JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF WORKS AND ENERGY

REPUBLIC OF KIRIBATI

A STUDY OF UTILIZATION OF PHOTOVOLTAICS FOR RURAL ELECTRIFICATION IN THE REPUBLIC OF KIRIBATI

FINAL REPORT

ATTACHMENT-Ⅲ

MARCH 1994

YONDEN CONSULTANTS CO., LTD.

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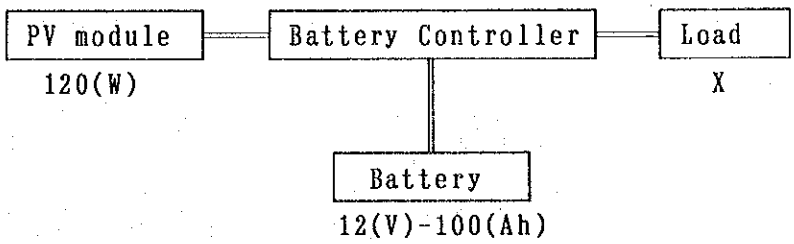
< C o n t e n t s >

<Reference-1>

Simulation of the North Tarawa PV System Design

1.Constitution

(1) Outline Diagram of System



(2) PV Module : 120(W) (at standard condition)

(3) Battery Controller

This controller is designed for repeating the input/output in between 50% and 100% of the battery capacity.

(4) Battery : 12(V)-100(Ah)

(5) Load

The load(11W,7W×2) for lighting is used.

Load-using conditions are as follows:

2.Irradiance and Loading Condition of Simulation

Data 1～3 show the results of load-balance simulation performed by selecting

The characteristic 6 days on the month showing the maximum, minimum, and average of irradiance of monthly average in 1986 (each A-diagram).

<Irradiance Quantity>

Case obtaining high irradiance (July 11-16)·····Data 1

Case obtaining medium irradiance (April 10-15)··Data 2

Case obtaining low irradiance (December 8-13)···Data 3

Data 1～3: Fig.B～D show each case of load-balance simulation on the 3 following conditions.

<Loading condition>

	Loading conditions	
Fig.B	11(W)× 6(h) 7(W)×12(h)× 2	Total 234 (Wh/day)
Fig.C	11(W)×12(h) 7(W)×12(h)× 2	Total 300 (Wh/day)
Fig.D	11(W)×24(h) 7(W)×24(h)× 2	Total 600 (Wh/day)

3.Results of Simuration

The system is designed for repeating the input/output in between 50 and 100% of the battery capacity, accoadigly, when battery capacity reaches 100% the solar energy thereafter will be discharged, and the battery capacity 50% at lead-using time will result in stopping of power supply. Based on the above state, energy-effective using system will be considered.

As a result of the above simulation, the following tables show the summariesof the stopping time of charge/discharge by the battery with the battery capacity 50 and 100%.

(1) Case obtaining high irradiance (Data 1) July, 1986

		11	12	13	14	15	16	Average
Fig.B	100%	4:10	4:23	5:41	5:25	5:30	5:48	5:10
	50%	0	0	0	0	0	0	0
Fig.C	100%	2:52	2:49	4:25	4:07	4:18	4:36	3:51
	50%	0	0	0	0	0	0	0
Fig.D	100%	0	0	0	0	0	0	0
	50%	0	0	0:56	2:45	5:12	3:36	1:46

(2) Case obtaining medium irradiance (Data 2) April, 1986

		10	11	12	13	14	15	Average
Fig.B	100%	1:07	3:16	1:57	3:25	2:48	3:30	2:41
	50%	0	0	0	0	0	0	0
Fig.C	100%	0	0:44	0	1:17	0:48	1:38	0:44
	50%	0	0	0	0	0	0	0
Fig.D	100%	0	0	0	0	0	0	0
	50%	0	8:34	11:45	12:13	10:12	11:00	8:47

(3) Case obtaining low irradiance (Data 3) December, 1986

		8	9	10	11	12	13	Average
Fig.B	100%	0	0	0	0	0	0	0
	50%	0	0	1:21	6:00	3:48	6:00	2:52
Fig.C	100%	0	0	0	0	0	0	0
	50%	0	1:10	8:06	6:00	6:04	6:00	5:33
Fig.D	100%	0	0	0	0	0	0	0
	50%	2:37	24:00*	24:00*	16:55	24:00*	12:48	17:23

*In Fig.D (Load 600(Wh/day)), 24 hours without using the battery on 9,10 and 12th include the time without full use of daytime load.

4.Summary

Irradiance quantity in Kiribati is stable throughout the years, and yearly average quantity is daily obtained.

Accordingly, with reference to Data 2, in case of the load 300(Wh/day),

JULY, 1986

Fig.A
IRRADIANCE
[kW/m²/h]

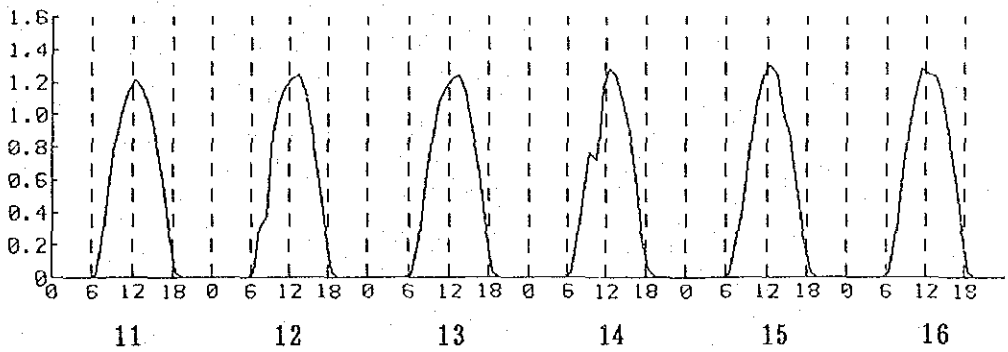


Fig.B
Battery
Charge
[%]

