

Gravimetric Fuel Consumption Meter

— Specifications and Instruction Manual —

FCL series

Weight Sensing Unit : <input type="checkbox"/> FCL-100R
<input type="checkbox"/> FCL-1000R
<input type="checkbox"/> FCL-2000R
<input type="checkbox"/> FCL-10KR
Display and Control Unit : FCL-4T/W

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◆1. Preface

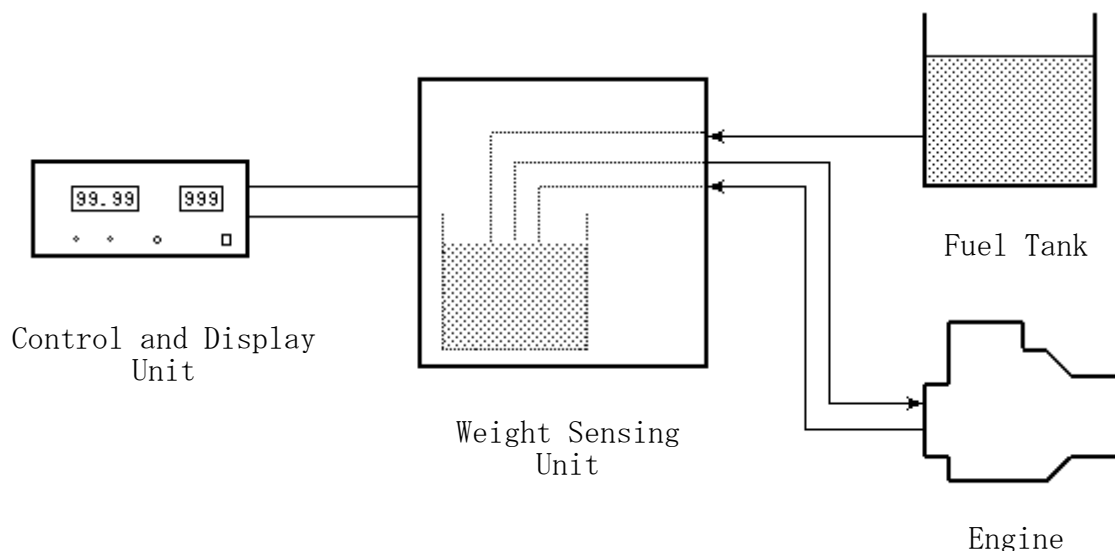
This fuel consumption meter directly measures fuel consumption in a weight unit by employing a load-cell metering unit, to display the measured time for consumption of fuel whose weight is preset. Specifically, it is most suitable for measuring engines which contain return fuel.

◆2. Outline

(1) Main Features

- (a) Maintenance is not required because there are no moving or sliding parts, such as knife-edges or bearings, in the load-cell metering unit.
- (b) Error is not caused by bubble generation or temperature changes.
- (c) Calibration using dead weights is available.
- (d) The inside of the metering vessel, made of heat-resistant glasses, can be visually inspected.
- (e) Return fuel is released to atmosphere and, after bubbles and pulsation are absorbed with a buffer plate, poured into the metering vessel.

