

OSx-1

# FKK Corporation

## Biomass burner Oxygen sensor Specification Data

Product name: Oxygen Sensor OSx-1

Drawing number: D2014-H6

Revised on: 2015.06.01



## General

This oxygen sensor have been designed by DENSO Corporation in cooperation with FKK Corporation to measure the proportion of unburned oxygen in exhaust gases of biomass, especially wood pellet burner systems.

The OSx-1 oxygen sensor with integrated zirconium heater, provide an output signal in the range of lambda and make it capable of being used as universal lambda sensor.

The main advantage of the OSx-1 is the high reliability design and superior quality standard.

## Technical principle

The oxygen sensor is placed in the exhaust gas stream of a biomass burner and is able to detect a rich or lean gas mixture. The sensor's basic structure consists of two platinum electrodes, separated by a zirconia electrolyte. One electrode is exposed to the exhaust gas and the other to ambient air. When there is a difference in the partial pressure of oxygen between the two gases, an electromagnetic force is generated and the sensor delivers a voltage output. The balance point between rich and lean mixture gas is the stoichiometric point.

## Application

Through oxygen measure of burner exhaust gases provide by the lambda sensor, the burner controller adjust automatically the solid fuel (wood pellet or other) consumption as well as the blower/exhaust fan speed to achieve the best ratio: fuel output / air. This technology can allow a saving of as much as 20% of annual consumption of wood pellet and allow a substantial decrease of harmful emissions (CO<sub>2</sub>, NO<sub>x</sub>, HC, etc).

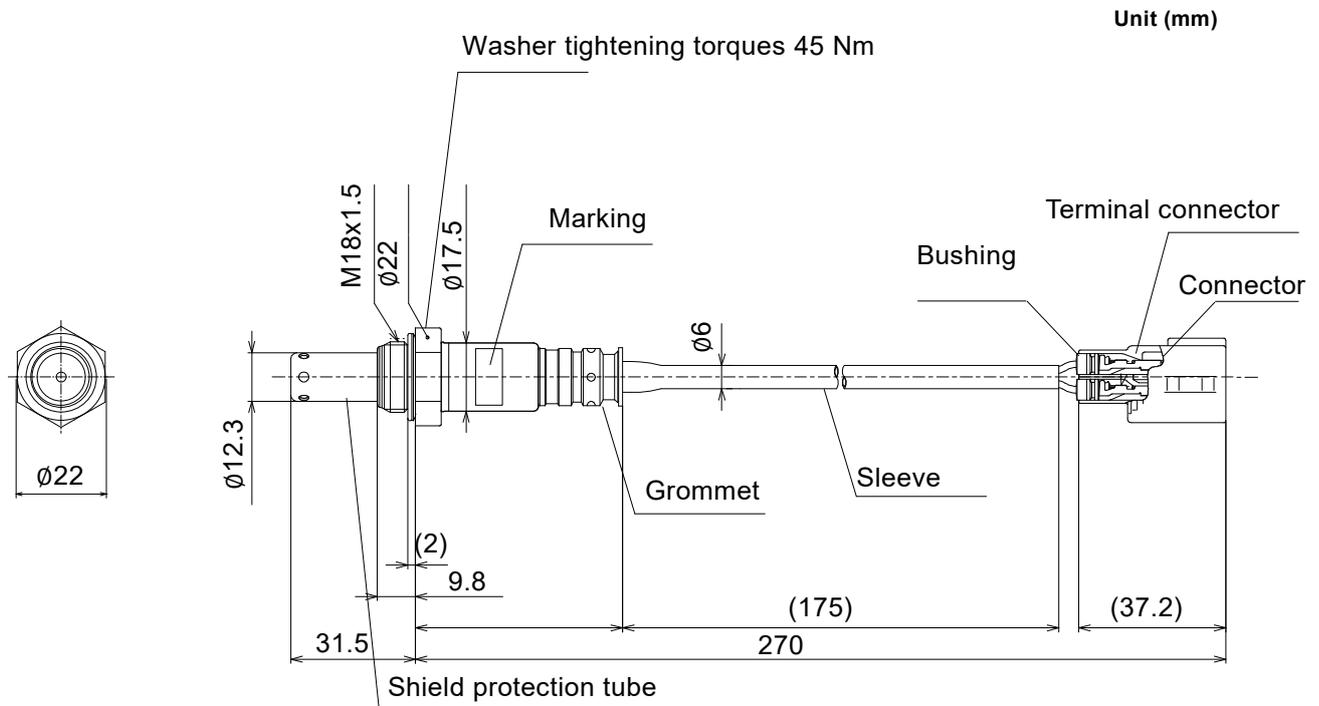
Theoretically, according to burner characteristic, when the oxygen sensor measures a too high oxygen rate, the controller diminishes the blower/exhaust fan speed while increasing the pellet auger output. In contrary, when the oxygen sensor measures a too low oxygen rate, the controller increases the blower/exhaust fan speed while diminishing the pellet auger output. By doing so, no matter of the wood pellet quality (humidity, combustion characteristics), the combustion process is adjusted to be the most efficient.

