AUTOMOTIVE OPACITY SMOKE METER

NDO-6000

OPERATION MANUAL

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CARMAN INTERNATIONAL

USER'S PRECAUTIONS

For the safely and effectively use of the products, read the manuals fully for the product before use the products.

① For the safety guarantee of the product's engineering and construction, refer to the manuals.

② To maintain the safety, this manual must be supplied together with the product to the final user.

③ The product must be kept at a place of well ventilated.

④ The product must not be cleansed by paint thinner or any strong chemical materials.

This manual can be changed without notice in order to enhance technical capacity.

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SECTION 1. QUALITY GUARANTEE REGULATION

If the product is handled according to this manual but there occurs a failure with in the guaranteed period, it will be repaired free of charge by our company. However, the compensation from the secondary damage and the following cases may not be guaranteed and repaired without fee:

(1) Out-of order or damage on the product due to user's fault, careless maintenance and inspection, and unsafe keeping.

(2) Out-of order or damage on the product due to the change or reconstruction of the product.

(3) Any naturally expendable parts such as rubber parts, and required exchange of those parts which are damaged.

(4) Out-of order or damage due to the use of not designated genuine parts.

(5) Un-clarified items (example: no specifically given item number)

SECTION 2. SAFETY GUIDELINE

Installing place and Precautions

① This product is geared to use AC110V or AC220V only. Make sure the source of electricity.

② As probe is heated hot, be careful not to be burned when detaching.

③ While analyzing, do not stay long time where sooty smoke emits.

④ While measuring, refrain from moving the product, and install the product at no vibrating place.

⑤ For the safety purpose, put resistant stuff in front and rear of the tire.

⑥ Install probe and when measurement completed remove it immediately from exhausting pipe.

⑦ Do not disassemble and reassemble the product on user's discretion.

SECTION 3. INTRODUCTION OF THE PRODUCT

3-1 Introduction

This opacity meter measures a diesel smoke density of automobile burning diesel as fuel to diagnose the condition of automobile and provide preventive maintenance in order to avoid air pollution.

3-2 Outlook appearance

3-2-1. Front / Rear view

3-2-2. Side view

3-3 Specification

Model/ Product	NDO-6000 / Automotive Opacity Smoke Meter							
Measuring item/method	Smoke opacity (%), k (m^{-1}); Light absorption coefficient, RPM(option), °C(option) / Light extinction method (Partial-flow sampling type)							
Light source	Green LED(565nm)							
Detector	Photodiode							
Shell length & inside diam.	Length : 215mm , Inside diameter : 21mm							
Shell temp.	Maintain constantly about 80℃							
Measuring range	smoke	0.0~100.0%	K	0.00~21.42 m^{-1}	RPM	0~8,000rpm	Oil temp.	0~200℃
Resolution		0.1%		0.01m^{-1}		10rpm		1℃
Display		4digit 7segmentLED		4digit 7segmentLED		4digit 7segmentLED		4digit 7segmentLED
Repeat	Within ±1%							
Precision	Within ±1% (RPM :±80rpm)							
Response time	0.5 Second (90% more)							
Display of smoke density	4 times per a second							
Data dispatch	RS232 Method, 4 times per a second (Ref. Protocol)							
Warming up time	About 5 ~10 minutes							
Using filter	0.5second Besel low pass digital filter							
Electricity source	220V / 110V AC 50 /60 Hz							
Consumption	About 100W							
Operation temperature	0~40℃ (Sampling probe hose : less than 300 ℃)							
Size / Weight	450(W) x 245(D) x 435(H) mm / About 7kg							
Probe length	1.5m							
Probe inside diam.	Inside diameter: 10mm							
Basic accessory	Probe & Hose, Power cable, RS232C cable, Manual, Fuse							
Option	Built-in printer, RPM sensor, Oil temp. sensor , Handheld terminal, Standard filter PC software,							

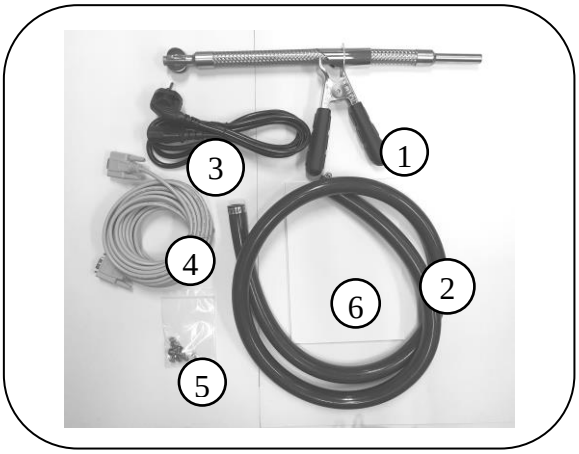
3-4 Composition

3-4-1. Measurement unit

NO.	NAME	Q'ty
1	Measurement unit	1

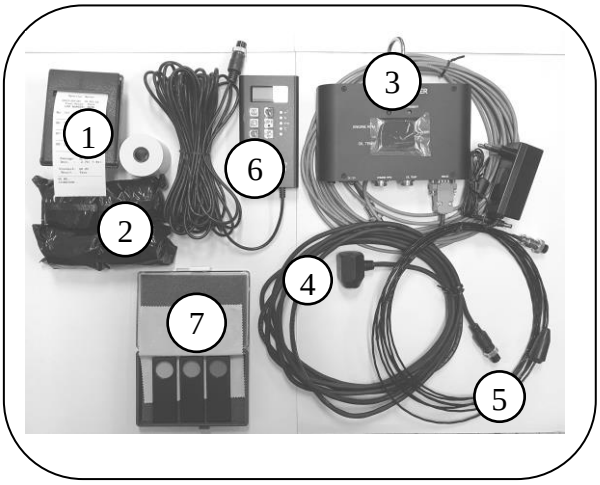
3-4-2. Basic accessory

NO.	NAME	Q'ty
1	Probe	1
2	Probe hose	1
3	Power cable	1
4	RS232C cable	1
5	Fuse	2
6	Manual	1