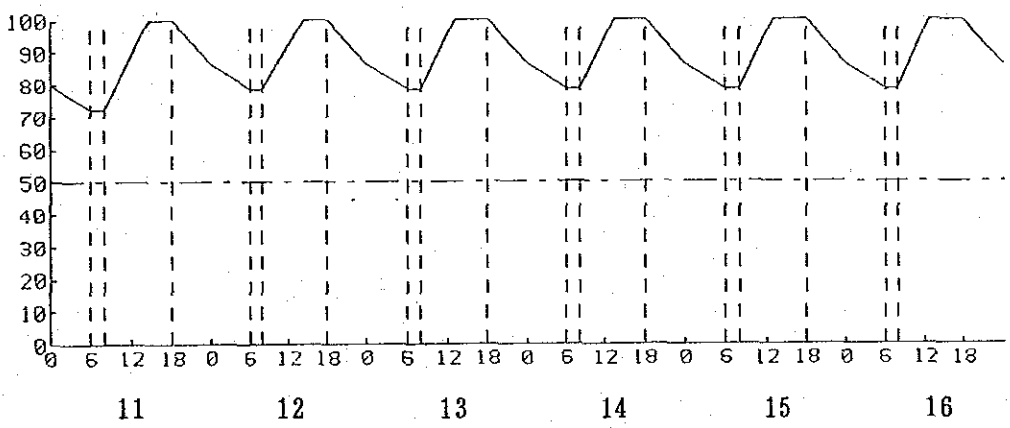


Fig.C
Battery
Charge
[%]

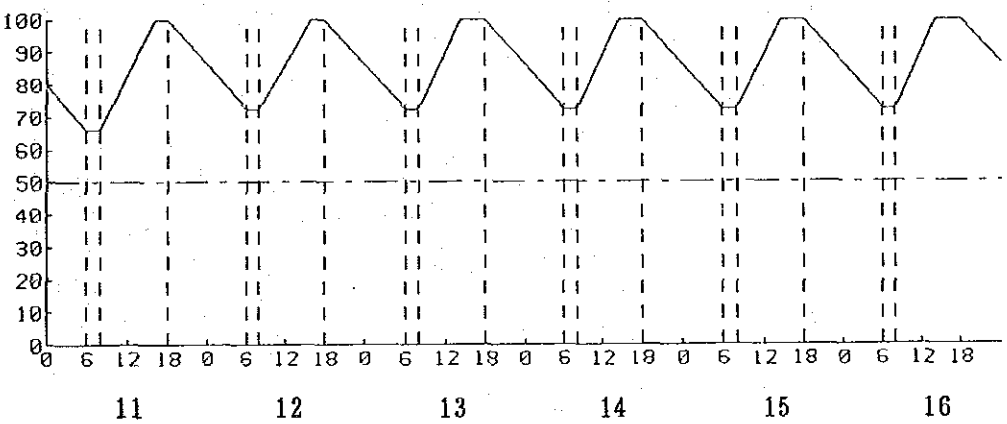
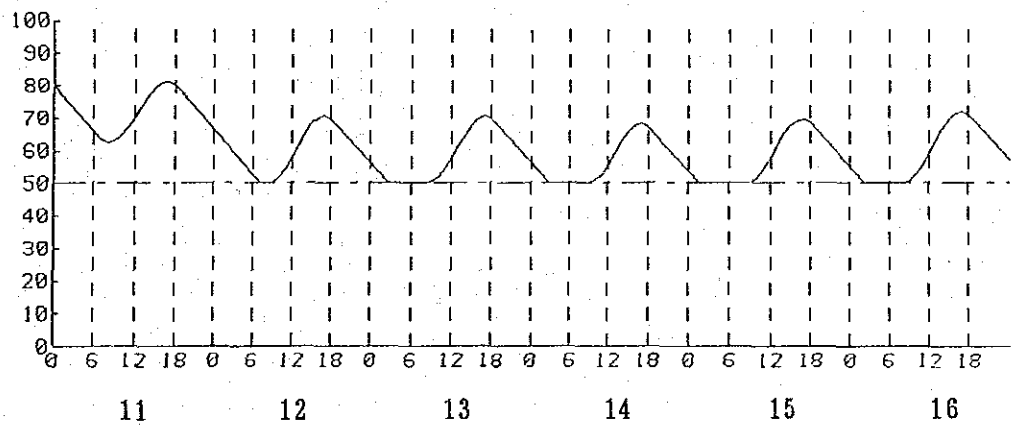


Fig.D
Battery
Charge
[%]



April, 1986

Fig.A
IRRADIANCE
[kW/m²/h]