(2) Block Diagram of Measuring System

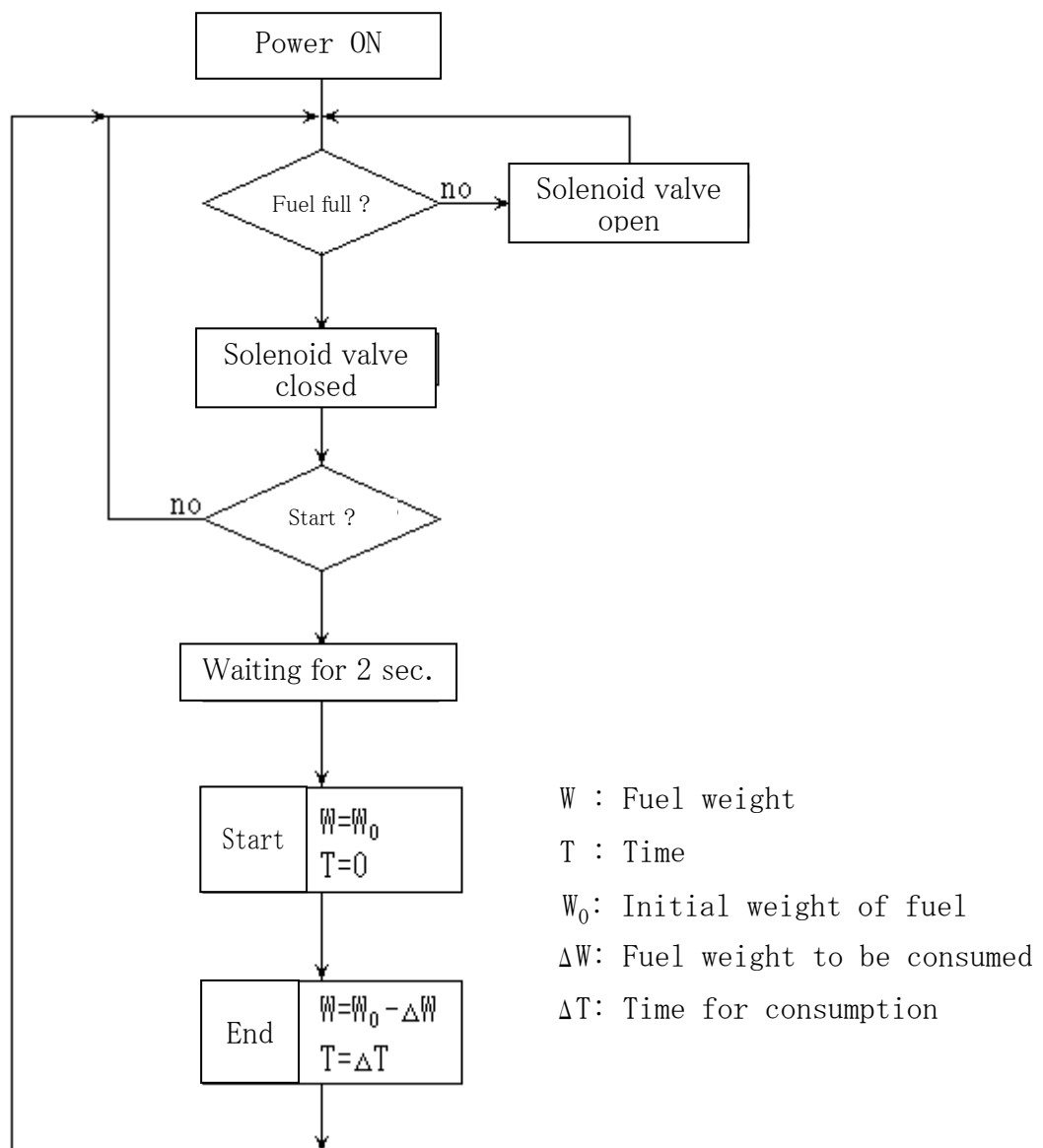


<Fig-1>

(3) Measuring Cycle

- (a) Start of measurement is ready with solenoid valve controlled and fuel in the metering vessel kept always constant.
- (b) Measurement is started when the measurement start button is depressed (the solenoid valve being closed, if open) after about 2 seconds of preliminary time.
- (c) When the fuel of preset weight has just been consumed, the time required for that consumption is displayed (this value is held until the next measurement is started).
- (d) The cycle returns to step (a)

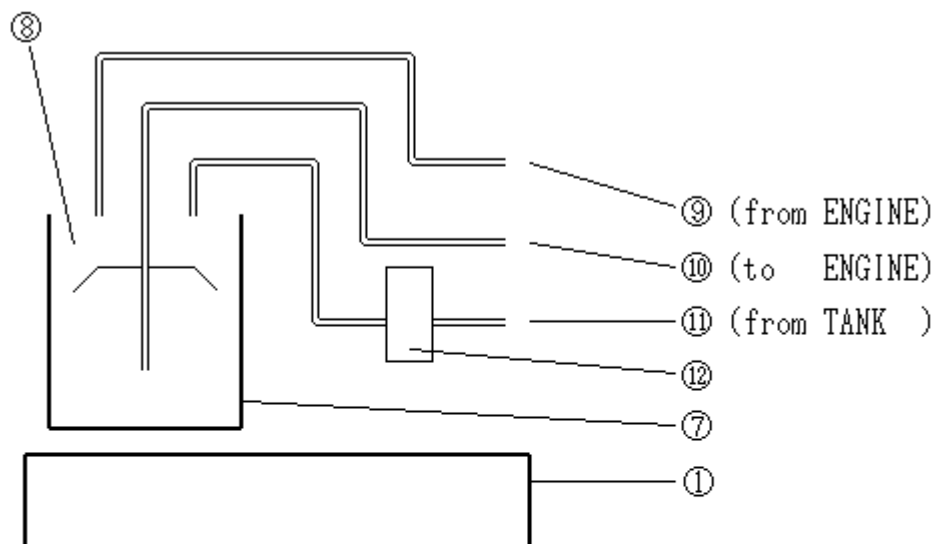
(4) Flow Chart



<Fig-2>

◆3. Weight Sensing Unit

(1) Schematic Diagram (See the attached drawing for details.)