## Part Number

Part number <b>OSx-1</b>	
Product type	<b>OSx</b> : Oxygen Sensor X
Oxygen sensor type	<b>1</b> : type H6

## Dimensions data

For precise dimensions information, please refer to the related drawing.



## Wiring technical specification

Connector	Yazaki Sogyo 7282-7040
Mating connector	Yazaki Sogyo 7283-7040
Pin 1	Heater (Black) Tin plated
Pin 2	Heater (Black) Tin plated
Pin 3	Sensor (+) (Blue) Gold plated (Signal)
Pin 4	Sensor (-) (White) Gold plated (Ground)
Wire material	Silicone varnished glass sleeve (Yellow)
Wire length	175 mm (optional 2m connecting cable available)
Wire diameter	AWG19 (PTFE coated)
Sleeve	Fiber glass / Silicone varnish coated

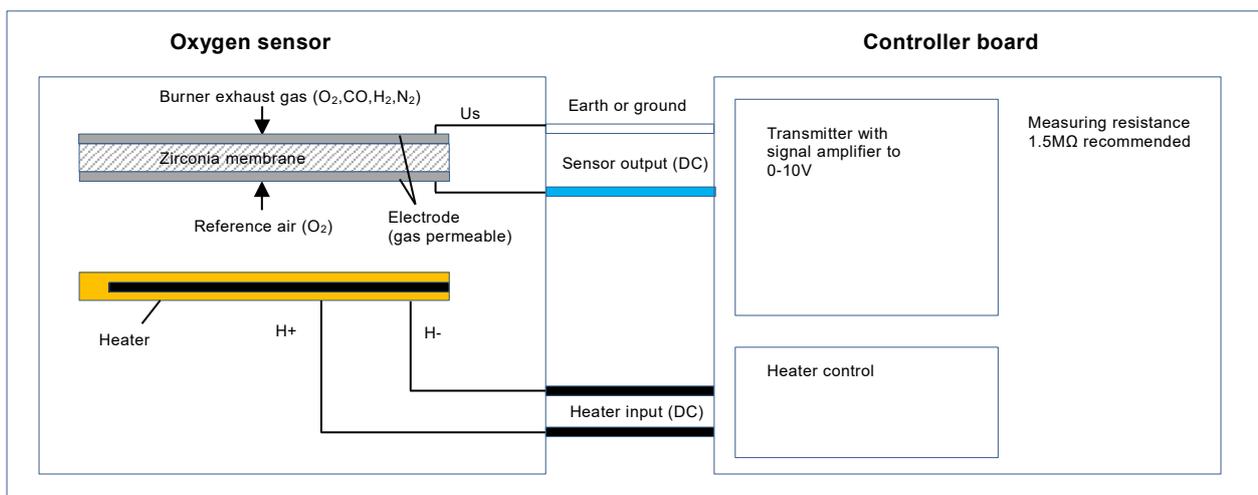
## Mechanical data

Weight	78 g
Thread	M18x1.5
Wrench size	22 mm
Tightening torque	45±5 Nm

## Electrical data

Heater supply voltage (DC)	DC9~12V
Heater power steady state	10W
Heater control frequency	≥ 10Hz
Nominal resistance of Nernst cell	40KΩ
Max current load for Nernst cell	≤5mA