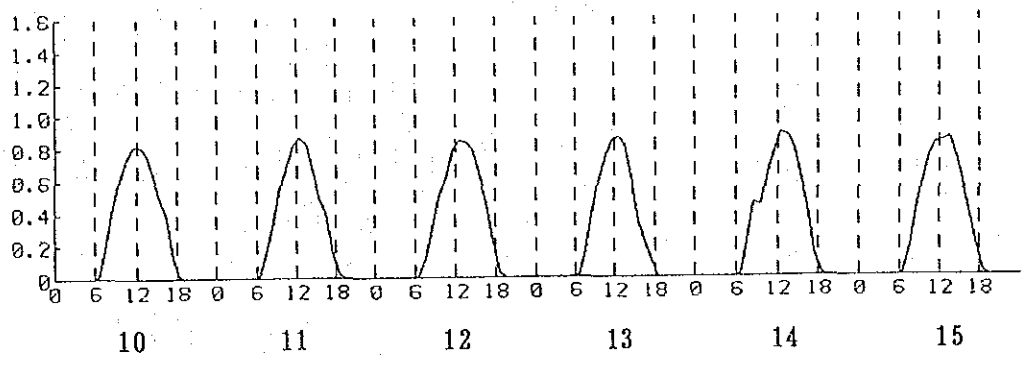


Fig.B
Battery
Charge
[%]

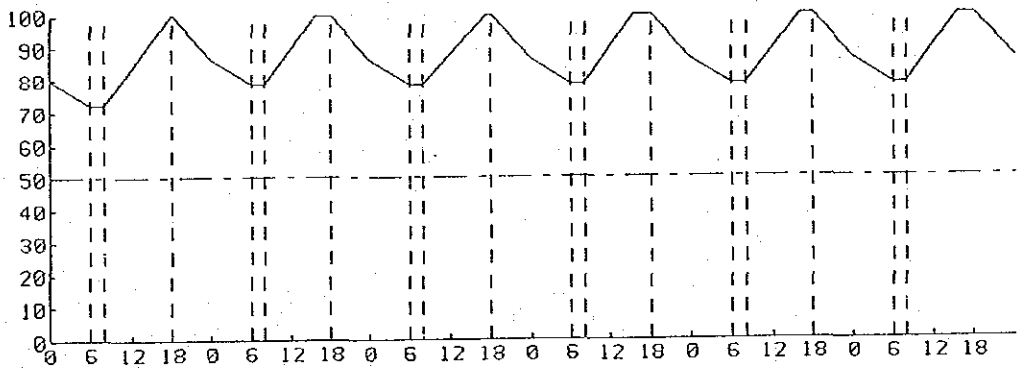


Fig.C
Battery
Charge
[%]

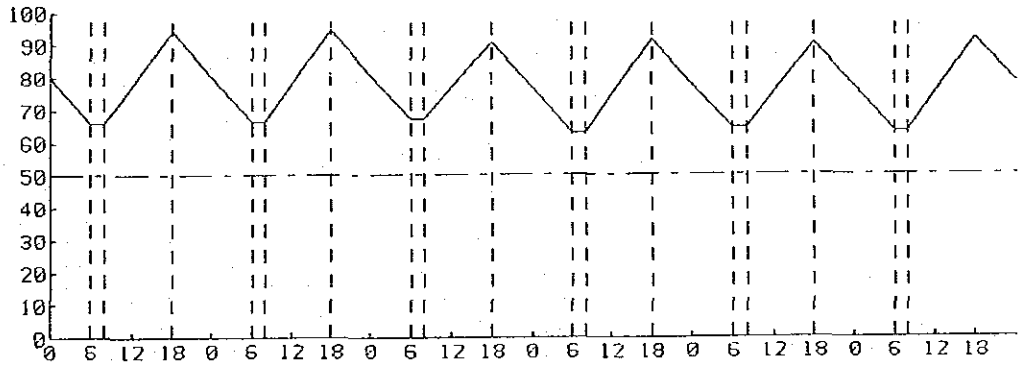
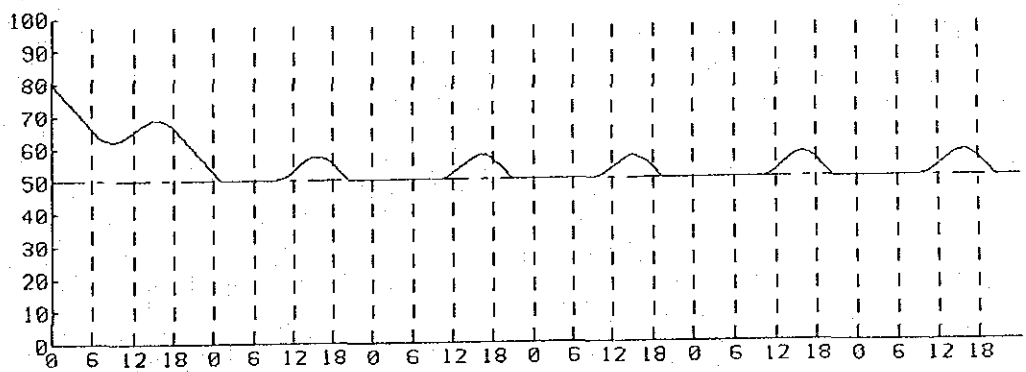


Fig.D
Battery
Charge
[%]



December, 1986

Fig.A
IRRADIANCE
[kW/㎡/h]