- | | |
|----------------------------|---------------------|
| ① Load-cell metering unit | ⑩ Fuel outlet |
| ⑦ Metering vessel | ⑪ Supply-fuel inlet |
| ⑧ Return-fuel buffer plate | ⑫ Solenoid valve |
| ⑨ Return-fuel inlet | |

<Fig-3>

(2) Specifications

	FCL-100R	FCL-1000R	FCL-2000R	FCL-10KR
Metering method	Direct metering of fuel weight			
Load-cell capacity	3kg, 2mV/V	10kg, 2mV/V	20kg, 2mV/V	100kg, 2mV/V
Metering vessel	φ 70×H90	φ 153×H170	φ 207×H240	280 ^{sq} ×H380
Capacity of vessel	about 330cm ³	about 3,000cm ³	about 7,900cm ³	about 29,500cm ³
Tubing Diameter	8A (PT 1/4)	15A (PT 1/2)	20A (PT 3/4)	20A (PT 3/4)
Buoyancy coeff.	0.960	0.980	0.983	0.993

<Table-1>

◆4. Outline of Control and Display Unit

(1) Function

- (a) This unit presets the fuel weight, and measures and displays the time required for consumption of fuel of preset weight.
- (b) Commanding the start of measurement is manual. (‘MEASURE START’ ⑩)
- (c) The following indicating lamps are provided.
- | | |
|------------|---|
| VALVE OPEN | Lights during supplying fuel into the metering vessel with the solenoid valve open. (⑧) |
| READY | Lights when measurement can be started. (⑨) |
- (d) When the start of measurement is not commanded, the fuel weight in the metering vessel is always controlled between the upper and the lower limits.
- (e) Calibration voltage is incorporated and available at any time.
- (f) Calibration using dead weight can be carried out with the built-in mode selector switch. (⑯)
- (g) A measured value is held until the next measurement cycle is started.

(2) Specifications for Control and Display Unit

	FCL-100R	FCL-1000R		FCL-2000R	FCL-10KR
		(unit=0.1g)	(standard)		
Full scale (FS)	99.9g	199.9g	999g	1999g	9990g
Setting range	10g~99.9g	20g~199.9g	100g~999g	200g~1999g	1000g~9990g
Count (Unit)	0.1g	0.1g	1g	1g	10g
" accuracy	$\pm 0.2g \pm 1$ count	$\pm 0.4g \pm 1$ count	$\pm 1g \pm 1$ count	$\pm 2g \pm 1$ count	$\pm 10g \pm 1$ count
Tare weight	30g, "3.00"	300g, "3.00"		500g, "50.00"	3kg, "3.00"
Upper limit	150g, (275mV)	1500g, (275mV)		4000g, (687mV)	15kg, (275mV)
Lower limit	120g, (229mV)	1200g, (229mV)		3200g, (565mV)	12kg, (229mV)
Theoretical CAL	7200, "72.00"	24500, "45.00" *)	7350, "73.50"	7372, "73.72"	7448, "74.48"
Output voltage	5mV/0.1g		5mV/1g	2mV/1g	5mV/10g
Time display	4 digits (0.01~99.99 sec.)				
" unit	0.01 sec.				
" accuracy	0.01% \pm 0.01 sec.				
Power supply	Standard : AC100V \pm 10%、50~60Hz				
Working temperature	Ambient : 0~50°C、Fuel : 0~70°C				

¹⁾ Value in "" is displayed in actuality, because of the decimal point to display a measuring time.

^{*} Value "45.00" is displayed in actuality, because of 4-digit display.

<Table-2>

(3) BCD Output (option)

