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No 005008

LABORATORIUM UJI KOMPONEN SISTEM FOTOVOLTAIK
PHOTOVOLTAIC COMPONENT TEST LABORATORY

SERTIFIKAT PENGUJIAN
TESTING CERTIFICATE

No. Referensi   : 005008
Reference Number
No. Kontrak   : Dated July 12 th, 2004
Contract Number

Identitas Pelanggan / *Customer Identity*

Nama / *Name*   : PT. Sundaya

Alamat / *Address*   : Jl. Pondok Randu No. 38 Cengkareng 11750, Jakarta Barat, Indonesia

Identitas Sampel / *Sample Identity*

Nama / *Name*   : Apple 10

Nama Pabrik / *Vendor*   : PT. Sundaya

Tipe / No. Seri   : Production code: 12 – 0017 and batch No: A0, with four samples represent
Type / Serial Number   1000 pcs

Pengujian / *Testing*

Metoda / *Methode*   : Prdocedure electrical performance & capacity of BCR

Tanggal / Lamanya   : July 24th – August 10th ,2004
Date / Duration

Sampel tersebut diatas telah diuji sesuai prosedur dalam **SNI 04-6391-2000**
"Prosedur pengujian karakteristik & kapasitas BCR"
Sertifikat ini merupakan bagian yang tidak terpisahkan dengan Laporan Pengujian No. 19/LAP.JATEK/
LSDE/BPPT/VIII/2004
The sample(s) has/have been tested based on procedure written in SNI 04 – 6391- 2000
This certification is part of testing report number: 19 /LAP.JATEK/ LSDE/BPPT/VIII/2004

Sertifikat ini berlaku sampai dengan adanya perubahan disain
This certification valid until change of design

Serpong, August 10th, 2004

Kepala / *Head of*
UPT – LSDE

Dr. Agus Rusyana Hoetman
NIP. 680000820

Dilarang keras mengutip/menggandakan, merubah dan atau mempublikasikan sertifikat ini tanpa izin dari UPT-LSDE.
Sertifikat ini sah apabila dibubuhi cap UPT-LSDE

TEST REPORT

ORDER NUMBER   : 005008

ADMINISTRATIVE NUMBER   : 19 /LAP.JATEK/LSDE/BPPT/VIII/2004

CONTRACT NUMBER   : Dated July, 12th 2004

SAMPLE IDENTIFICATION

NAME   : The Controller Type : Aplle 10

MANUFACTURE/ DISTRIBUTOR: PT- SUNDAYA

TYPE/ SERIAL NUMBER   : Production code : 12 – 0017 and batch No : A0

OWNER IDENTIFICATION

NAME   : PT- SUNDAYA

ADDRESS   : Jl. Pondok Randu No. 38 Cengkareng 11750
                          Jakarta Barat, Indonesia
                          Telp   (021) 541 6103
                          Fax   (021) 541 6106

This report comprises of 15 Pages

Date of issue : August 10th , 2004

Kepala UPT-LSDE

Dr. Agus Rusyana Hoetman
NIP - 680 000 820

Technical Implementation Unit
Energy Technology Laboratory (UPT-LSDE)

Photovoltaic Component Test Laboratory (PCTL)

TABLE OF CONTENT

TEST REPORT
The Controller Type: Apple 10

1. Objective:

The Objective of this test is to inspect the quality of Controller (BCR) type Apple 10 by observing its function; specification and electrical performance.

The test is intended to explore the possibility of using this controller in the Solar Home System and match to their requirement for SNI-standard

This test and its report is done according to the order from PT Sundaya dated: July 12th, 2004

2. Basic of Testing:

- Internal procedure of Photovoltaic ComponentsTest Laboratory, UPT LSDE
- Standard of "SNI ; Bagian I : Prosedur Uji dan Persyaratan Elektris Battery Charge Regulator (BCR)" ; SNI – 04-6391- 2000 .

3. Description of Sample

- Sample collection was done by personal from the PT Sundaya.
- Number of samples that were received from the PT Sundaya are 4 (four) BCR (Battery Charge Controller) type Aplle10 that all of them have the same production code: 12–0017 and Batch No: A0
- A picture of sample is shown in Figure 1
- Technical specifications of the samples as stated in the dicumentation (as the test parameter) are as follow:

Technical Specification:

Nominal voltage	: 12 Volts
Maximum input current	: 10 Amp
Maximum output current	: 10 Amp
Boost charge voltage	: 14.3 to 14.6 Volts
PWM Low	: 13.6 Volts
PWM High	: 14.00 volts to 14.25 volts
LVD (Low Voltage Disconnect)	: 11.45 volts 11.70 volts (after Boost charge voltage is reached)
PLVD(Penalty LVD):	: 11.75 volts to 12.2 volt (if Boost charge voltage is not reached)
Buz voltage	: 11.55 volts to 11.85 volts (after Boost charge voltage is reached)
PBuz(Penalty Buz):	: 11.90 volts to 12.35 volt (if Boost charge voltage is not reached)

Load reconnect	: 12.70 V to 13.10 V

Protections:
- Overload : occurs at 130 % rated current
- Short circuit : included (electronic protection)
- Module reverse polarity : included (electronic protection)