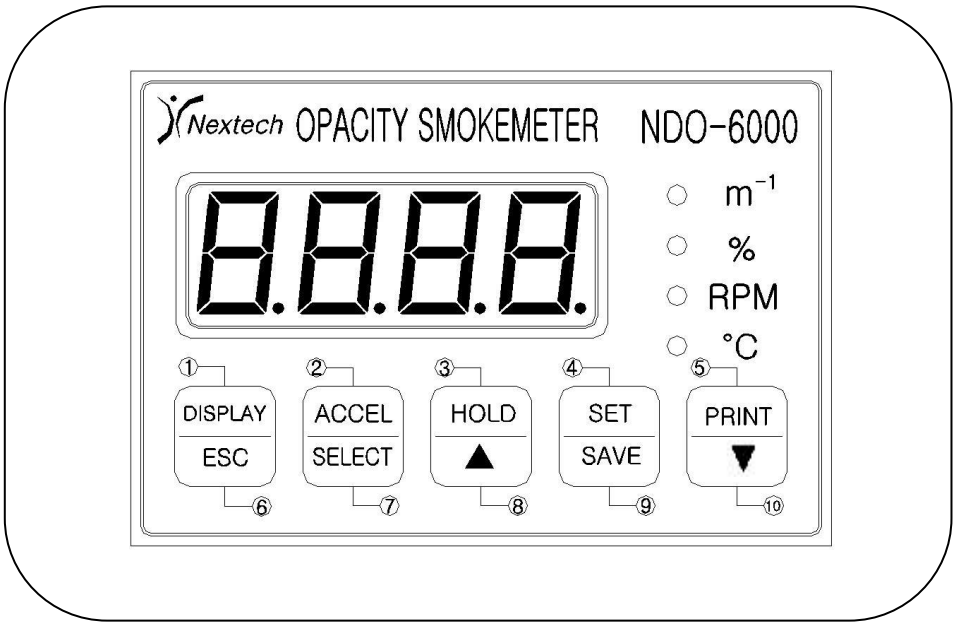


3-4-3. Option

NO.	NAME	Q'ty
1	Built-in printer	1
2	Printer paper	5
3	SMART RPM meter (body)	1
4	RPM sensor	1
5	Oil temp. sensor	1
6	Handheld terminal (RC:remote con.)	1
7	Standard filter (40/60/80%)	1
8	PC software	1



3-5 Display and Function Key structure



① DISPLAY : Select display screen

② ACCEL : FREE ACCELERATION TEST (Inspection mode)

③ HOLD : Holding the displayed screen (Ref.8-3. Hold set-up)

There are two kinds of hold mode, which are HOLD and PEAK HOLD.

✓ HOLD : Pressing HOLD key, displayed screen is being held. Once more pressing releases the Hold.

✓ PEAKHOLD : Pressing HOLD key, highest value of the measure is displayed on the screen and is being held. Once more pressing releases the Hold.

④ SET : Moving from Measuring mode to Set-up mode. (Ref. Section 8, Set-up)

⑤ PRINT : Printing

⑥ ESC : Moving from Set-up mode, Free acceleration test to Measuring mode.

⑦ SELECT : Moving from one Set-up mode to another Set-up mode.

⑧ ▲ : Changing from each set-up value

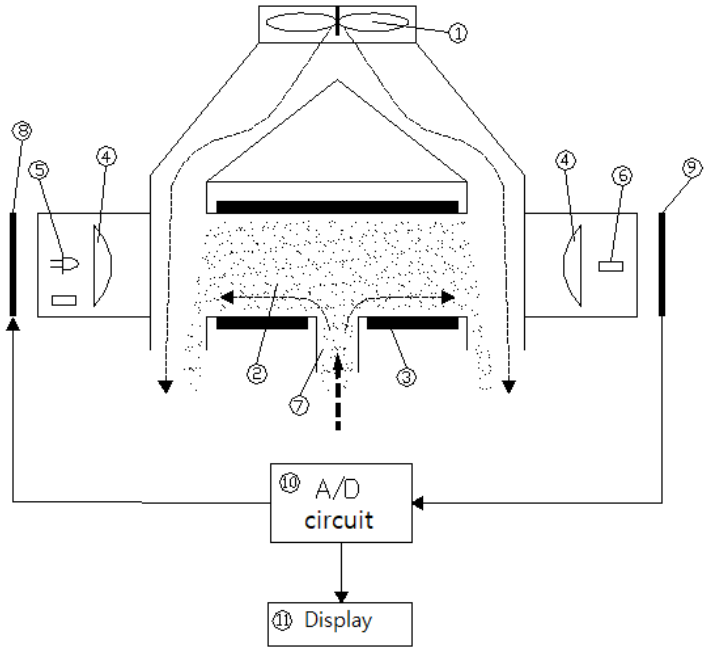
⑨ SAVE : Save the each set up value

⑩ ▼ : Changing from each set-up value

SECTION 4. MECHANICAL CIRCUIT

4-1 Principle of Measurement

Attach light source at the end of the sample-shell where smoke pass through and attach detecting part at the other end of the sample-shell, and it detects the smoke density then converting it into figures and display.