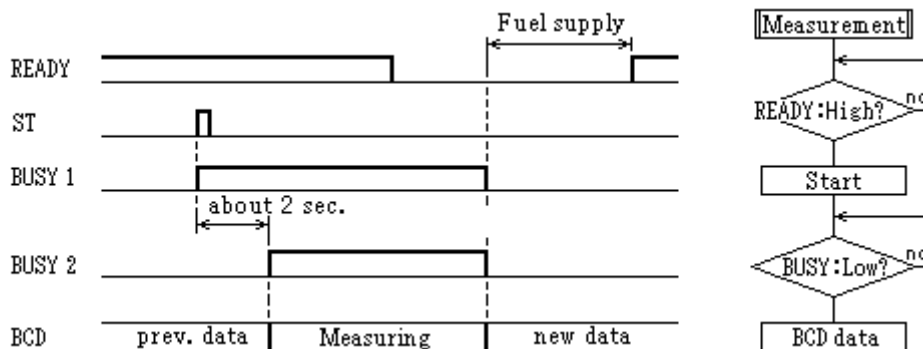
<Pin number and contents>

<Table-3>

No	Signal name	(Logic : TTL)
1	(NC)	(no connected)
2	10 ³ -8	10 sec. BCD data
3	10 ³ -4	„
4	10 ³ -2	„
5	10 ³ -1	„
6	10 ² -8	1 sec. BCD data
7	10 ² -4	„
8	10 ² -2	„
9	10 ² -1	„
10	10 ¹ -8	0.1 sec. BCD data
11	10 ¹ -4	„
12	10 ¹ -2	„
13	10 ¹ -1	„
14	10 ⁰ -8	0.01 sec. BCD data
15	10 ⁰ -4	„
16	10 ⁰ -2	„
17	10 ⁰ -1	„
18	READY	Measurement can be started.
19	BUSY1	‘High’ when the start push-button is depressed, and between measuring.
20	BUSY2	‘High’ between measuring.
21	VD	+5V output, or provided from outside. ¹⁾
22	GND	Common
23	(NC)	(no connected)
24	ST	An instruction of measurement.

¹⁾ Please cut ‘JP’ on board, if +5V is provided from outside.

<Time Chart>



<Fig-4>

◆5. Operating Procedure

(1) Procedure

- (a) Connect the weight sensing unit to an engine and to a fuel tank with tubes.
- (b) Connect the weight sensing unit to control and display unit with two cables.
- (c) Connect a power cord to the control and display unit.
- (d) Turn on the power switch (fuel is supplied to the metering vessel).
- (e) Wait until the 'READY' lamp (⑨) lights at the time of a constant weight of fuel having been supplied to the metering vessel.
- (f) When 'READY' lamp (⑨) lights, the start of measurement becomes ready regardless of the state of 'VALVE OPEN' lamp (⑧).
- (g) Set the fuel weight to be consumed (at any time except for the period of measurement).
- (h) Depress 'MEASURE START' button (⑩).

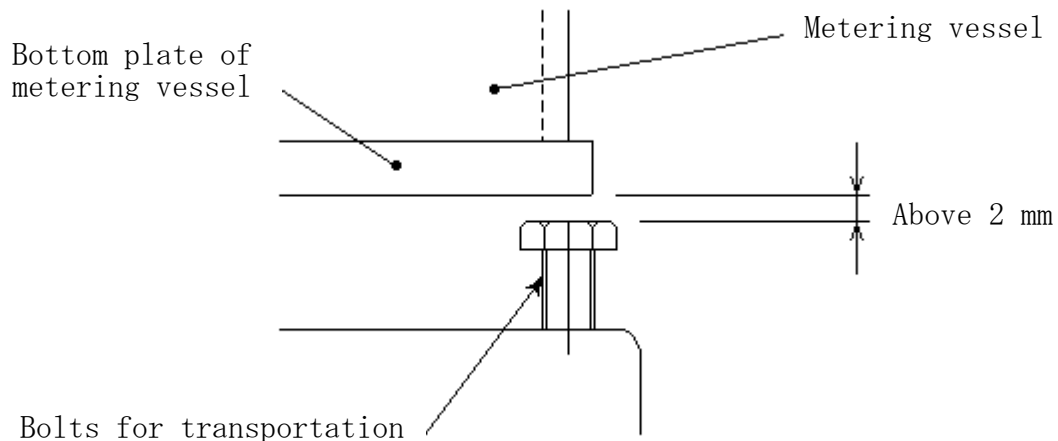
If the solenoid valve is open ('VALVE OPEN' lamp lights), it is closed first of all.

(2) Cautions for Use

- (a) Carry out the setpoint change for fuel weight to be consumed other than at the time of measurement.
- (b) Do not turn off power during an engine is operating even if measurement is not carried out.
- (c) Normally, start measurement leaving the meter for about 15 to 30 minutes after turning on power, to stabilize the analog circuits in the meter.
- (d) Engage or disengage the connectors with the power switch turned off without fail. When engaging or disengaging the connectors, take sufficient care not to stick dust, fuel, and others to the connector pins because this may cause error or erroneous actions.
- (e) If a power contactor or the like is installed near the meter, suppress the electric noise inserting a "spark killer" or similar device between its contacts.
- (f) Pay thorough attention not to give shocks when carrying the meter.

- (g) Mount the meter on a level and rigid table. (Adjust it with adjusting bolts (⑥) observing the attached spirit level (⑭).)
- (h) Be sure to sink the bolts for transportation (⑰) by 2 mm or more before use.

(In case of 'FCL-100R' or 'FCL-10KR' turn the stopper handle to the right.)