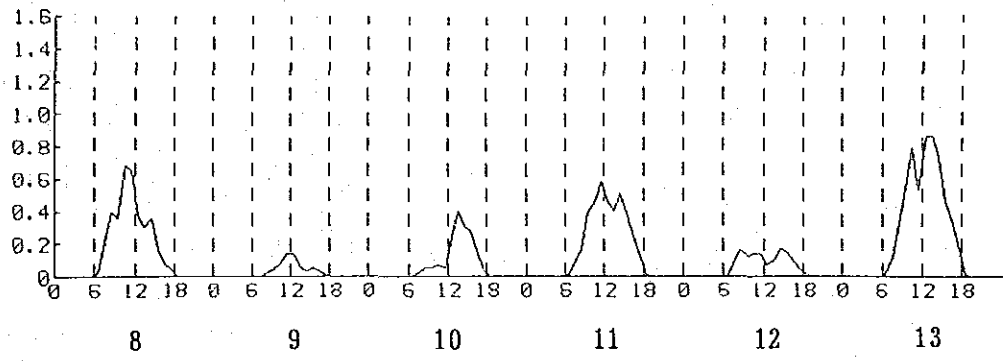


Fig.B
Battery
Charge
[%]

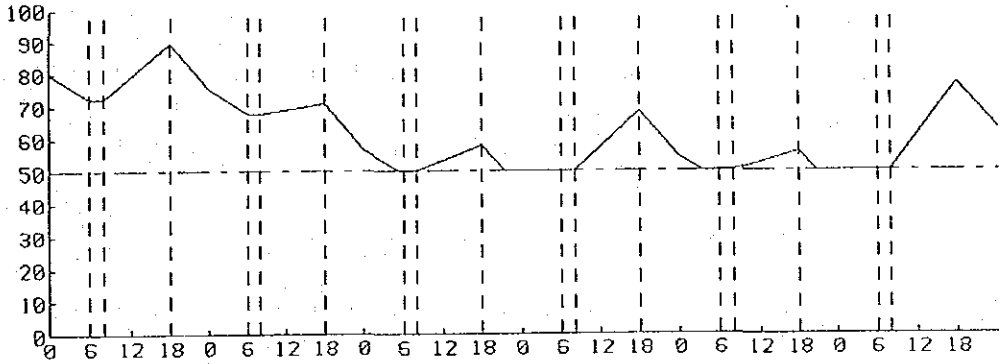


Fig.C
Battery
Charge
[%]

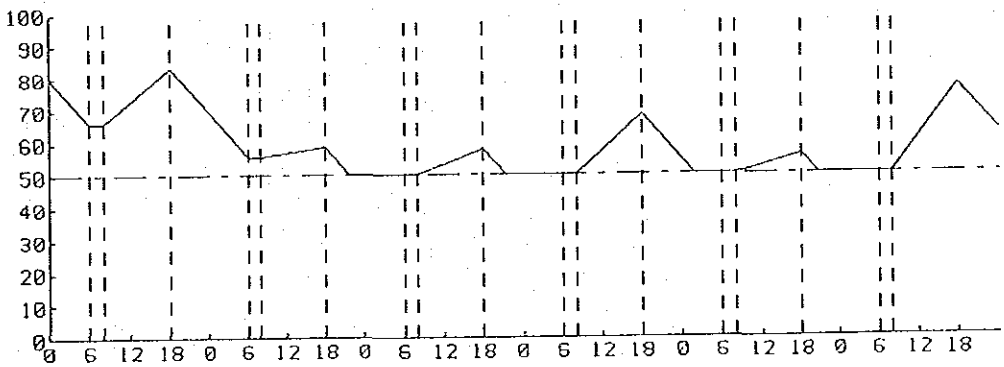
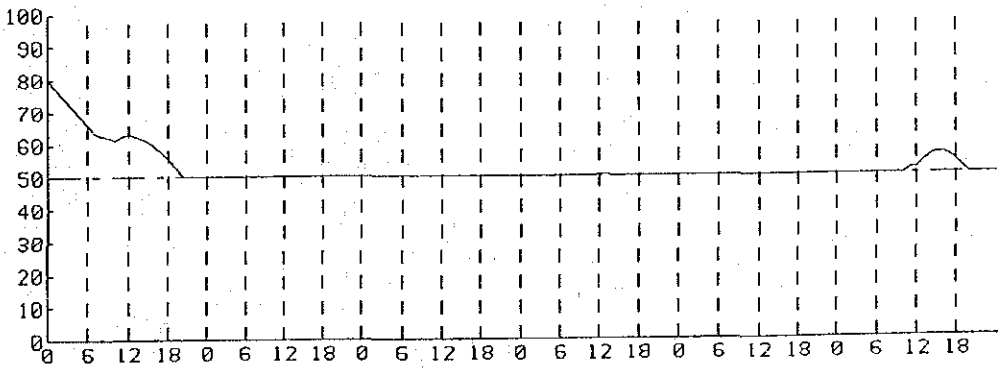


Fig.D
Battery
Charge
[%]