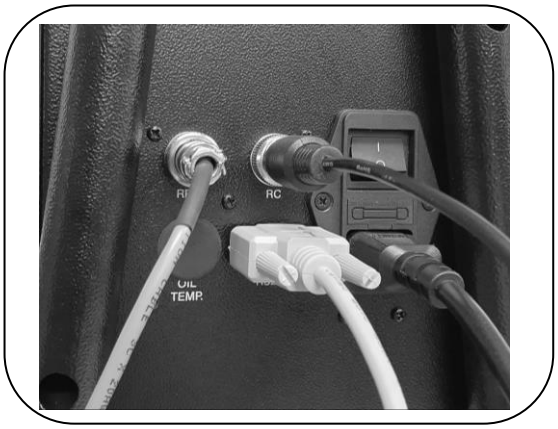


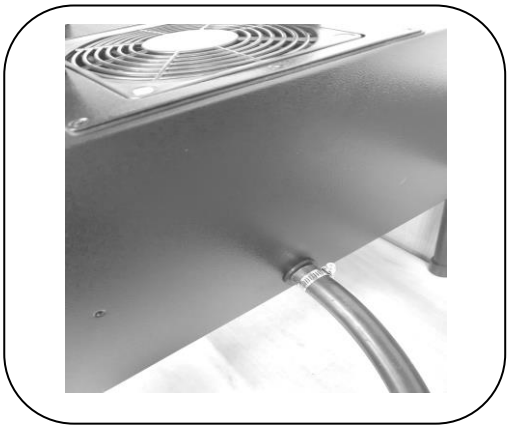
① Purge pan
② Sampling-shell.
③ Sampling-shell constant temperature purpose heater.
④ Concentrating light lens
⑤ Light source(Green LED)
⑥ Detector (Photodiode)
⑦ Collecting gas inhaling hole.
⑧ Light source control circuit
⑨ Signal input and Analyzing circuit
⑩ AD Converter circuit
⑪ Displaying part

SECTION 5. INSTALLING METHOD

5-1 Installing Method.

Connect all of cables to the correct port each other on the side of measurement unit. And connect the probe hose on the rear of the measurement unit. Move the ON/OFF switch to “ON” position. Then NDO-6000 will be start.





◈ Handheld terminal (RC: remote controller)

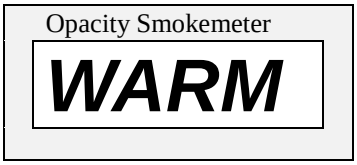
The handheld terminal is operated together with the display of the measurement at the same time. (Power ON/OFF: Press the ON/OFF switch for 3 seconds.)

SECTION 6. INITIAL DISPLAY

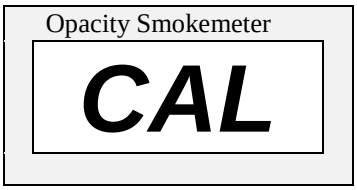
6-1 Warming up

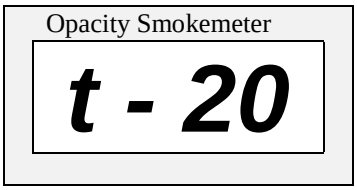
Switch the power [ON]. NDO-6000 will perform the initialization process for about 10 seconds.

The warming up will be performed for 5~10 minutes.

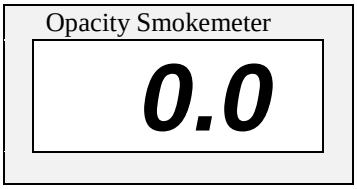


The initial calibration is automatically performed once the warming up is over.





Upon completion of the initial calibration, the following will be indicated on the display that NDO-6000 is in a ready for measurement.



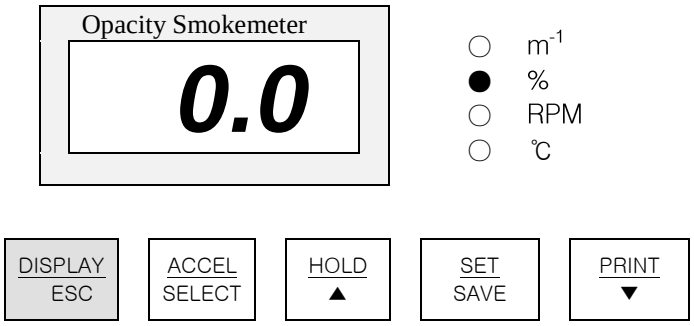
[CAUTION]

During above procedures, keep the end of the probe at fresh air available place.
If not placed at fresh and clean air, while adjusting 0-point it shows "Error" message. When this message appears, check if the end of the probe is placed at clean air available place or not

SECTION 7. MEASUREMENT

7-1. Display

Pressing [DISPLAY] key, it will advances [Smoke(%) → K(m^{-1}) → RPM → ℃] in sequence. The LED of the measuring item will be on.

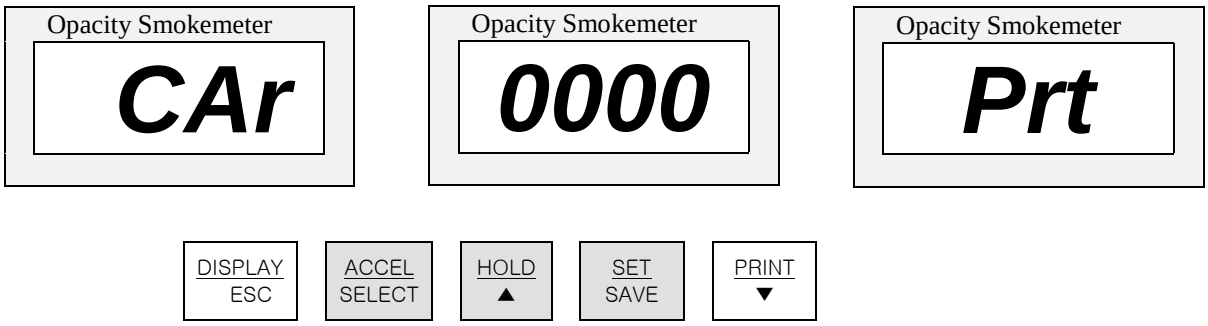


7-2. Print

At normal measurement or inspection mode, by using [PRINT] key,

move to printing screen (Car).