## Electrical diagram (reference only)

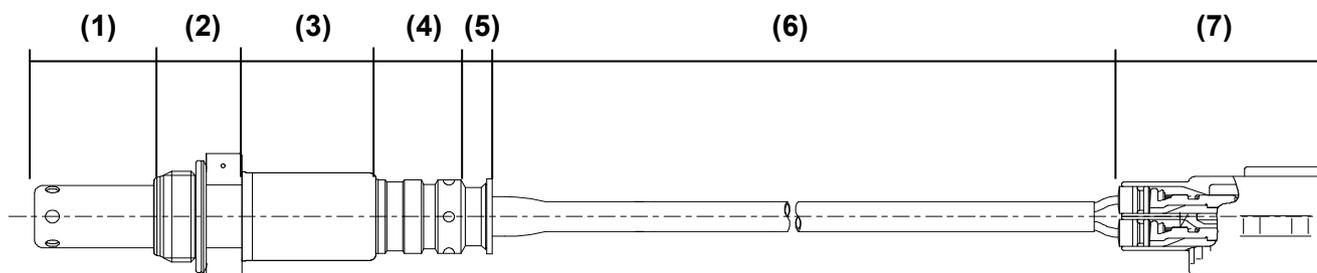


FKK Corporation do not provide any ECU controller board. This diagram is for information only.

# Application environmental condition

Exhaust gas temperature range (1) (operating)	≤ 900 °C
Hexagon temperature (2)	< 600 °C
Sensor body temperature (3)	< 350 °C
Grommet temperature (4)	< 280 °C
Bushing temperature (5)	< 240 °C
Wire and sleeve temperature (6)	< 180 °C
Terminal connector temperature (7)	< 120 °C
Storage temperature range	-40 to 40 °C
Max vibration	392 m/s <sup>2</sup>

