CONEX-PSD

Two-Axis Position & Power Sensing Device

User’s Manual

Newport®
Experience | Solutions

Precision Motion – Guaranteed™
Warranty

Newport Corporation warrants that this product will be free from defects in material and workmanship and will comply with Newport’s published specifications at the time of sale for a period of one year from date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Newport's option.

To exercise this warranty, write or call your local Newport office or representative, or contact Newport headquarters in Irvine, California. You will be given prompt assistance and return instructions. Send the product, freight prepaid, to the indicated service facility. Repairs will be made and the instrument returned freight prepaid. Repaired products are warranted for the remainder of the original warranty period or 90 days, whichever comes first.

Limitation of Warranty

The above warranties do not apply to products which have been repaired or modified without Newport’s written approval, or products subjected to unusual physical, thermal or electrical stress, improper installation, misuse, abuse, accident or negligence in use, storage, transportation or handling. This warranty also does not apply to fuses, batteries, or damage from battery leakage.

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**Newport**

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EU Declaration of Conformity

CONEX-PSD series
Two-axis Position & Power Sensing Device

Year CE mark affixed: 2016

EC Declaration of Conformity

The manufacturer:
MICRO-CONTROLE Spectra-Physics,
9, rue du bois sauvage
F-91055 Evry FRANCE

Hereby declares that the product:

• Description: "CONEX-PSD9 & CONEX-PSD10GE"
• Function: Two-axis Position & Power Sensing Device
• Type of equipment: Electrical equipment for measurement, control and laboratory use

– complies with all the relevant provisions of the Directive 2014/30/EU relating to electromagnetic compatibility (EMC).

– was designed and built in accordance with the following harmonised standards:
  • NF EN 61326-1:2013 « Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements »
  • NF EN 55011:2010/A1:2011 Class A

– was designed and built in accordance with the following other standards:
  • NF EN 61000-4-2
  • NF EN 61000-4-3
  • NF EN 61000-4-4
  • NF EN 61000-4-5
  • NF EN 61000-4-6
  • NF EN 61000-4-11

Date: 30/06/2016
Hervé Le Cointe
Quality Director

MICRO-CONTROLE Spectra-Physics
Zone Industrielle
F-45340 Beaune La Rolandé, France
ConEx-PSD Two-Axis Position & Power Sensing Device

Preface

Documentation Organization

CONEX-PSD documentation set includes 2 parts:

- **Sensor Manual** (this document) describing sensor features and measurement optimization.
- **Controller Manual** describing available commands.

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Maintenance

The CONEX-PSD Controller/Driver should only be cleaned with a lightly damped cloth or sponge with a soapy water solution. Do not use an acetone or alcohol solution; this will damage the finish of the enclosure.

Service Information

The user should not attempt any maintenance or service of the CONEX-PSD Controller/Driver and its accessories beyond the procedures outlined in this manual.

Any problem that cannot be resolved should be referred to Newport Corporation. When calling Newport regarding a problem, please provide the Tech Support representative with the following information:

- Your contact information.
- System serial number or original order number.
- Description of problem.
- Environment in which the system is used.
- State of the system before the problem.
- Frequency and repeatability of problem.
- Can the product continue to operate with this problem?
- Can you identify anything that may have caused the problem?

Complete a copy of the Service Form as represented at the end of this document and include it with your shipment.
Newport Corporation RMA Procedures

Any CONEX-PSD Controller/Driver being returned to Newport must have been assigned an RMA number by Newport. Assignment of the RMA requires the item serial number.

Packaging

CONEX-PSD Controller/Driver being returned under an RMA must be securely packaged for shipment. If possible, reuse the original factory packaging.
## 1.0 Introduction

### 1.1 Definitions and Symbols

The following terms and symbols are used in this documentation and also appear on the CONEX-PSD Controller/Driver where safety-related issues occur.

#### 1.1.1 General Warning or Caution

![General Warning or Caution Symbol](image1)

*Figure 1: General Warning or Caution Symbol.*

#### 1.1.2 The Exclamation Symbol in General Warning or Caution

![Exclamation Symbol](image2)

Figure 1 may appear in Warning and Caution tables in this document. This symbol designates an area where personal injury or damage to the equipment is possible.

#### 1.1.3 Electric Shock

![Electric Shock Symbol](image3)

*Figure 2: Electrical Shock Symbol.*

#### 1.1.4 The Electrical Shock Symbol in Electric Shock

Figure 2 may appear on labels affixed to the CONEX-PSD Controller/Driver. This symbol indicates a hazard arising from dangerous voltage. Any mishandling could result in irreparable damage to the equipment, in personal injury, or death.
1.1.5 European Union CE Mark

Figure 3: CE Mark.