Pressing [SELECT] key, current car (vehicle) number value is blinking.



By pressing [SELECT] & [▲], [▼] key , it moves to next step (4 digits) & changes the number in sequence.

When setting up is completed, save it by pressing [SAVE] key.

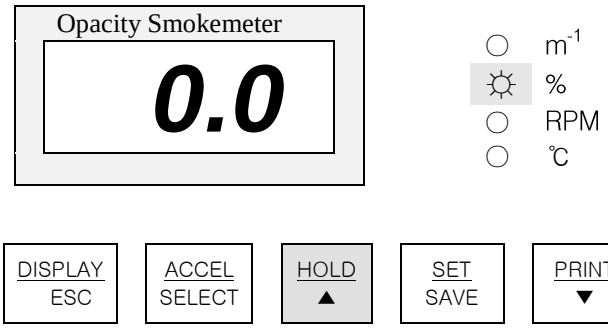
By pressing [PRINT], it's printed.

◈ To print without the car number, press the [PRINT] key twice in a row.

7-3. Free(Snap) acceleration test (Normal mode)

★ **For normal mode of free snap acceleration test, set HOLD mode in the setting menu to PEAK HOLD mode.**

(1) After reaching peak revolution speed by burst acceleration of engine of the testing vehicle in neutral gear (idling status), idle the engine for 2 seconds and maintain the idling status for 5~6 seconds. Repeat this process three times.
(2) Install the probe of the tester more than 5mm away from the wall of exhaust pipe and insert it around 5㎝ inside.
(3) Press [HOLD] KEY to move to PEAK HOLD status.
(The LED on the display window will flash and a buzzer will go off.)



(4) Put one foot on the accelerator pedal and burst accelerate the engine to the maximum revolution speed and take gas samples. Time for the acceleration is within 5 seconds. Read the number held this time and if you want to print, press [PRINT] KEY twice in a row. If you want to test again, press [HOLD] KEY to be released from HOLD mode and repeat (3)~(4) steps.

Opacity Meter

2023-09-16 17:17:39
Normal Test [Peak]
CAR NUMBER: 0000

Opacity (%) : 11.4
K value(m^{-1}) : 0.28
RPM (rpm) : 3500
Oil Temp.(℃) : 56.3

VE NO. :
SIGNATURE :

(Printer display)

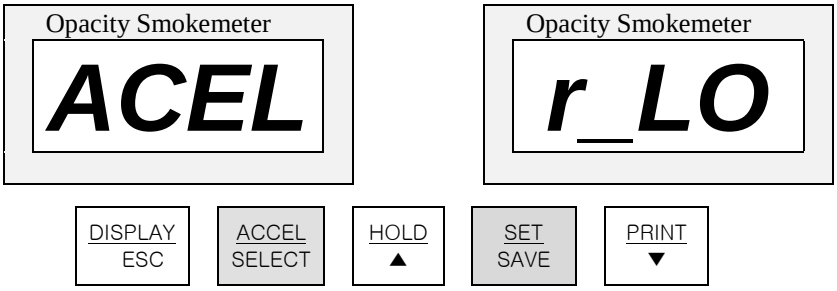
(5) Take out the probe from exhaust pipe after the test.
(Please be cautious of burns since the probe is hot.)

7-4. Free(Snap) acceleration test (Inspection mode)

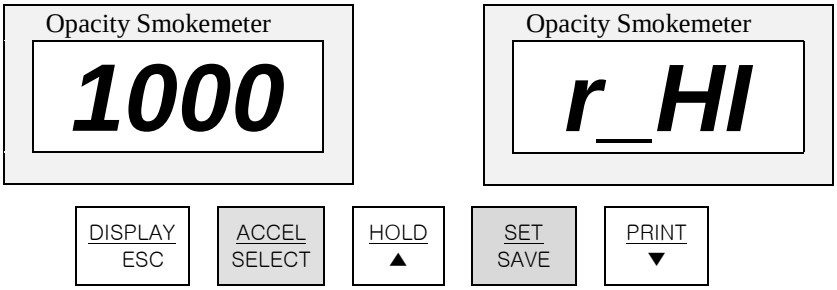
(1) After reaching peak revolution speed by burst acceleration of engine of the testing vehicle in neutral gear (idling status), idle the engine for 2 seconds and maintain the idling status for 5~6 seconds. Repeat this process three times.

(2) Install the probe of the tester more than 5mm away from the wall of exhaust pipe and insert it around 5㎝ inside.

(3) Press [ACCEL] KEY, if you see "ACCEL" on the display. Press [SET] KEY .

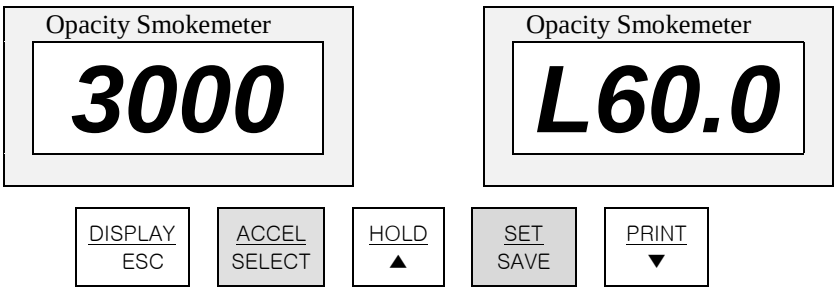


(4) When you see the menu of the minimum rpm (low rpm) of the engine, [SET] key to view the currently set value. Press the [SET] key again to get the engine maximum rpm (high rpm) screen.