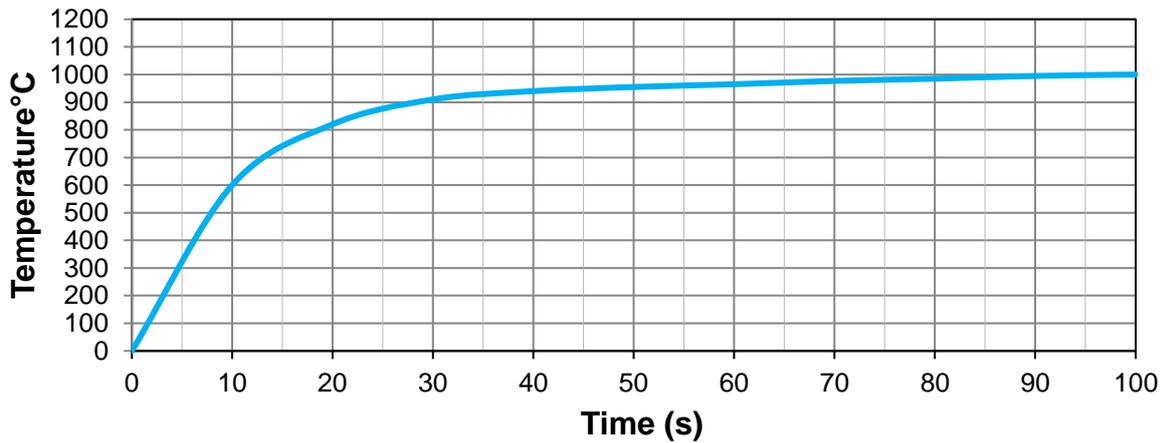
( ) number on below diagram



## Internal heater characteristics

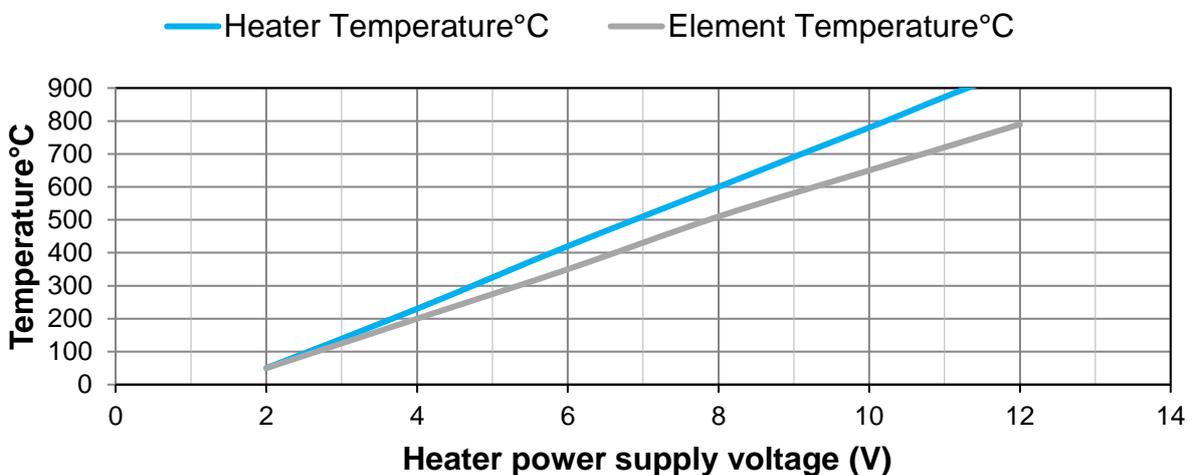
Characteristics	Unit	Minimum	Normal	Maximum
Heater resistance at 20 °C	Ω	5.0	5.6	6.2
Heater voltage (DC)	V		10	12
Inrush current (-40±1°C , DC 14V)	A	-	-	3.02
Heater current (DC 10V)	A	-	1.0	-
Heater wattage (DC 10V)			10W	
Max heater temperature (power Off)			1000°C	
Max temperature change rate			180 °C/s	

## Internal heater rising temperature



## Internal heater control

The heater can be control and adjust to 1000°C or less by using the following graph data.



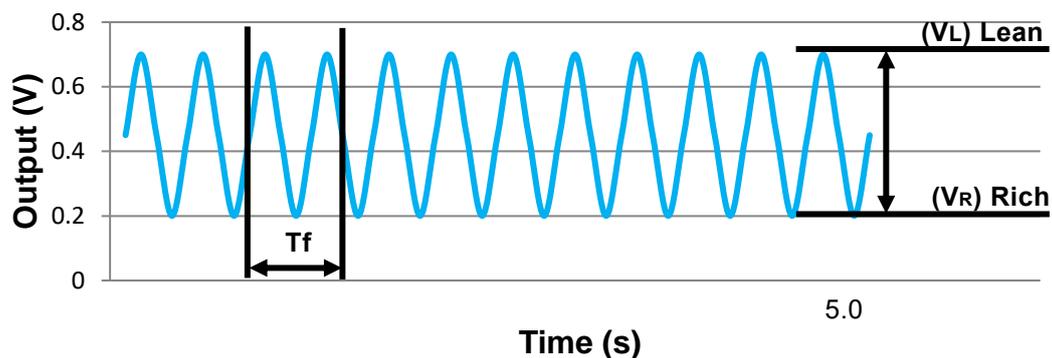
## Sensor cell characteristics

Max temperature for short time	950°C
Max temperature change rate	≤ 40°C/s at 20 °C
Sensor Internal resistance	≤ 40kΩ