The presence of the CE Mark on Newport Corporation equipment means that it has been designed, tested and certified as complying with all applicable European Union (CE) regulations and recommendations.

1.2 Warnings and Cautions

The following are definitions of the Warnings, Cautions and Notes that may be used in this manual to call attention to important information regarding personal safety, safety and preservation of the equipment, or important tips.

<table>
<thead>
<tr>
<th>WARNING</th>
<th>Situation has the potential to cause bodily harm or death.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAUTION</td>
<td>Situation has the potential to cause damage to property or equipment.</td>
</tr>
<tr>
<td>NOTE</td>
<td>Additional information the user or operator should consider.</td>
</tr>
</tbody>
</table>

1.3 General Warnings and Cautions

The following general safety precautions must be observed during all phases of operation of this equipment.

Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the equipment.

- Heed all warnings on the unit and in the operating instructions.
- To prevent damage to the equipment, read the instructions in this manual.
- Route power cords and cables where they are not likely to be damaged.
- Keep air vents free of dirt and dust.
- Keep liquids away from unit.
- Do not expose equipment to excessive moisture (>85% humidity)
- Do not operate this equipment in an explosive atmosphere.
- Disconnect power before cleaning the CONEX-PSD unit. Do not use liquid or aerosol cleaners.
- Do not open the CONEX-PSD Controller. There are no user-serviceable parts inside.
- Return equipment to Newport Corporation for service and repair.
- Follow precautions for static-sensitive devices when handling electronic circuits.
2.0 General Description

2.1 Part Number

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSD9-SI</td>
<td>9 x 9 mm sensor for wavelength from 320 to 1100 nm</td>
</tr>
<tr>
<td>PSD10-GE</td>
<td>10 x 10 mm sensor for wavelength from 800 to 1700 nm</td>
</tr>
</tbody>
</table>

2.2 Dimensions

2.2.1 Silicon Sensor

2.2.2 Germanium Sensor
2.3 System Environmental Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td></td>
<td>5 °C to 40 °C</td>
<td></td>
</tr>
<tr>
<td>Operating humidity</td>
<td></td>
<td>20% to 85% relative humidity, non-condensing</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td>Indoor use only</td>
<td></td>
</tr>
</tbody>
</table>

2.4 Sensor Characteristics

NOTE

The values are estimated based on the sensor manufacturer’s typical values at ambient temperature. They are not calibrated to each unit.

2.4.1 Silicon Sensor

2.4.1.1 Absolute Maximum Rating (Ta = 25 °C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse Voltage</td>
<td>V_r Max.</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>T_{opr}</td>
<td>-20 to +60</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>T_{stg}</td>
<td>-20 to +80</td>
<td>°C</td>
</tr>
</tbody>
</table>

2.4.1.2 Electrical and Optical Characteristics (Ta = 25 °C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral response range</td>
<td>λ</td>
<td></td>
<td>–</td>
<td>320</td>
<td>to 1100</td>
<td>Nm</td>
</tr>
<tr>
<td>Peak sensitivity wavelength</td>
<td>λ_p</td>
<td></td>
<td>–</td>
<td>960</td>
<td>–</td>
<td>Nm</td>
</tr>
<tr>
<td>Photo sensitivity</td>
<td>S</td>
<td>λ = λ_p</td>
<td>–</td>
<td>0.6</td>
<td>–</td>
<td>A/W</td>
</tr>
<tr>
<td>Interelectrode resistance</td>
<td>Rie</td>
<td>V_b = 0.1 V</td>
<td>5</td>
<td>7</td>
<td>15</td>
<td>kΩ</td>
</tr>
<tr>
<td>Position detector error</td>
<td>E</td>
<td>λ = 900 nm, V_R = 5 V, Spot size = 0.2 mm</td>
<td>–</td>
<td>±150</td>
<td>±250</td>
<td>µm</td>
</tr>
<tr>
<td>Dark current</td>
<td>ID</td>
<td>V_R=5V</td>
<td>–</td>
<td>1</td>
<td>50</td>
<td>nA</td>
</tr>
<tr>
<td>Saturation photocurrent</td>
<td>Ist</td>
<td>λ = 900 nm, V_R = 5 V</td>
<td>–</td>
<td>500</td>
<td>–</td>
<td>µA</td>
</tr>
<tr>
<td>Rise time</td>
<td>tr</td>
<td>RL = 1 kΩ</td>
<td>–</td>
<td>2</td>
<td>–</td>
<td>µs</td>
</tr>
<tr>
<td>Terminal capacitance</td>
<td>Ct</td>
<td>V_R = 5 V, F = 10 kHz</td>
<td>–</td>
<td>500</td>
<td>1000</td>
<td>pF</td>
</tr>
<tr>
<td>Position resolution</td>
<td>ΔR</td>
<td>IO = 1 µA, F = 10 kHz</td>
<td>–</td>
<td>1.5</td>
<td>–</td>
<td>µm</td>
</tr>
</tbody>
</table>
2.4.1.3 Wavelength Consideration