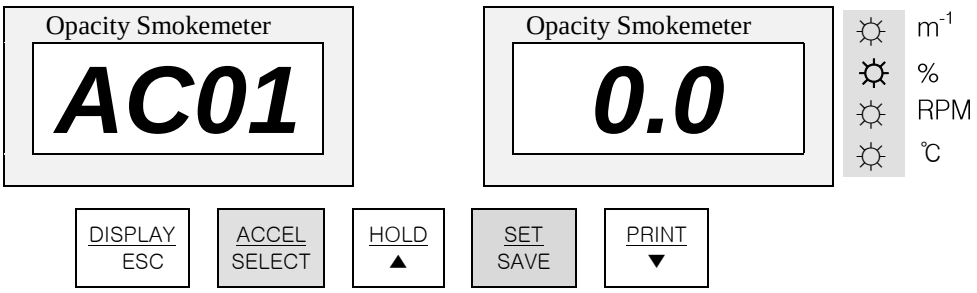
◈ To change the set rpm value, press the [SELECT] key and use the [SELECT] key and [▲▼] key to change the value and then save it as the [SAVE] key.

(5) When you see the menu of the maximum rpm (hi rpm) of the engine, [SET] key to view the currently set value. Press the [SET] key again to get the menu of the acceptance limit of the smoke.



◈ To change the acceptance limit of the smoke, press the [SELECT] key and use the [▲▼] key to change the value and then save it as the [SAVE] key.

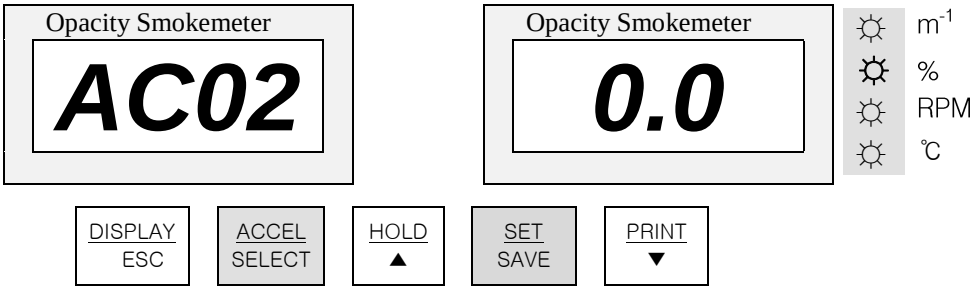
(6) When you see the menu of the acceptance limit of the smoke, [SET] key to test start (AC01). When you press [SET] KEY once more, you will see one LED flashes, and hear the buzzer sound to start the test.
(From this time on, the peak point of the smoke opacity will be renewed.)



◈ When you use [DISPLAY] KEY, you will see "K value (m^{-1})→smoke opacity (%)→RPM→℃".

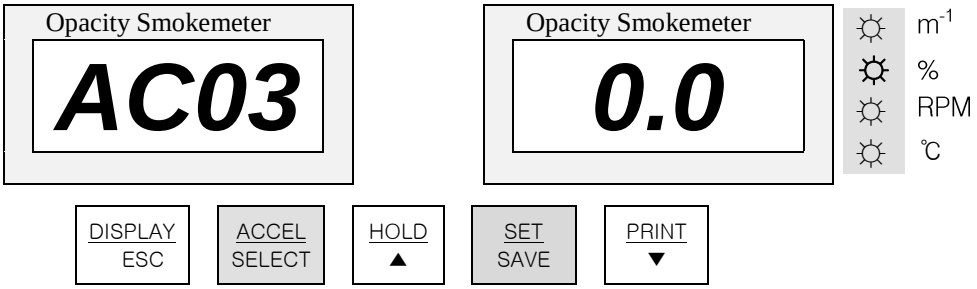
(7) Put one foot on the accelerator pedal and burst accelerate the engine to the maximum revolution speed and take smoke samples. Time for the acceleration is within than 5 seconds.

(8) After finishing the first test, press [SET] KEY to move to the second test.
You will see "AC-2" on the display. When you press [SET] KEY once more, you will see one LED flashes, and hear the buzzer sound to start the second test.

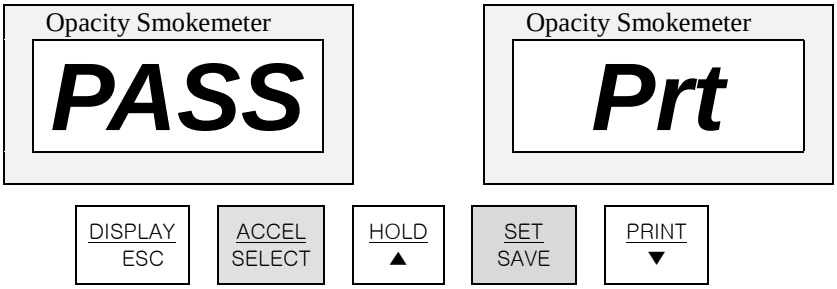


(9) Put one foot on the accelerator pedal and burst accelerate the engine to the maximum revolution speed and take smoke samples. Time for the acceleration is within than 5 seconds.

(10) After finishing the second test, press [SET] KEY to move to the third test.
You will see "AC-3" on the display. When you press [SET] KEY once more, you will see one LED flashes, and hear the buzzer sound to start the third test.



(11) Put one foot on the accelerator pedal and burst accelerate the engine to the maximum revolution speed and take smoke samples. Time for the acceleration is within than 5 seconds.