<Fig-5>

- (i) When re-transport the meter, raise the bolts for transportation to the extent that those bolts lightly touch the bottom plate of the metering vessel and fix them with screw-lock resin or equivalent.

(In case of 'FCL-100R' or 'FCL-10KR' turn the stopper handle to the left.)

◆6. Calibration

(1) Calibration by Calibration Switch

- (a) The meter can be checked by a calibration voltage at any time except for the period of measurement.
- (b) When the 'CAL' switch on the rear panel is thrown down, the display mode is transferred to "LOAD" and, at the same time the preset calibration voltage is applied to the load signal amplifier and displayed as a

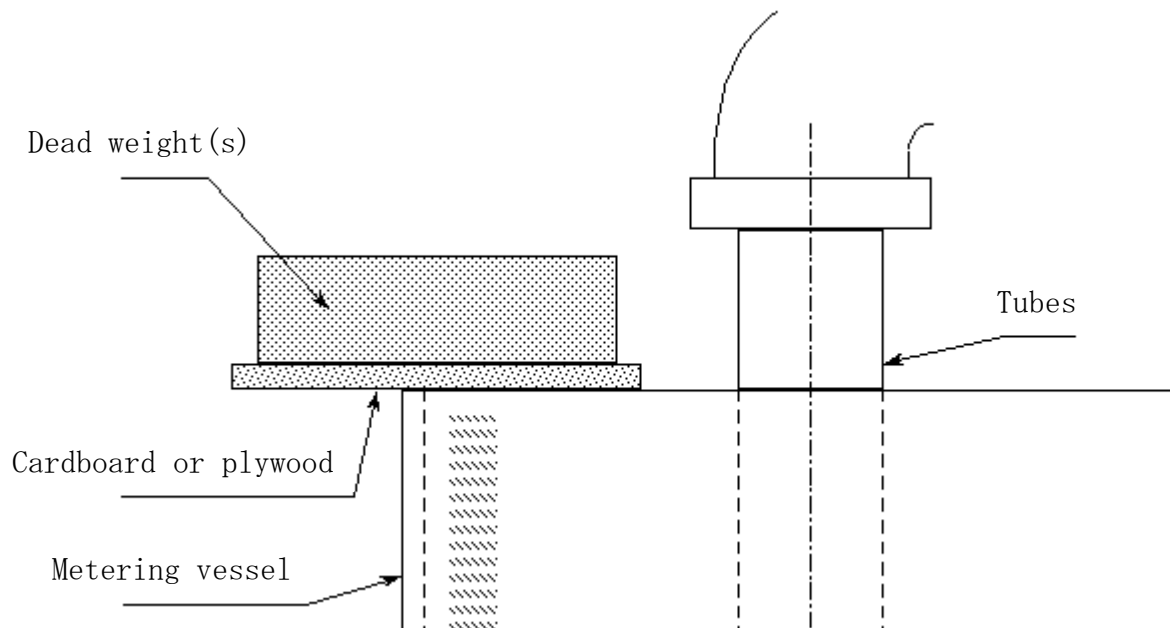
“CALibration value” .

(c) Span adjustment:

- 1) Remove the name plate on the rear panel.
- 2) Throw down the CAL switch (⑮).
(Be sure the mode selector switch (⑯) is thrown down.)
- 3) Turn the coarse and fine span adjusters (⑰ and ⑱) to agree the displayed value with the CAL value.
- 4) Re-place the name plate to complete the procedure.

(2) Calibration by Means of Dead Weights

- (a) Draw out fuel in the metering vessel (It is all right that the remainder of fuel is 1/3 of the set weight or less).
- (b) Make space for supporting the dead weight on the metering vessel (Put a cardboard or plywood plate on the left half of the metering vessel frame).



<Fig-6>

(c) Next, follow the next procedure.

- 1) Remove the name plate on the rear panel.
- 2) Throw up the mode selector switch (⑯).

- 3) Depress the reset button (⑰) and make the display “0” .
 - 4) Put a dead weight(s) on the above board or plate and collate the displayed value with the numerical value in the separate table <Table-4>.
 - 5) If the display value is differet from the value in the separate table, adjust the span.
 - 6) Repeat to put on and remove the weight several times to confirm equality.
 - 7) Throw down the mode selector switch and re-place the name plate.
- (d) If resetting the mode selector switch is forgotten, measurement then becomes unavailable. Be careful .(If the metering vessel is touched with a hand, it is all right as far as the display is not changed.)
- (e) It is normally sufficient to calibrate the meter by the dead weights once a year.
- (f) In this calibration mode (using dead weights), a weight (unit: g) is displayed but should be read ignoring the decimal point.

