the R/W bit set to zero, followed by at least one data byte. The 2-first data byte is the register address, which determines which register is to be written. The device asserts an ACK on SDA if a valid register address is detected. 32 bits data received after the register address goes into the selected register. For each additional 32 bits word received from the master, the device auto-increments the register address. After all bytes are written, the master generates a STOP condition. The following examples shows a single-register I2C write.



Reading frame

To read from the device, the master generates a START condition and then transmits the slave address with the R/W bit set to zero. The master then sends the registers address to be read. After the device asserts an ACK on SDA, the master sends a repeated START condition followed by the slave address with the R/W bit set to one. The device then sends an ACK followed by the bytes contained in the register. The device auto increments the register address, and, if the master asserts an ACK, the device sends the next bytes. To end the read transaction, the master must generate a NACK followed by a STOP condition.