(12) After three tests, if the result is acceptable, you will see "PASS" on the display and the test will be ended automatically and each time you press [SET] KEY, you will see the result of the first, the second and the third test in their average (Avrg) and deviation (devi.).
Press [PRINT] KEY twice to print, and the same print is possible until you press [ACCEL] KEY to exit the inspection mode.

◈ To print without changing the car number, press the [PRINT] key twice in a row.
Refer to [7-2.Print] for instructions on changing the car number and printing.

◈ For the above process to proceed normally, the engine rpm must be measured higher than the set [r_HI](high rpm : 7-4 (4)).
If the engine rpm is not measured normally, please set [SET] Menu 11. P.RHI to OFF or [SET] Menu 10. RPM to R-nn (no rpm) before proceeding.

Opacity Meter

2023-09-16 17:17:39
Free Accel. Test
CAR NUMBER: 0000

No: (%)	rmin	rmax (m^{-1})	(s) (℃)
01: 18.0	746	4478	1.5
		0.46	53.5
02: 20.9	757	4480	2.5
		0.55	53.6
03: 15.7	755	4477	1.5
		0.40	53.5

Average: 18.2%
Devi. : 5.2%(8.8%)

Standard: 60.0%
Result : Pass

VE NO. :
SIGNATURE :

(Printer display)

(13) If the gap between the maximum and the minimum of exhaust emissions density tested three times is larger than 5% or the final test result is over the acceptable limits for exhaust emissions, an additional test will be done once more automatically and up to maximum 5 times. In every test, if the calculated result of the last three tests is within the range of 5% gap and the average result is within the acceptable range, the test will be ended with the display of “PASS”.
The decimal point of the average result value is cut and displayed as the final value.

Even after 5 times of repeated tests, if the gap between the maximum and the minimum is larger than 5% or the average result is over the acceptable limits for exhaust emissions, the final test result will be the average of the last three (3th, 4th, 5th) tests, you will see “FAIL” on the display and the test will be ended automatically.

However, in the last three (3rd, 4th, and 5th) tests, the final result (PASS or FAIL) does not determine the deviation, but only based on the average value.

(14) Take out the probe from exhaust pipe after the test.
(Please be cautious of burns since the probe is hot.)

SECTION 8. SET-UP

Pressing [SET] key, it moves to SET-UP mode.

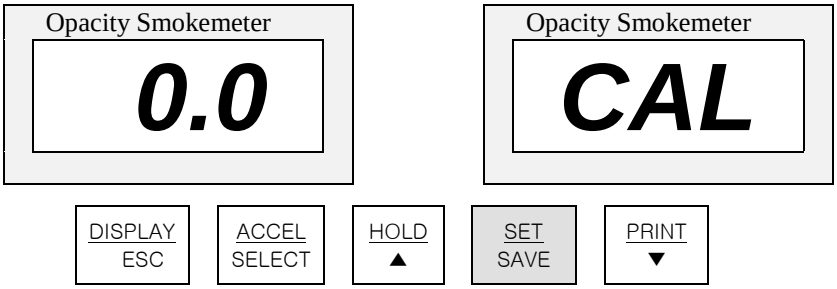
Pressing [SET] key, it moves to [CAL → YEAR → DATE → TIME → HOLD → PRT → VERSION → TEST → PC → PRM → P.RHI → P.RLO → P_S → P_K → P_T] in sequence.

[SET] Menu configuration chart

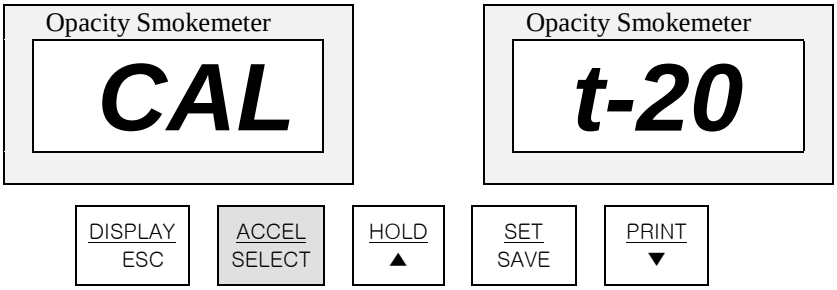
1. CAL (Zero calibration)
2. YEAR (Year set)
3. DATE (Date set)
4. TIME (Time set)
5. HOLD (Hold set) : HD-N(normal), HD-P(peak)
6. PRT (Print density set): P-05~25
7. VERSION (Firmware version)
8. TEST (Light source brightness)
9. PC (Display mode set): PC-Y, PC-N
10. RPM (rpm type set): R-BS(battery & sound), R-ST(smart rpm), R-nn(no rpm), R-no(no rpm & only oil temp.)
11. P.RHI (max rpm print & inspection set, Print Rpm HIgh(PRHI)): ON, OFF
12. P.RLO (min rpm print & inspection set, Print Rpm LOw(PRLO)) : ON, OFF
13. P_S (Acceleration time(sec) print & inspection set) : ON, OFF
14. P_K (K value print & inspection set) : ON, OFF
15. P_T (Oil temp. print & inspection set) : ON, OFF

8-1. Calibration

Press the [SET] key in the measurement mode to select the calibration mode.