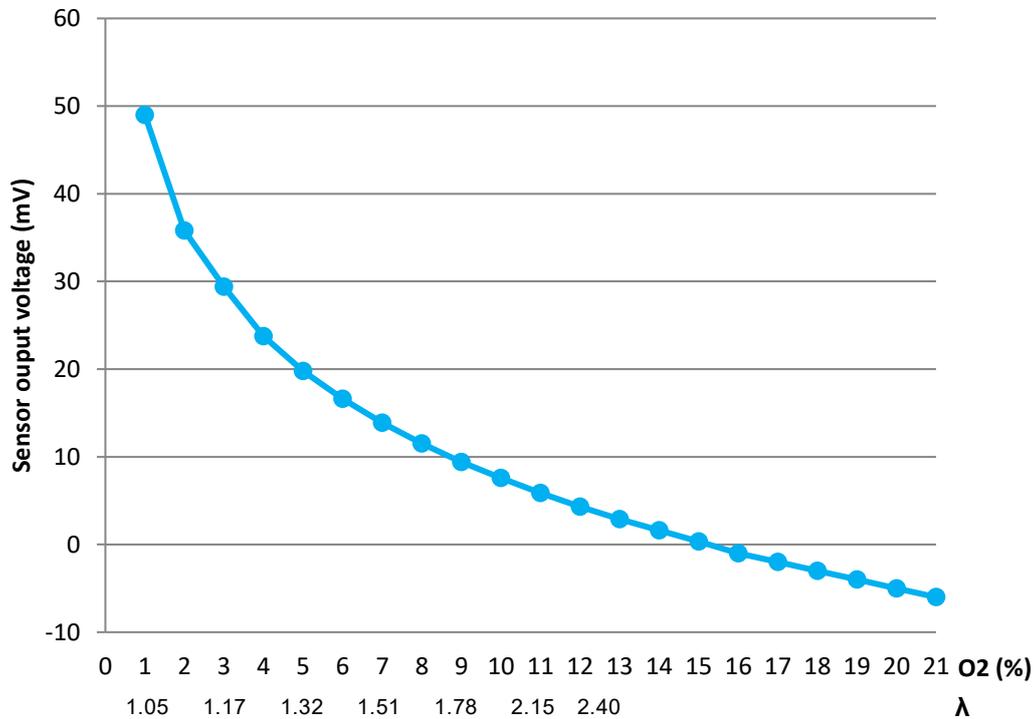
## Output characteristics

Signal output (DC)	mV
Lambda control range	1.0...2.0 λ up to 2.0 for special application
Sensor output voltage for 1.05...2.15 λ 220 °C and flow rate of 30l/min	48...6 mV
Sensor output voltage in 21% O <sub>2</sub> 220 °C and flow rate of 30l/min	-5...-9 mV
Accuracy at lambda 1	±0.02
Rich mixture voltage (V <sub>R</sub> )	≥ 700mV (0.9λ)
Lean mixture voltage (V <sub>L</sub> )	≤ 200mV (1.1λ)
Response time T <sub>f</sub>	≤ 860ms

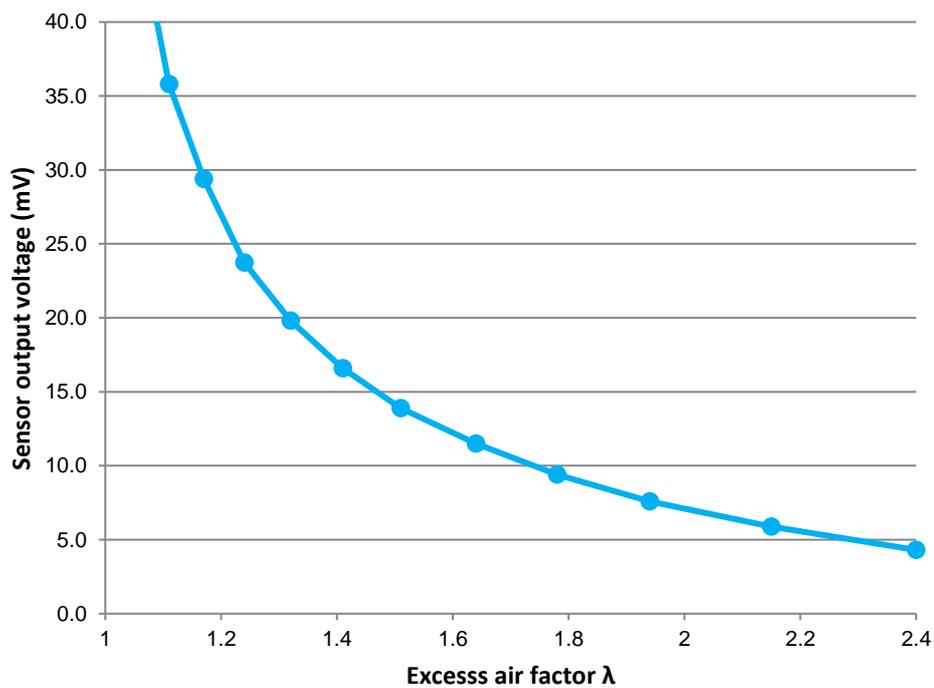
Based on 400°C temperature at sensor tip and 3.0m/s gas velocity condition, heater control at 6.6W