(3) Buoyancy Correction Table

- (a) In this fuel consumption meter, the metering vessel is not made tubing for the purpose of increasing measurement sensitivity in the weight sensing unit (load-cell metering unit). For this reason, the fuel sending-out tube is inserted into the metering vessel down to the vicinity of the bottom. Therefore, if the meter is calibrated by dead weights, buoyancy correction is necessary according to the following equation. Numeric values in the table below are those calculated with this equation for the convenience of readers.

$$\text{Buoyancy correcting equation : } W_p = \frac{S_1 - S_2}{S_1} \cdot W = k \cdot W$$

W : Net weight of dead weight	S_1 : Inner cross sectional area of the metering vessel
W_p : Displayed value	S_2 : Cross sectional area of the inserted tube (based on O.D. of the tube)
k : Buoyancy correcting coefficient	(see <Table-1>)

(b) Net weight and displayed value:

FCL-100R, k=0.960		FCL-1000R, k=0.980		FCL-2000R, k=0.983		FCL-10KR, k=0.993	
net	display	net	display	net	display	net	display
50g	4.80	500g	4.90	1000g	9.83	5kg	4.965
100g	9.60	1000g	9.80	2000g	19.66	10kg	9.93
150g	14.40	1500g	14.70	3000g	29.49	15kg	14.895
200g	19.20	2000g	19.60	4000g	39.32	20kg	19.86

<Table-4>

(4) Adjustment of Zero Point for Aging

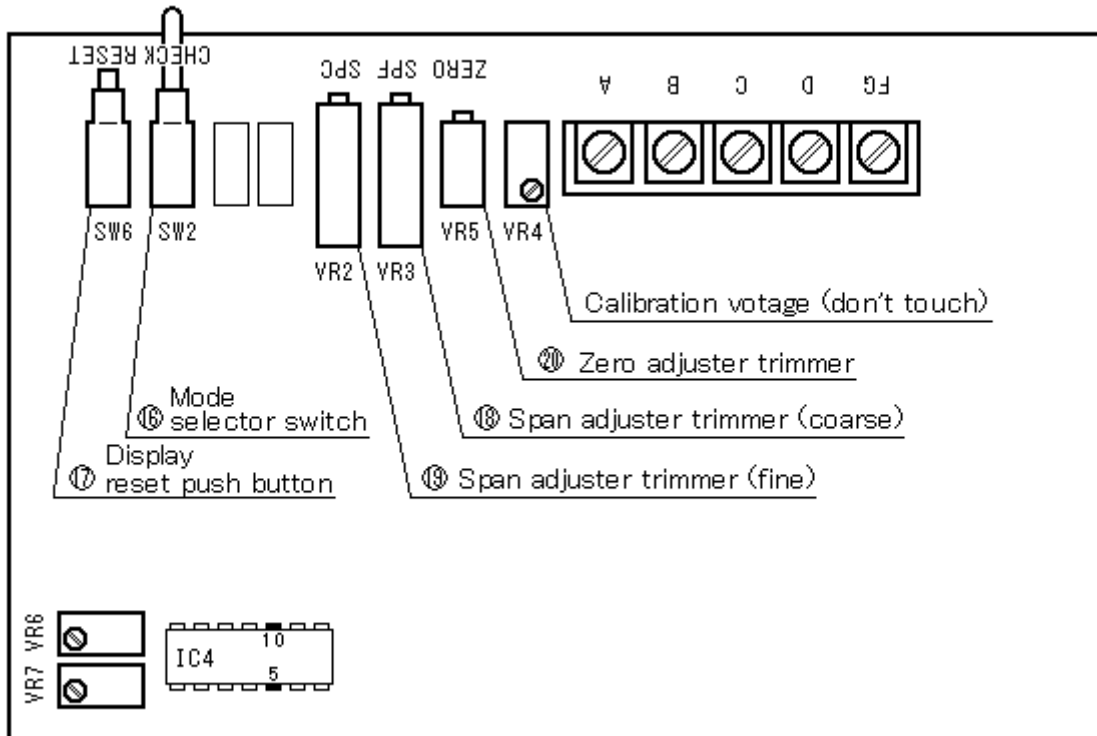
(a) Zero point of weight sensing unit might be varied due to excess shock, aging, and others. If the fuel level in the vessel seems to be abnormal in visual inspection and fuel overflow or underflow might occur, check and adjust the fuel level or weight in the following procedure.

(b) Procedure of Adjustment of Zero point:

- 1) Throw up the mode selector switch (⑩).
- 2) Displayed value is following.
 - No fuel in the vessel: Tare weight
 - Fuel exist normally: Between the upper limit and the lower limit
- 3) IF the difference between the displayed value and the value of <Table-2> is less than $\pm 20\%$, decide it normal.
- 4) If the difference is larger than $\pm 20\%$, turn the trimmer 'ZR' (⑳) for adjustment.