Power/Wavelength

![CONEX-PSD Optical Power](image)

Responsivity/Wavelength

![CONEX-PSD Responsivity](image)

2.4.2 Germanium Sensor

2.4.2.1 Electrical and Optical Characteristics (Ta = 25 °C)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral response range</td>
<td>( \lambda )</td>
<td></td>
<td>( 800 ) to ( 1700 )</td>
<td></td>
<td></td>
<td>nm</td>
</tr>
<tr>
<td>Peak sensitivity wavelength</td>
<td>( \lambda_p )</td>
<td></td>
<td>( 1550 )</td>
<td></td>
<td></td>
<td>nm</td>
</tr>
<tr>
<td>Photo sensitivity</td>
<td>( S )</td>
<td>( \lambda = \lambda_p )</td>
<td>( 0.9 )</td>
<td></td>
<td></td>
<td>A/W</td>
</tr>
<tr>
<td>Interelectrode resistance</td>
<td>( R_{ie} )</td>
<td></td>
<td>( 100 )</td>
<td></td>
<td></td>
<td>( \Omega )</td>
</tr>
<tr>
<td>Shunt resistance</td>
<td></td>
<td></td>
<td>( 1 )</td>
<td>( 2 )</td>
<td></td>
<td>k( \Omega )</td>
</tr>
<tr>
<td>Shunt capacitance</td>
<td></td>
<td></td>
<td>( 30 )</td>
<td></td>
<td></td>
<td>( nF )</td>
</tr>
<tr>
<td>Position resolution</td>
<td>( \Delta R )</td>
<td>( F = 136 ) Hz</td>
<td>( 5 )</td>
<td></td>
<td></td>
<td>( \mu m )</td>
</tr>
</tbody>
</table>
2.4.2.2 **Wavelength Consideration**

The sensor should be operated with beam power between 0.1mW and 1mW. Nonlinearities and saturation can occur above 1mW.

![CONEX-PSD Typical Spectral Response](image)

![CONEX-PSD Maximum Percentage Returned by the GP Command for a 1 mW Beam](image)

2.5 **Sensor Care**

The input window is coated with a soft silicone resin. Avoid touching the window to keep grime from accumulating or prevent surface damage that can decrease the PSD's sensitivity. External force applied to the resin surface may deform or cut off the wires.

**WARNING**

**DO NOT TOUCH SENSOR WINDOW.**

Silicone resin swells when it absorbs organic solvents, so do not use any solvent other than Alcohol.

**WARNING**

**USE ONLY ALCOHOL TO CLEAN SENSOR WINDOW.**
3.0 Functional Description

3.1 Principle
Position Sensing Devices (PSDs) consist of a p-n junction photodiode in which two sides of the junction have electrically separate contacts.

X, Y positions returned by the Get Position GP command are given according to the above referential.

3.2 Sensors Outputs
For Si sensor, the cut-off frequency is at 319 Hz.
For Ge sensor, the cut-off frequency is at 136 Hz.

3.3 Beam Size Considerations

3.3.1 Max. Size
For best measurement quality, the beam should remain within the sensitive area (9 x 9 mm for Si, 10 x 10 mm for Ge). If the beam is moving during measurement (ΔX, ΔY), its size should be reduced using the following formula:

Maximum Beam size for Si: BS_x = 9 mm – ΔX and BS_y = 9 mm – ΔY
Maximum Beam size for Ge: BS_x = 10 mm – ΔX and BS_y = 10 mm – ΔY

3.3.2 Min. Size
To maintain measurements quality, it is recommended to use a beam size ≥ 0.2 mm

WARNING
MINIMUM BEAM SIZE: 0.2 mm.
3.4 Beam Energy/Power Considerations

3.4.1 Max. Power

The maximum acceptable total beam power depends on the Wavelength. The maximum current generated by the sensor is 0.5 mA for Si and 1mA for Ge. In case of higher beam power, it is possible to mount Newport neutral density filter such as model “FBR-NDxx” on the Newport “Model 883-OH 1” filter holder.

3.4.2 Max. Density

The maximum acceptable beam intensity is limited by the device itself: 30mw/mm².

WARNING
MAXIMUM BEAM POWER DENSITY: 30 mW/mm².