## Sensor output voltage vs. O<sub>2</sub>% and λ (reference only)



## Sensor output voltage vs. λ (lean range) (reference only)



## Sensor output property (gas 220°C, 30l/min) (reference only)

Sensor output voltage (mV)	$\lambda$	O2 %	N2 %	H2O %
146	1	0	79.9	20
49	1.05	1	78.9	20
36	1.11	2	77.9	20
29	1.17	3	76.9	20
24	1.24	4	75.9	20
20	1.32	5	74.9	20
17	1.41	6	73.9	20
14	1.51	7	72.9	20
12	1.64	8	71.9	20
10	1.78	9	70.9	20
8	1.94	10	69.9	20
6	2.15	11	68.9	20
5	2.40	12	67.9	20
3	2.71	13	66.9	20
2	3.12	14	65.9	20
0	3.68	15	64.9	20
-1	-	16	63.9	20
-2	-	17	62.9	20
-3	-	18	61.9	20
-4	-	19	60.9	20
-5	-	20	59.9	20
-6	-	21	58.9	20

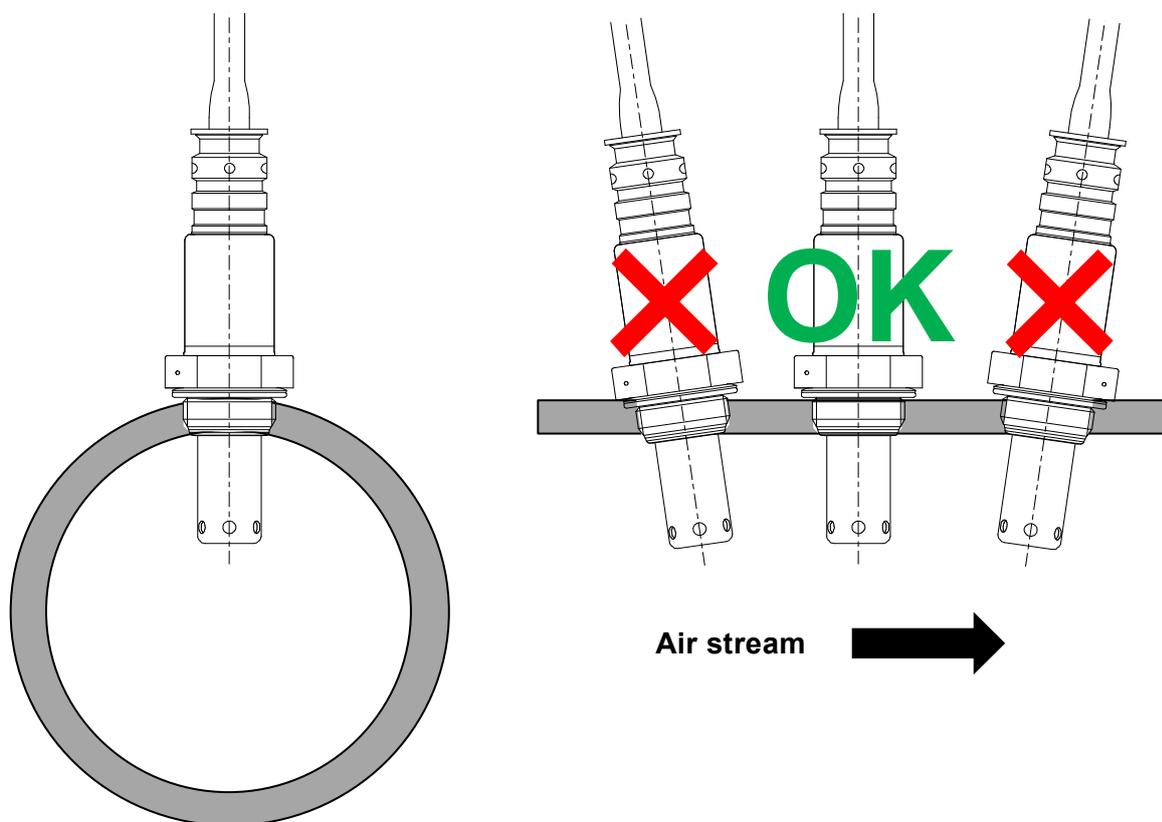
Based on 220°C exhaust gas temperature at sensor tip and 30 l/min gas velocity condition.

## Design requirement

For optimal performance and a long lifetime of oxygen sensor, please read carefully the following installation requirements and notices.

After the installation, the operating temperature of the oxygen sensor should be inspected and tested so that each temperature satisfies the specified temperatures limit prescribed in “Application environmental condition” section.