◆7. Others

(1) View of Print Circuit Board

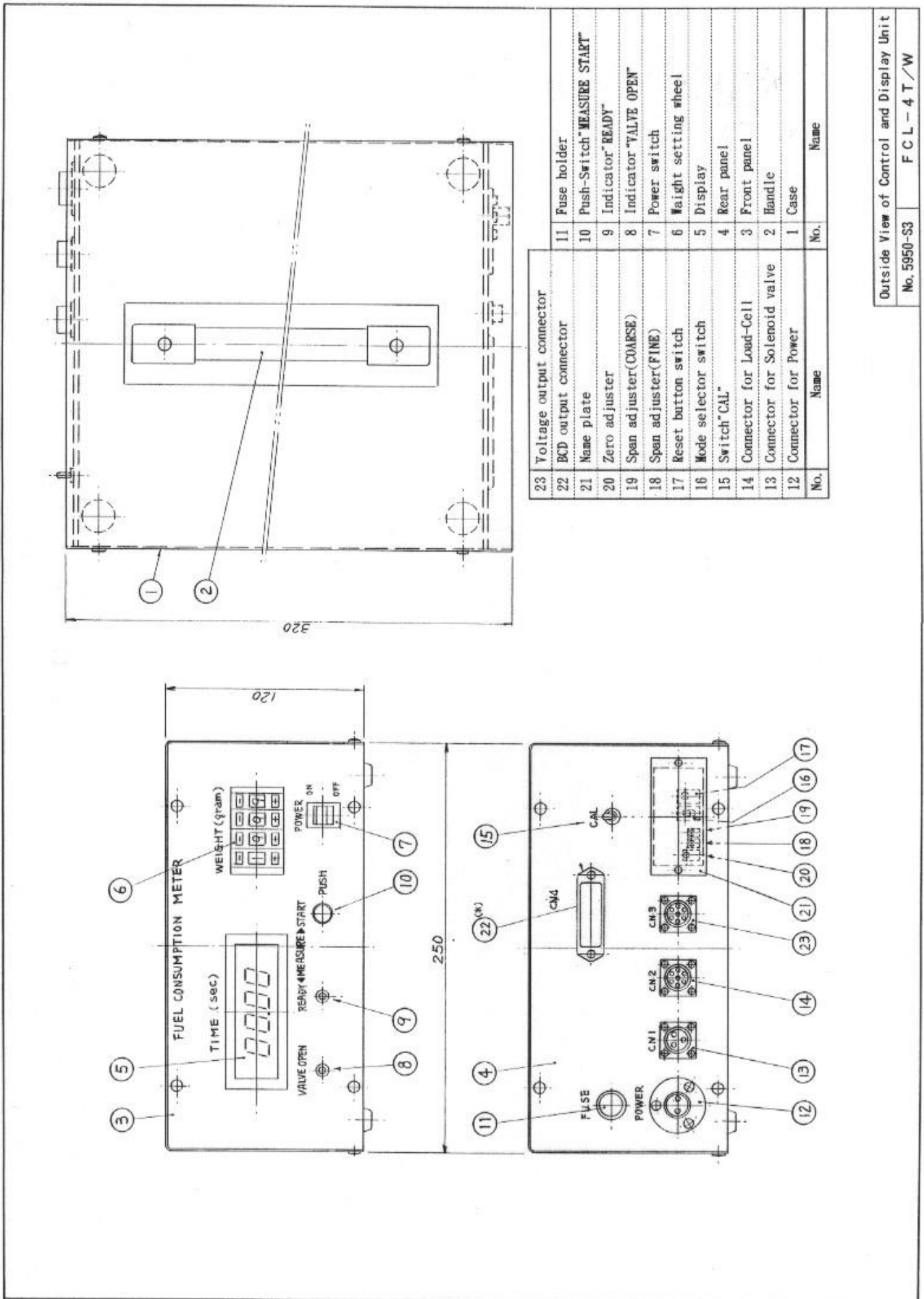


- VR6 : The upper limit adjuster trimmer (voltage: IC4-5)
 - VR7 : The lower limit adjuster trimmer (voltage: IC4-10)
- (If adjustment is carried out, adjust VR6 earlier than VR7)