3.4.3 Max. Energy

Although PSD sensors are mostly used to check continuous lasers, they can be used to check the average power of pulsed laser. However, high energy, short pulses beam might damage the sensor. It is strongly recommended to NOT exceed the following values:

- Beam size: ≥1 mm².
- Beam power: ≤1mW.
- Repetition rate: ≥10 kHz.
- Pulse duration: ≥5 ns.

WARNING
DO NOT USE TOO SHORT, TOO HIGH ENERGY PULSES.
4.0 Optimizing Measurements

This section provides general recommendations for improving light measurement setups.

4.1 Avoid Stray Light

As the sensitive area of a PSD is relatively large (81 mm² for Si, 100 mm² for Ge), it may collect unwanted light on top of the beam being measured. This may affect the measurement accuracy.

PSD’s are also sensitive to a large spectral range (300 to 1100 nm for Si and 800 to 1700 for Ge). Although the light to be measured might be centered on one particular wavelength, sensor will be affected by other wavelengths.

For example, stray light can easily reach 10 μW/mm² on a broad spectral range in a room. This might not be negligible, especially if a large gain was set in the controller.

There are 2 ways to minimize the effect of stray light:

- Shield the sensor from unwanted light.
- Block the unwanted wavelength.

4.1.1 Shielding the Sensor

To minimize this effect, it is recommended to shield the sensor from stray light.

One or several Newport filter holders can be used for that.

4.1.2 Filtering and Attenuation

Several types Newport filter can be mounted on the Newport “Model 883-OH 1” filter holder.

For example:

Absorptive Neutral Density Filter (FSR-xxxx):

![Typical Optical Density](image-url)
Or Bandpass Filter (10BPFx-y):

Or Mercury Line Filter (10MLFx-y):

NOTE
Keep in mind to take filter attenuation into account in the measurements.

4.2 Optimizing Controller Parameters

4.2.1 Offset
Controller offset can be used to compensate for stray light. Proceed as follows:

- Prepare your optical setup.
- Turn the beam OFF.
• Using an application software or Windows HyperTerminal (see CONEX-PSD Controller Documentation) set all gains to 1 with the following commands:
  o “1PX1”
  o “1PY1”
  o “1PS1”
• Use the 1RA? command to get the current offsets.
• On PSD9 silicon, this command will return 3 parameters: OX, OY, OS (in volts).
  Set the offsets using the following commands:
  o “1IXnn” with nn = OX value
  o “1IYnn” with nn = OY value
  o “1ISnn” with nn = OS value
• On PSD10Ge, this command will return 4 parameters: offset1, offset2, offset3, offset4 (in volts).
  Set the offsets using the following commands:
  o “1OFaa,bb,cc,dd” with aa = offset1 value, bb = offset2 value, cc = offset3 value and dd = offset4 value
  Those 4 values correspond to electrical offsets. For optical offset compensation and full scale adjustment (section below), use OX/PX and OY/PY commands to compensate X and Y positions and scalings.
• Using the command “1GP?”, verify that the corrected positions and power are set to 0.
• Turn the beam to be measured ON.
• Using the command “1GP?”, read your beam position and power level.

4.2.2 Gain (-1 – +1)
To facilitate measurements, a gain can be used to modify the reported value of position and power.
For example:
• To change the sign of beam X position, use “1PX-1”.
• To change beam position unit from mm (default) to inches, use “1PX0.0393”.

4.2.3 Frequency (LF 0-1000)
CONEX-PSD sensor features an analog filter with a fixed cut-off frequency of 319 Hz for Si sensor and 136 for Ge sensor.
This allows an average power measurement for pulsed lasers.
An additional programmable low pass filter can be set to increase noise immunity (such as the 100–120 Hz coming from room fluorescent lights) using the command: “1LF80”.
5.0 Appendix: Firmware Version V2.2.x

Not every command can be executed in all states of the CONEX-PSD and some commands have different meaning in different states. It is therefore important to understand the state diagram of the controller, see section