The sensor should be installed with its tip facing downward of exhaust pipe (electrical connection upwards), to prevent the collection of liquid or other contaminant inside the sensor’s shield protection tube. The tip should also not face upstream of the air stream.



Do not install the sensor in a place where it can be exposed to water splash.

The sensor body and element should not be exposed to contamination (oil, dust, etc). Contamination of the sensor body or sensor element may cause various functional or electrical failures. The sensor grommet and internal sensor element should never be contaminated by Si, Pb or P base materials.

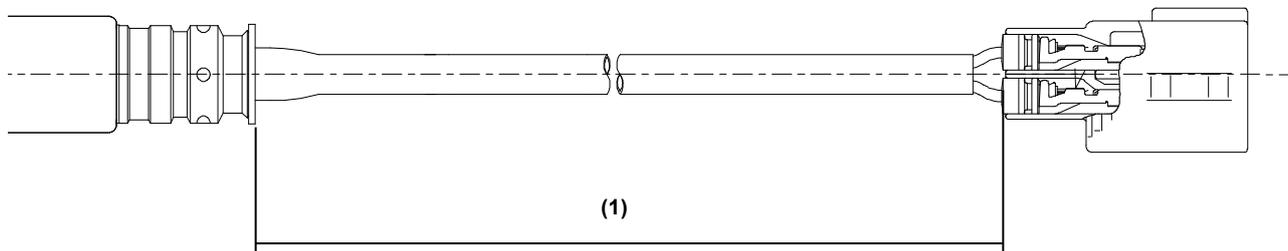
The sensor should not be exposed to strong mechanical shocks. Excessive shock may crush the sensor or crack the internal heater or sensor element.

A removed sensor should not be reused but replaced with a new one. If a sensor is removed, there is a possibility of gasket damage.

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The wiring part (cf. (1) below figure) should not be bent over 60 degree angle tensile.

The minimum bending radius of wiring part (cf. (1) below figure) must be 20 mm (R20).



Substantial tensile stress of wiring must be avoided in the operation condition. After installation, the wiring part must be free from tensile stress.

In order to prevent body injuries or serious damage, you should ensure to design a safety environment to place this product, taking in count a possible failure of this component.

## Handling precautions and prohibitions

The following items may seriously affect the rated life and properties of this product.

- Please avoid colliding or giving excessive shock to the sensor tip or body part (drop down from more than 1m height). This could crush or crack the heater or sensor element.
- Do not hold the sensor by the wiring side only. This handling may cause to hit the sensor body against the operation desk, the rack, the wall, etc. The sensor may be crushed or internal parts cracked. Please always handle the products with care.
- Do not tighten or fix the sensor by spinning connector or wiring only. It may cause tensile stress on connector and disconnect it.
- The sensor shall be tightening with  $45\pm 5$  Nm torque wrench. Material characteristics and strength of the thread must be appropriate. Do not apply excessive strength on the sensor body, while tightening.
- The sensor thread must be greased before installation. Please take care to not put greasing fluid on the tip or sensor grommet when applying grease fluid on the thread.
- The sensor body and element must be covered when spraying grease, cleaning or rust proof oil.
- After the installation, the wiring connection should be inspected and tested to avoid electrical or functional failures.
- Never touch the sensor when it is connected, it is equipped with a heating element and becomes very hot.

This product specification data guarantee the whole product as well as the part. Please contact our company for specific usage or conditions. Please inform us if you want to make modification to the product. All modification made to the product occurring after the delivery would be consider as outside the scope of the present specification data and the warranty.

## Storage

The oxygen sensor should be carried and stored in the original packaging until installation in the burner. If the sensors are stored in original package, be careful to handling with care. The products can be damaged by wetting, dropping, stacking or mechanical shock, etc.

Storage in the below conditions should be avoided:

- Sea breeze, C12, H2S, NH3, SO2, NOX environment
- Exposition to direct sunlight
- Long storage in moist and oily condition or in conditions other than -40~40°C normal storage temperature and 45~85% of normal storage humidity

Maximum storage time is 2 years.

## Warranty

FKK Corporation warrants that Products delivered by FKK Corporation are free from defects in material and workmanship in accordance with the respective state-of-the-art at the time of delivery.