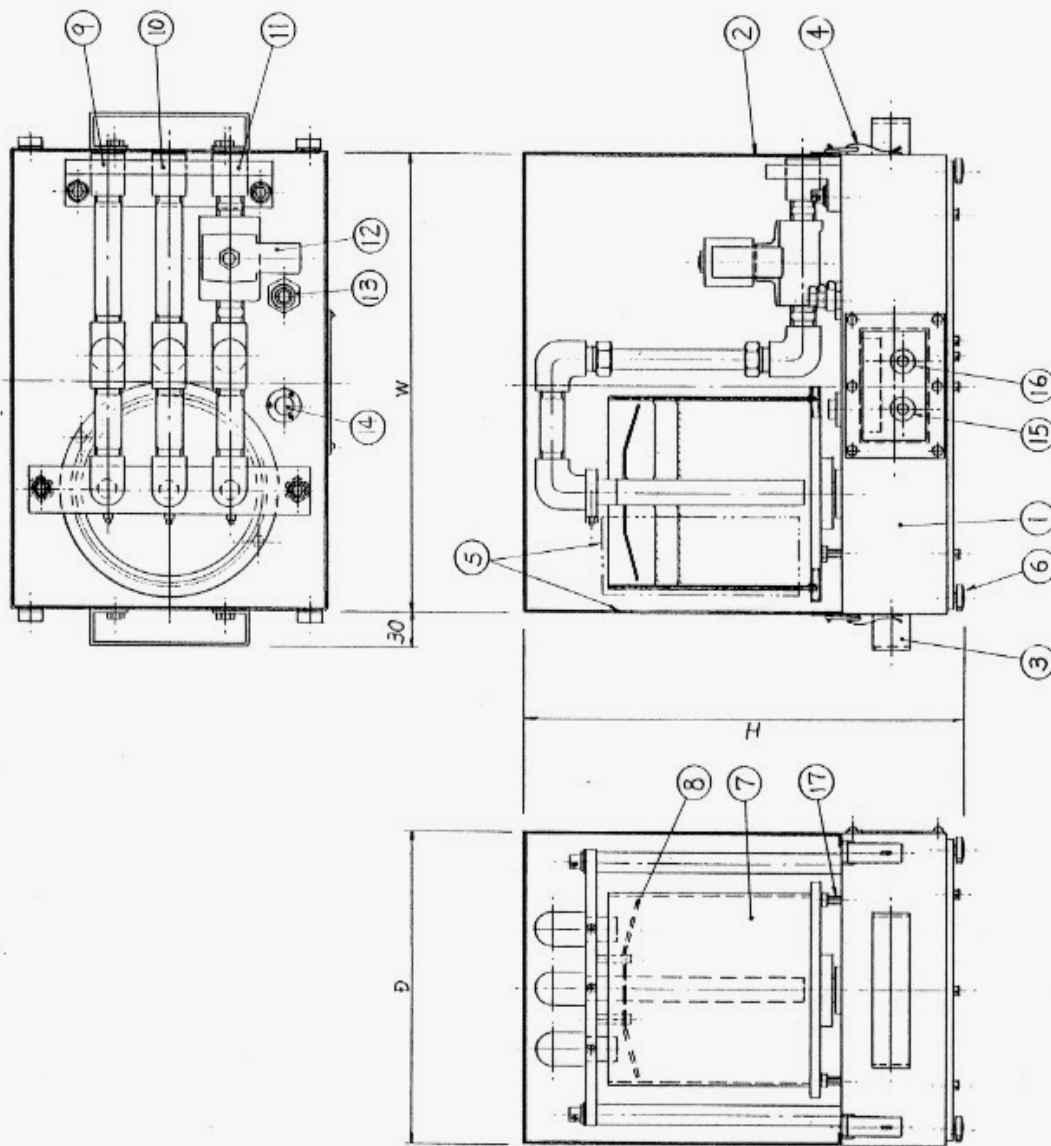
<fig-7>

(2) Standard Accessories

- | | | |
|----------------------|---|---|
| (a) Power cord (5 m) | : | 1 |
| (b) Connecting cable | : | Each 1 (for solenoid valve and load signal) |
| (c) Fuse (1A) | : | 1 |
| (d) Hose fitting | : | 3 |



Outside View of Control and Display Unit
 No. 5950-S3 FCL-4T/W



	FCL-1000R	FCL-2000R
W	380	470
H	365	445
D	260	320

17	Bolts for transportation
16	Cable for Solenoid valve
15	Cable for Load-Cell
14	Spirit level
13	Bushing
12	Solenoid valve
11	Supply-Fuel inlet
10	Fuel outlet
9	Return-Fuel inlet
8	Return fuel buffer plate
7	Metering vessel
6	Adjusting bolts
5	Window
4	Locks
3	Handle
2	Cover
1	Load-Cell metering unit
No.	Name

Outside View of Weight Sensing Unit
 No. 5946-S3 FCL-1000R, FCL-2000R