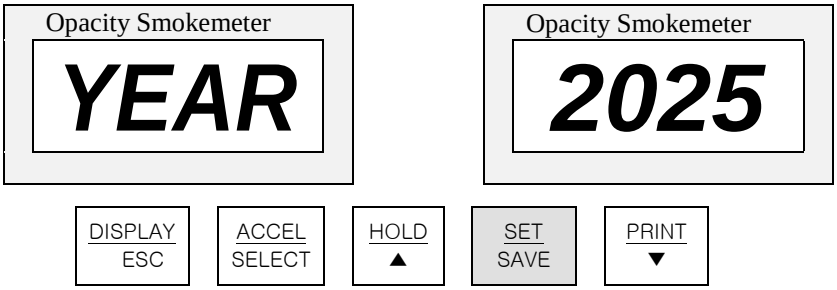


Press the [SELECT] key. The calibration will be performed.



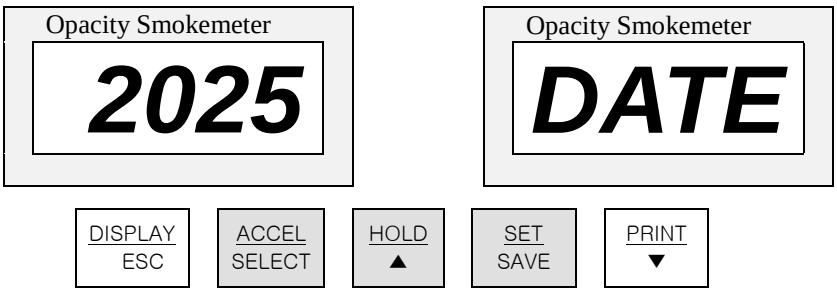
8-2. Time set-up

At Set-up mode, by using [SET] key, move to “Year set-up”.



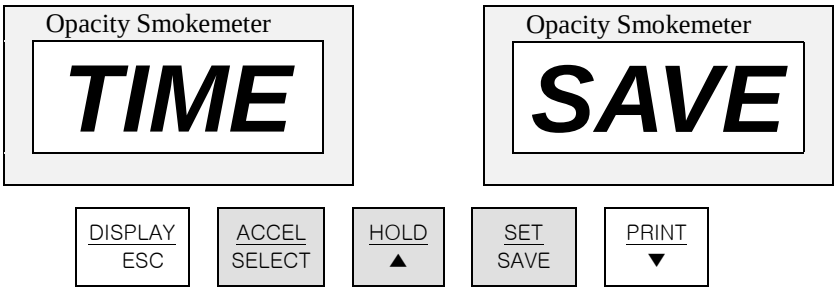
Pressing [SELECT] key, current set-up value is blinking.

When setting up is completed, save and move to “Date set-up” by pressing [SAVE] key.



When setting up is completed, save and move to “Time set-up” by pressing [SAVE] key.

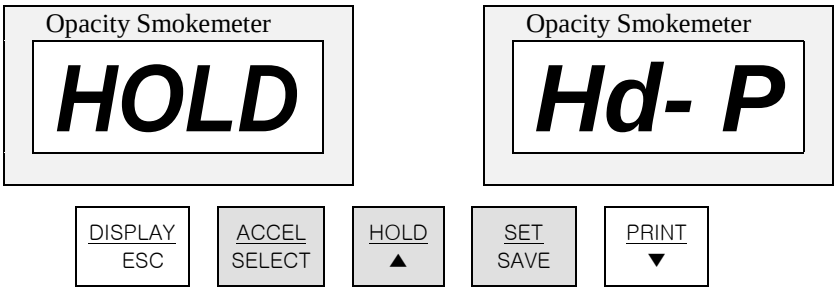
When the “time set-up” is completed by pressing [SAVE] key, it is finished.



8-3. Hold set-up

At Set-up mode, by using [SET] key, move to Hold mode set-up screen.

Pressing [SELECT] key, current set-up value is blinking.



By pressing [▲] key, it moves to [HOLD → PEAKHOLD] in sequence.

When setting up is completed, save it by pressing [SAVE] key.

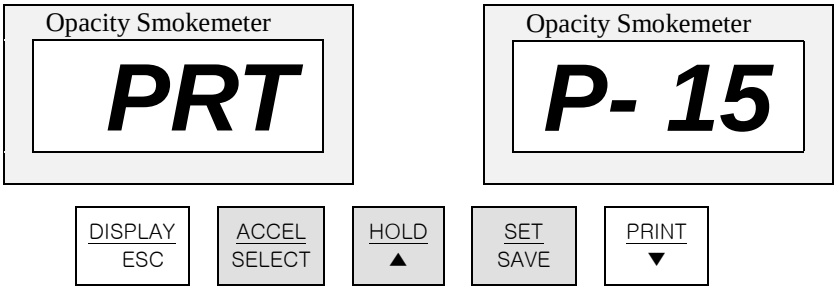
◈ HOLD mode (Hd-n) : Holding currently measured screen.

◈ PEAKHOLD mode (Hd-P) : Renewed maximum value measured is displayed on the screen and the screen is being held.

8-4. Printing density set-up

At Set-up mode, by using [SET] key, move to printing density set-up screen.

Pressing [SELECT] key, current set-up value is blinking.



By pressing [▲,▼] key, it moves to [05 → 25] in sequence.

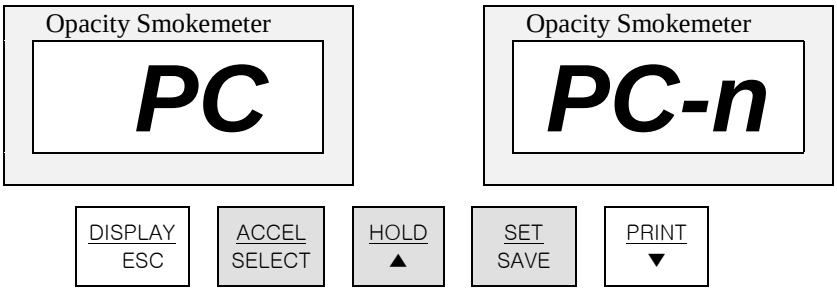
When setting up is completed, save it by pressing [SAVE] key.