<table>
<thead>
<tr>
<th>Command</th>
<th>Ready</th>
<th>Config.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GP</td>
<td>●</td>
<td>●</td>
<td>Get X, Y positions and laser power</td>
</tr>
<tr>
<td>ID</td>
<td>□</td>
<td>○</td>
<td>Set/Get stage identifier</td>
</tr>
<tr>
<td>IS</td>
<td>□</td>
<td>○</td>
<td>Set/Get offset on ADC input Sum (Si sensor) Not used (Ge sensor)</td>
</tr>
<tr>
<td>IX</td>
<td>□</td>
<td>○</td>
<td>Set/Get offset on ADC input X (Si sensor) Set/Get offsets on X position (Ge sensor)</td>
</tr>
<tr>
<td>IY</td>
<td>□</td>
<td>○</td>
<td>Set/Get offset on ADC input Y (Si sensor) Set/Get offsets on Y position. (Ge sensor)</td>
</tr>
<tr>
<td>LF</td>
<td>□</td>
<td>○</td>
<td>Set/Get low pass filter frequency</td>
</tr>
<tr>
<td>OF</td>
<td>□</td>
<td>○</td>
<td>Not used (Si sensor) Set/Get offset on ADC inputs 1 to 4 (Ge sensor)</td>
</tr>
<tr>
<td>PS</td>
<td>□</td>
<td>○</td>
<td>Set/Get gain on ADC input Summ (Si sensor) Not used (Ge sensor)</td>
</tr>
<tr>
<td>PX</td>
<td>□</td>
<td>○</td>
<td>Set/Get gain on ADC input X Set/Get gain on X position (Ge sensor)</td>
</tr>
<tr>
<td>PY</td>
<td>□</td>
<td>○</td>
<td>Set/Get gain on ADC input Y (Si sensor) Set/Get gain on Y position. (Ge sensor)</td>
</tr>
<tr>
<td>PW</td>
<td>●</td>
<td>●</td>
<td>Enter/Leave CONFIGURATION state</td>
</tr>
<tr>
<td>RA</td>
<td>●</td>
<td>●</td>
<td>Get raw analog input values</td>
</tr>
<tr>
<td>RC</td>
<td>●</td>
<td>●</td>
<td>Get corrected analog input values</td>
</tr>
<tr>
<td>RS</td>
<td>●</td>
<td>●</td>
<td>Reset controller</td>
</tr>
<tr>
<td>RS##</td>
<td>□</td>
<td>□</td>
<td>Reset controller’s address to 1</td>
</tr>
<tr>
<td>SA</td>
<td>–</td>
<td>○</td>
<td>Set/Get controller’s address</td>
</tr>
<tr>
<td>TB</td>
<td>●</td>
<td>●</td>
<td>Get command error string</td>
</tr>
<tr>
<td>TE</td>
<td>●</td>
<td>●</td>
<td>Get last command error</td>
</tr>
<tr>
<td>TS</td>
<td>●</td>
<td>●</td>
<td>Get positioner error and controller state</td>
</tr>
<tr>
<td>VE</td>
<td>●</td>
<td>●</td>
<td>Get controller revision information</td>
</tr>
</tbody>
</table>

○ Changes configuration parameters. Those changes will be stored in the controller’s memory with the PW1 command and remain available after switching off the controller.

□ Changes working parameters only. Those changes will get lost when switching off the controller.

● Accepted command.

– Write command not accepted (will return an error).

Command Command passed without preceding controller number applies to all controllers.
## OF — Set/Get offset on ADC inputs 1 to 4

<table>
<thead>
<tr>
<th>Syntax</th>
<th>xxOFnn,nn,nn,nn or xxOF?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameters</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>xx [int] — Controller address.</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>xx — 1 to 31</td>
</tr>
<tr>
<td></td>
<td>nn [float] — &gt; -1 and &lt; 1</td>
</tr>
<tr>
<td><strong>Units</strong></td>
<td>xx — None</td>
</tr>
<tr>
<td></td>
<td>nn — None</td>
</tr>
<tr>
<td><strong>Defaults</strong></td>
<td>xx Missing: Error B.</td>
</tr>
<tr>
<td></td>
<td>Out of range: Error B.</td>
</tr>
<tr>
<td></td>
<td>Floating point: Error A.</td>
</tr>
</tbody>
</table>

### Description
This command is only available with the Ge sensor. In CONFIGURATION state, this command will set the offset for the ADC input 1 to 4.

### Errors
- A — Unknown message code or floating point controller address.
- B — Controller address not correct.
- D — Controller address not correct.

### Rel. Commands
- ZT — Get all parameters.

### Example
1OF0.01221,0.01221,-0.02442,-0.01221 | Sets the ADC input offset of controller #1.
Service Form

Name: ________________________________  Return authorization #: ________________________________

Company: ______________________________________ (Please obtain prior to return of item)

Address: ______________________________________ Date: ___________________ Phone Number: _____________

Country: ______________________________________ Fax Number: __________________

P.O. Number: __________________________________ Serial #: __________________

Item(s) Being Returned: ________________________________ Model#: __________________

Description: ________________________________________________________________________________________________________

Reasons of return of goods (please list any specific problems):
__________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________
__________________________________________________________________________________________________________________

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