Complaints for defects have to be notified to FKK Corporation in writing within 14 days of the receipt of the Products, or with respect to hidden defects which could reasonably not have been detected upon receipt of the Products within 14 days of the detection of such hidden defect. If nothing to the contrary has been agreed in writing, a warranty period of 24 months from shipment date applies.

Subject to timely notice, the warranty is fulfilled at the discretion of FKK by a replacement delivery or elimination of the fault at no charge.

The warranty is valid on condition that the customer contacts FKK Corporation during the warranty period and provide all details about the failure (pictures, installation check-list form, etc.). The complaint will then undergo a reviewing process. Once the complaint is found to be legitimate, the product can be returned to FKK Corporation in Japan. The transport costs (DDP - delivered duty paid) for the return shipment in cases of warranty must be borne by the buyer.

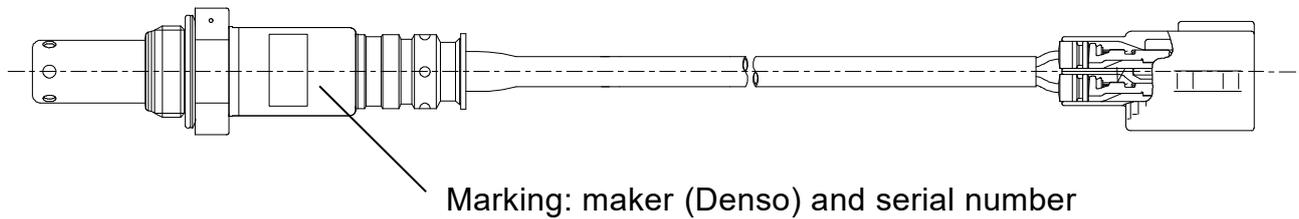
No warranty applies in the following cases:

- Non observance of data sheet installation requirement
- Overloading, inappropriate use or handling
- Damage caused during the delivery
- Repair and modification made by other company than FKK Corporation
- Damaged caused during natural disaster, fire, etc.
- Damage due to natural wear

The warranty is limited to the purchase price of the product only. It does not cover any transport costs, labor or consequential loss or damage. FKK Corporation will not be held liable for any loss or damages of whatsoever nature, whether directly or indirectly, sustained by the purchaser arising from the use or defect of this product. In case of damaged product, please advise with your FKK sales representative. In case of replacement of damaged products FKK sales representative will ask you to provide the related product's invoice and serial number (cf. section below).

## Serial number marking

All products are marked with a serial number representing the year and month of production.



## Conformity with EC regulation

This product complies with European community regulations as follow:

- 1907/2006/EC      European Directive of June 2006 on Registration, Evaluation, Authorization and Restriction of Chemicals in Electrical and Electronic Equipment (REACH).
- 2011/65/EU        European Directive of June 2011 on Restriction of the use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS).
- 2006/95/EC        European Directive of December 2006 on electrical equipment designed for use within certain voltage limits (LVD).

## Revision history

Specification sheet number		Drawing number	D2014-H6		
Customer company name		Designated product	OSx-1		
Specification sheet number	Revised date	Content of revision			Author
		Page number	Item name	Content	
	14/10/10	all	all	Creation	M.S
	14/11/20	all	all	Complete review	M.S
	15/06/01	all	all	Complete review	M.S
	17/10/30	12	all	Warranty condition, lot marking	M.S

## Information

For use beyond typical operating conditions or applications, please consult your FKK sales representative or distributor for further information.

The products digital data-sheet and drawing can be downloaded on FKK web site or by scanning the QR code below.



**Data-sheet**



**Drawing**

## About FKK

FKK Corporation (Fuji Kogyo Kabushiki) was incorporated in 1954 and since then producing ignition components for gas, oil and biomass sector. The company complies with ISO 9001 and ISO 14001.

For more information about FKK and our products, please visit [www.plug.fkk-corporation.com](http://www.plug.fkk-corporation.com)

## About DENSO Corporation

DENSO is a leading supplier of advanced automotive technology, systems and components for all the world's major automakers, operates in more than 35 countries and regions with approximately 140,000 employees. Global consolidated sales totaled US\$39.8 billion for fiscal year ended March 31, 2014. DENSO is number one supplier of Toyota car for Lambda sensor components.

For more information about DENSO, please visit [www.globaldenso.com](http://www.globaldenso.com)

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