◈ Normal density is around 15 and depending on the printing material or how much dark and light printing required, it could be adjusted.

8-5. PC set-up

At Set-up mode, by using [SET] key, move to PC set-up screen.

Pressing [SELECT] key, current set-up value is blinking.



By pressing [▲] key, it moves to [PC-y → PC-n] in sequence.

When setting up is completed, save it by pressing [SAVE] key.

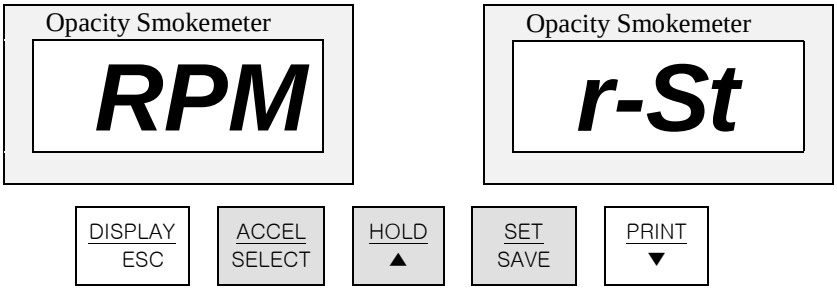
◈ Display mode (PC-y) : The display screen shows only PC, and the measurement data is sent to the computer.

◈ Display mode (PC-n) : The display screen shows the measurement data, and the measurement data is sent to the computer.

8-6. RPM set-up

At Set-up mode, by using [SET] key, move to RPM set-up screen.

Pressing [SELECT] key, current set-up value is blinking.



By pressing [▲] key, it moves to [r-bS → r-St → r-nn → r-no] in sequence.

When setting up is completed, save it by pressing [SAVE] key.

◈ RPM type set (r-bS) : battery& sound type

◈ RPM type set (r-St) : smart rpm

◈ RPM type set (r-nn) : no rpm

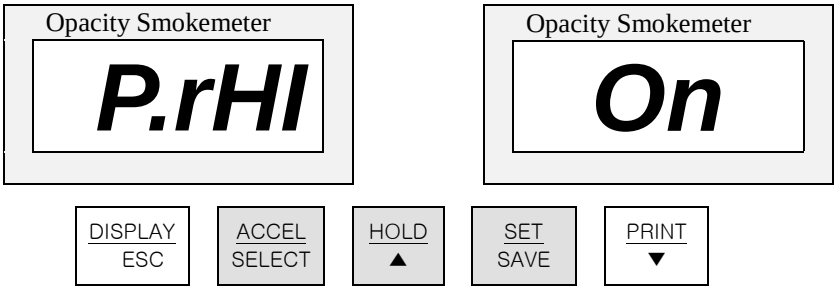
◈ RPM type set (r-no) : no rpm & only oil temp.

◈ Please refer to the separate manual supplied separately for how to use the RPM meter.

8-7. P.RHI / P.RLO / P_S / P_K / P_T set-up

At Set-up mode, by using [SET] key, move to P xxx set-up screen.

Pressing [SELECT] key, current set-up value is blinking.



By pressing [▲] key, it moves to [On → OFF] in sequence.

When setting up is completed, save it by pressing [SAVE] key.

◈ P.RHI (max rpm print & inspection set, Print Rpm High(P.rHI)) : ON,OFF

◈ P.RLO (min rpm print & inspection set, Print Rpm Low(P.rLO)) : ON,OFF

◈ P_S (Acceleration time (sec) print & inspection set) : ON, OFF

◈ P_K (K value print & inspection set) : ON, OFF

◈ P_T (Oil temp. print & inspection set) : ON, OFF

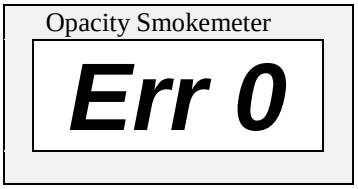
SECTION 9. MAINTENANCE and MANAGEMENT

9-1. Lens cleaning

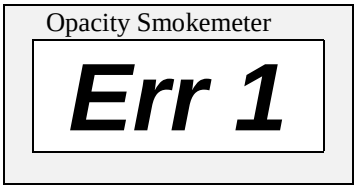
For the proper maintenance and management of the equipment, it is necessary to regularly clean the lens by cleansing polluted area of the lens.

9-2. Error codes

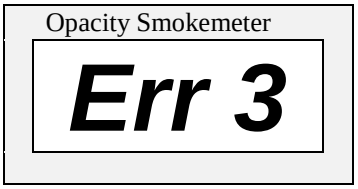
With the end of probe placed at unclean area, adjusting the span, or some problem with the equipment, adjusting error is displayed.



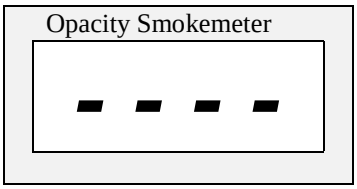
(Light / Detector sensor Error)



(Lens pollution Error)



(Cell temperature Error)



(RPM & Oil temp.sensor is not connected)

After eradicating the cause of the error, pressing [ESC] key.

And please perform the zero calibration[CAL] again.

9-3. Checking of calibration

The both sides of the concentrating light lens should be cleaned by cleaning with a soft cloth.

Before checking, the gauge should be set to zero and then Insert the standard filter(option) into the hole at the bottom of the gauge.

If there is the error value over ±2% between the measurement value and the standard filter, Please return the machine to us for checking.

[Concentrating light lens]

[Before inserting the standard filter]

[After inserting the standard filter]

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