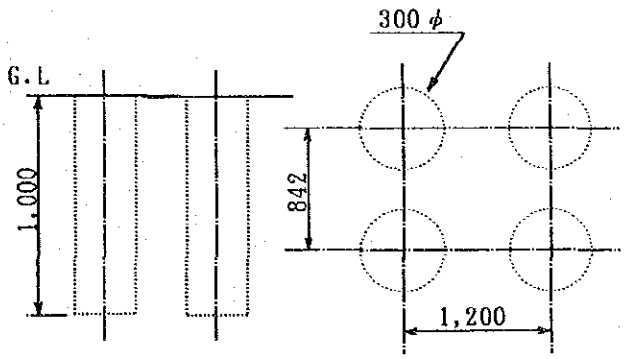
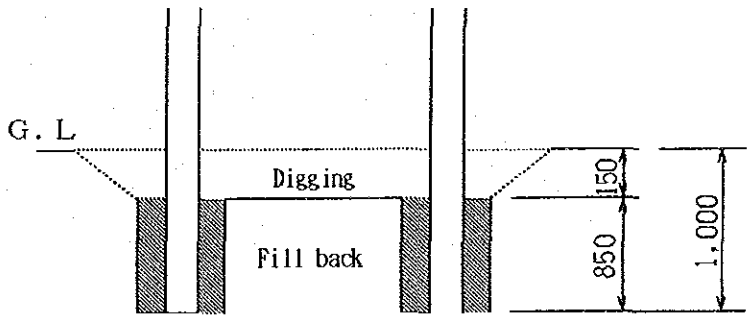
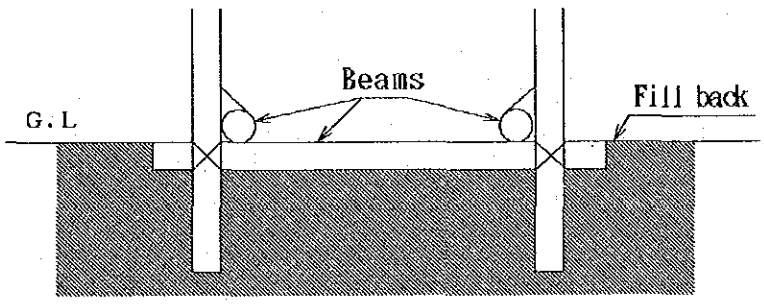
<Reference-2> *Construction Prosedure*

1.1 Installation of Module Monuting and Pole Mount for Solar Module

1.1.1 Installation of Module Monuting for MANEABA

The PV modules for MANEABA are set on the frame stand built by coconut log and L-shaped steel angle. (see Figure-4)

(1) Procedure of work

Procedure of Work	Illustration
a.Digging holes Diameter : 300mm Depth : 1,000mm Number : 4 (see figure-1) Dig at three points by the Maneaba.	
b.Install the columns Install four columns in each holes and fill holes with sand then dig trenches along the columns again. Depth : 150mm Width : 500mm (see figure-2)	
c.Fixing beams Fix under beams to columns with rope then fix upper beams with clamps and refill trenches with sand. (see figure-3)	

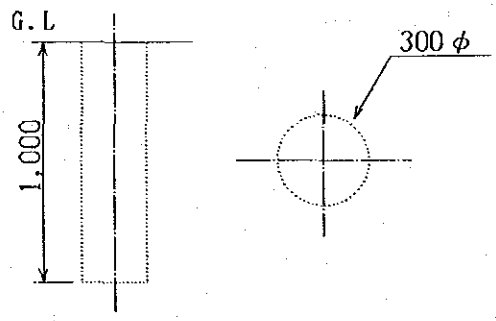
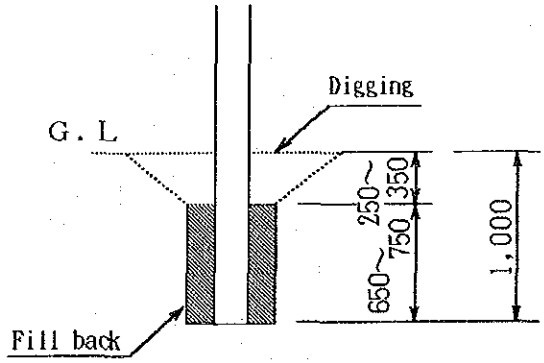
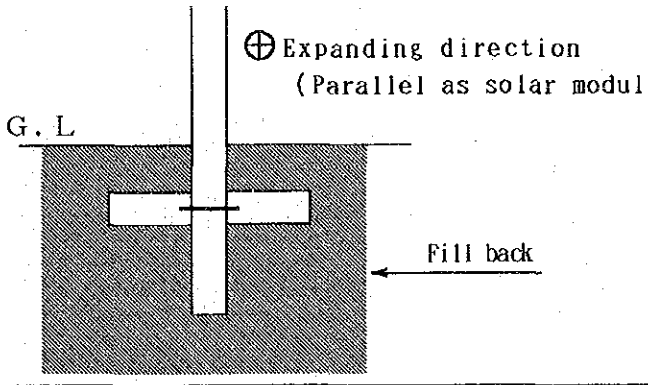
Note : For the assemble of PV modules, refer to manufacturer's instruction.

Figure-4 Stand frame for Maneaba

1.1.2 *Installation of pole mount stand for households*

The PV modules for households are set on the frame of L-sharped aluminum angle on the pole mount. (see Figure-4)

(1)Procedure of work

Procedure of Work	Illustration
a.Digging holes Diameter : 300mm Depth : 1,000mm Number : 1 (see figure-5) Dig each hole at pointed place by each household-s.	
b.Install the columns Install the pole and fill hole with sand about 650 to 750mm then dig trench along the pole again. Depth : 250 to 350mm Width : 500mm Length : 1,000mm (see figure-6)	
c.Fixing the beam Fix the beam to the pole with fixing band, the direction of beam should be parallel with the face of PV module, then refill with sand. (see Figure-7)	

Note : For the assemble of PV module, refer to manufacturer's instruction.

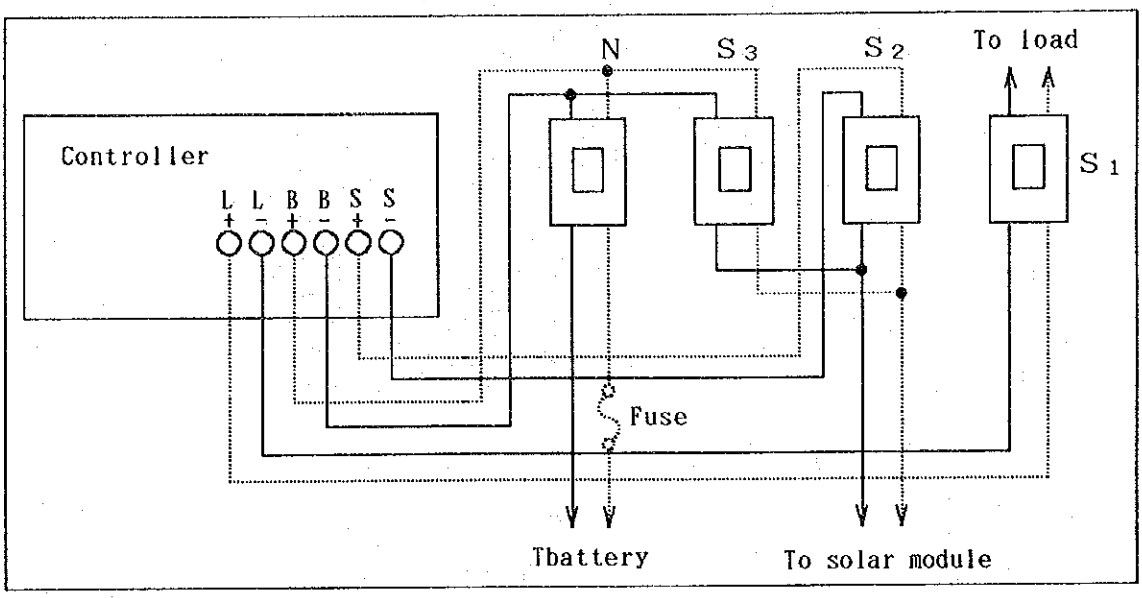
Figure-8 Pole mount frame for household

1.2 Switchboard

1.2.1 Wiring of the switchboard

The wiring of the switchboard is made with SV1.6mm X 2C cable.

(see Figure-9)

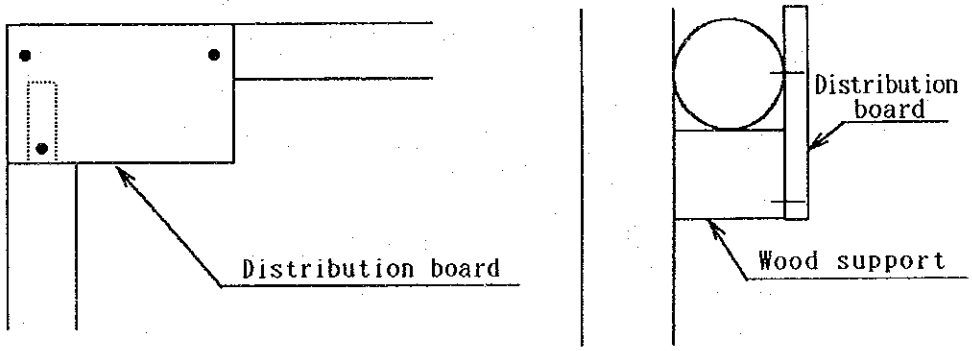


Note : The primary terminal of fuseless breaker switch(NFB) should be lowerside.

1.2.2 Fixing of the switchboard

The switchboard is fixed to columns or beams of house with screwnail or coconut rope tightly.

The example is shown in Figure-10.



1.3 Storage battery

1.3.1 Initial charge

(1)Non-seal type battery (12CT-110)

The storage battery is charged at SOUTH TARAWA(in SEC) using battery charger, then carried to NORTH TARAWA.

Four batteries are possible to be charged in parallel,however should be checked the terminal voltage to keep uniform charging.

The charge should start after the temperature of liquid in battery becomes below 40 degrees C.

The procedure of initial charge of Non-seal battery:

a.Fill the liquid(diluted sulfuric acid)
Use goggles, plastic or rubber gloves and apron.
↓
b.Start initial charging(maximum four batteries in parallel)
After the temperature of liquid cooled down below 40 degrees C.
Check the terminal voltage of each battery.
↓
c.Carry to NORTH TARAWA

Note : Refer to manufacturer's instruction of "the battery for PV system".

(2)Seal type battery (12CTE-120)

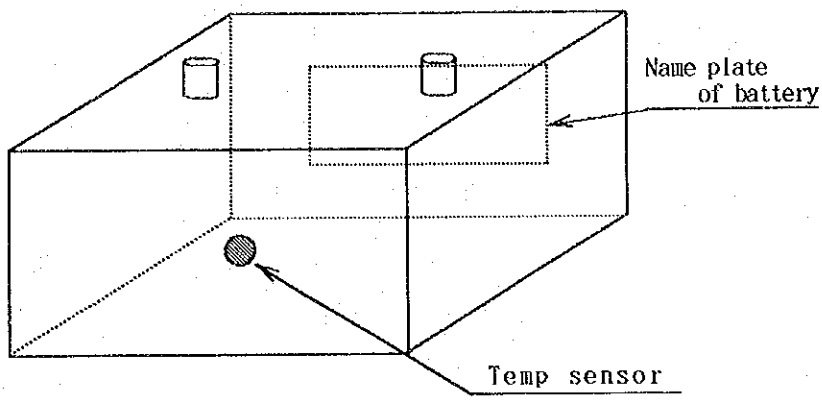
The initial charge of this type battery is done at the site of installation.

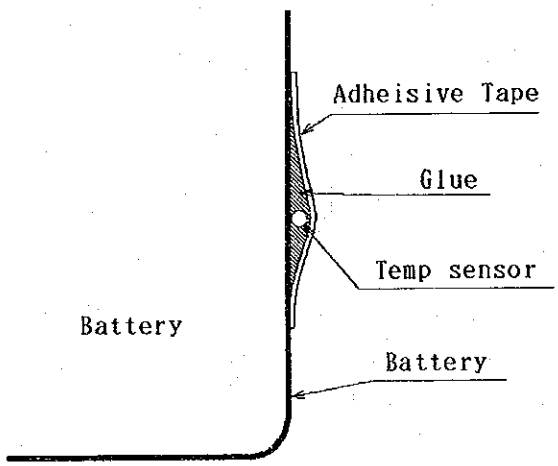
After the PV system is installed, the battery is charged by PV module directly (by-pass the controller).

This battery is not necessary to fill the liquid.

a.Carry to NORTH TARAWA.
↓
b.Install the PV system.
↓
c.Initial charge.
Fuseless breaker switch (NFB) is ON.
Overcharge protection switch of controller is OFF.
Switch to load is OFF.
Charge through two days.
↓
d.Ordinary operation.
Overcharge protection switch is ON.
Switch to load is ON.

1.3.2 Set the thermometer to the seal-type battery(12CTE-120)
See Figure-11 and Figure-12.





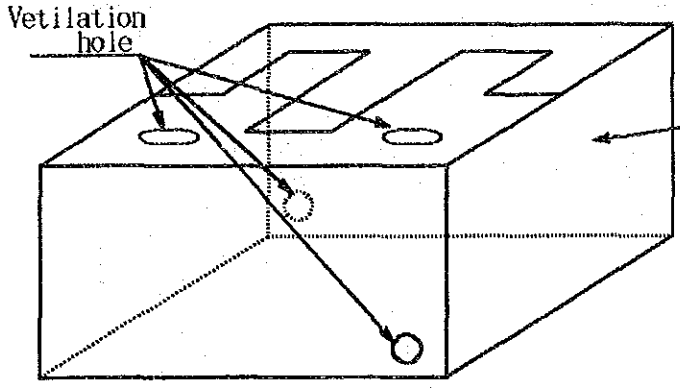
The point of thermometer is the opposite side of the battery name plate.
The thermometer is bonded with adhesives and fixed with adhesive tape included in attachment.
The excess length of thermometer cable is winded and kept in the battery box.

1.3.3 Instruction for battery transportation
Avoid a strong shock to prevent the separation of active material of electrodes and the leakage of liquid.
Avoid a contact of sea water.

1.3.4 The battery box

Bore holes on the top and sides of the box for ventilation.

(see Figure-13)



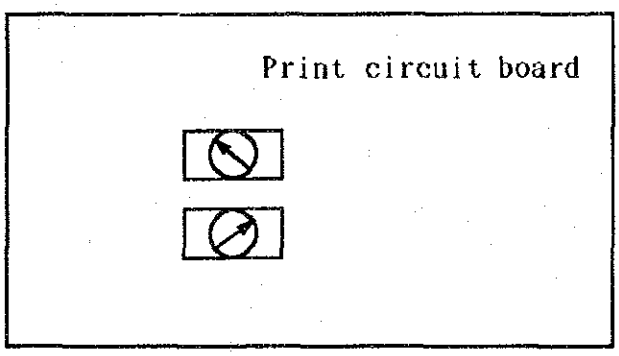
— Notice —

Ventilation hole should be punch out at lower place of box.

1.4 Controller for the system evaluation

Change the dip switch for discharge contrail (yellow) from 5 to 9.

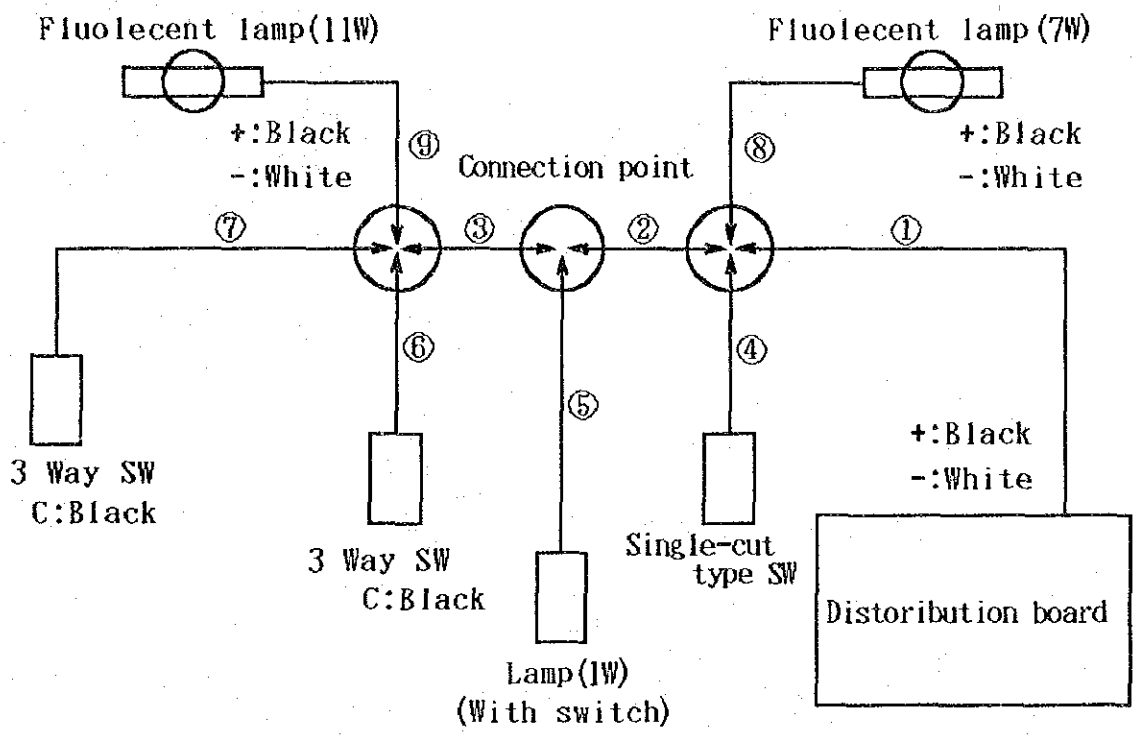
(see Figure-14)



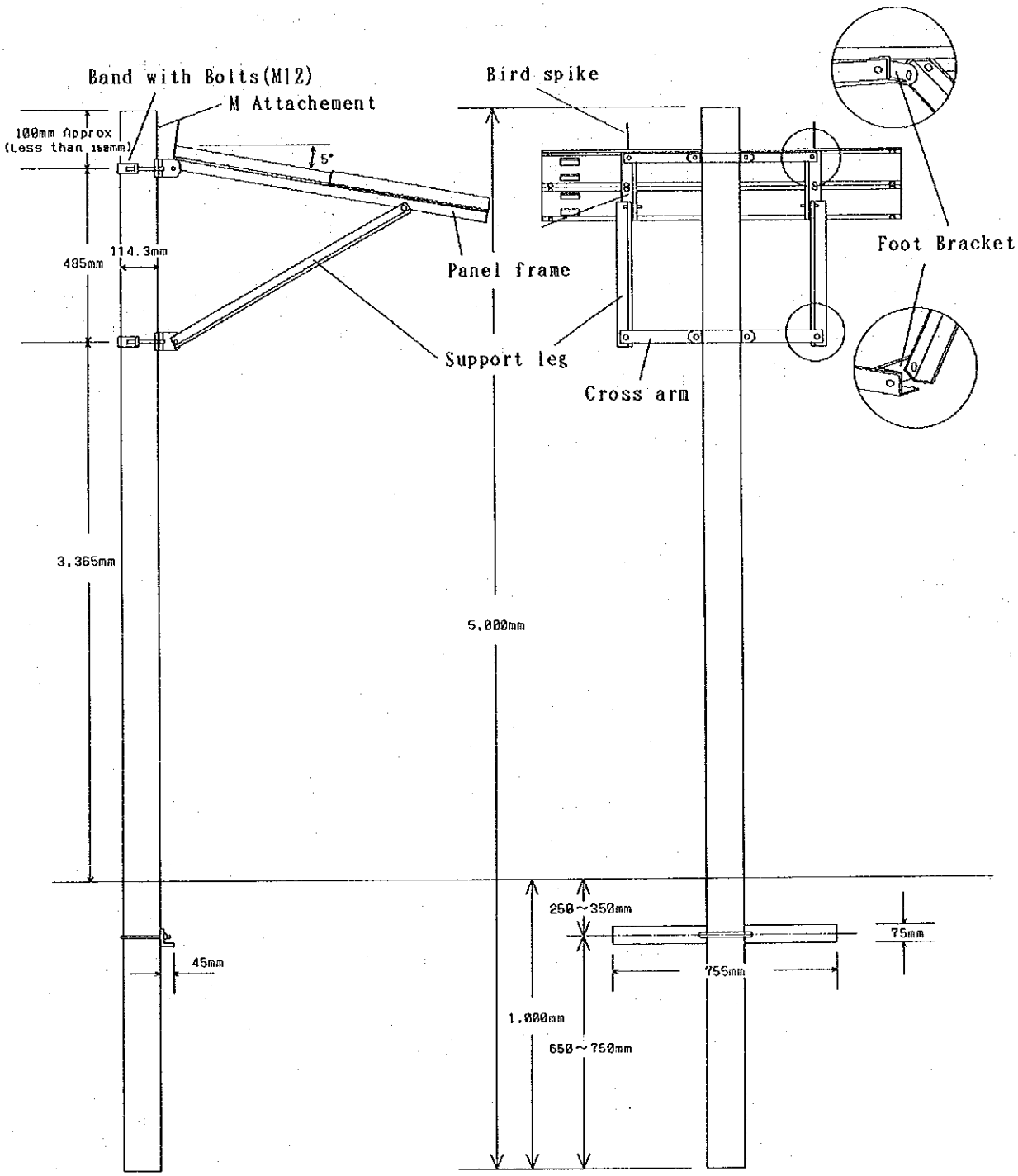
Yellow dip switch
(For discharging)

1.5 Wiring in the household

Standard wiring diagram of household is shown in Figure-15.



The consumer must try saving electricity such as switching off a light during the day and should be directed that the storage battery must be maintained satisfactory condition so as not to be made a state of overdischarging.


Band with Bolts(M12)
M Attachement
100mm Approx
(Less than 150mm)
5°
485mm
114.3mm
3,365mm
Bird spike
Panel frame
Support leg
Cross arm
Foot Bracket
5,000mm
250～350mm
75mm
755mm
45mm
1,000mm
650～750mm