Indicators : there are 12 LED's; 8 LED's for level battery capacities; LED No.9 for load cut off; LED No.10 for Penalty; LED No.11 for PV cut-off or charging and LED No.12 for start/stop/overload
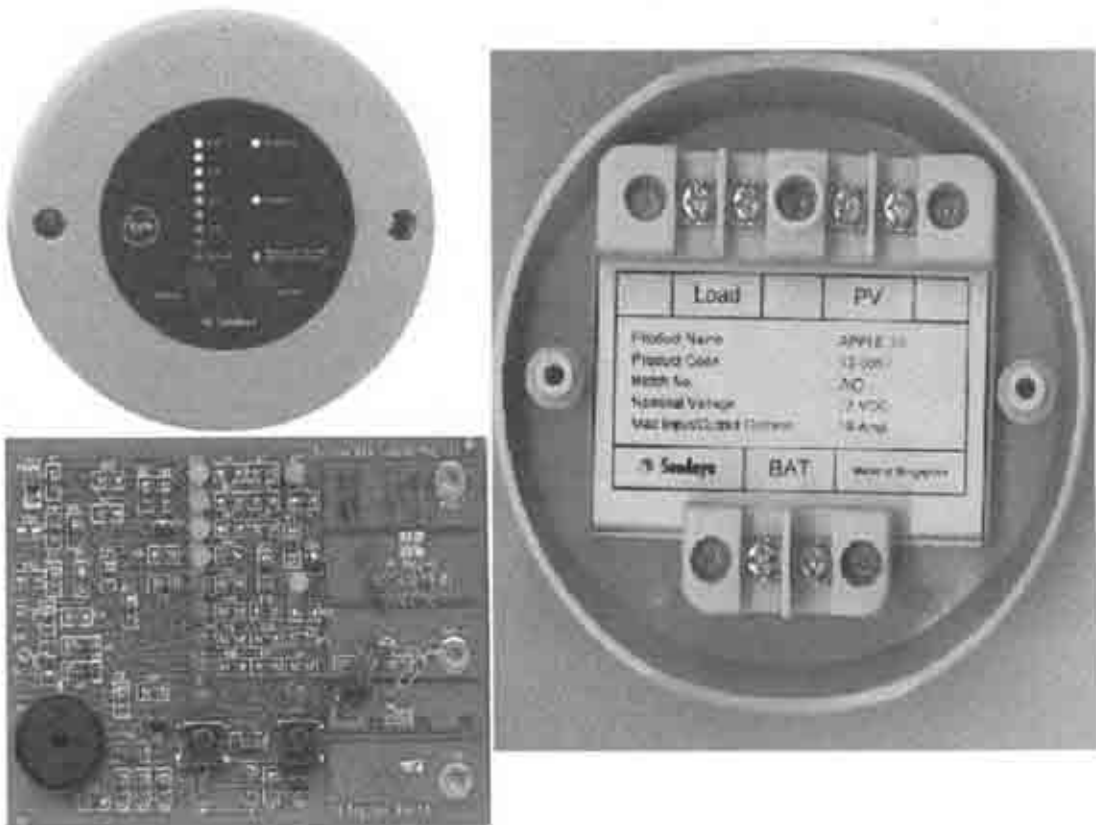

Figure 1

4. Test Procedures

There are 3 (three) kinds of test, they are:
- Pre-test, which describes as visual and technical documentation inspection of the samples component
- Function Test, which describes as measurement of controller's function i.e.: threshold voltage and its display indicators as declared in manufacture specification.
- Detail test, which consists of :
    - Self-power consumption test
    - Switching/ current compensation test of threshold voltage
    - Voltage drop between PV – Battery terminals and between Battery – Load terminals
    - Endurance test
    - Protections test :
        - Reverse polarity test
        - Overload and load short circuit tests

5. The test equipment

Block diagram of test equipment is shown in figure 2
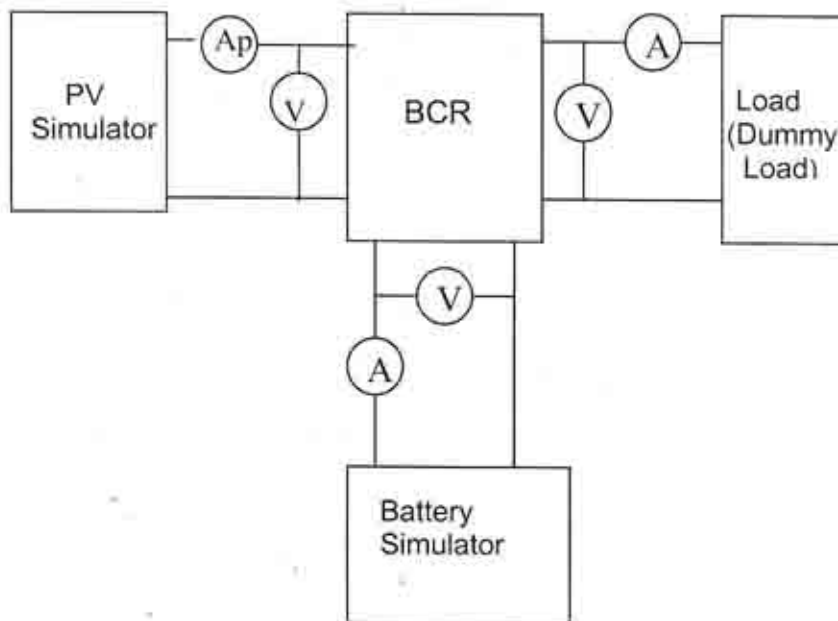

Figure 2

Where :

PV Simulator , consists of :
- Power Supply

Battery Simulator, consists of :
- Power supply
- Electronic Dummy Load

Load, consists of :
- Electronic Dummy Load

A_{pv} ; A_b ; and A_L are :
- Digital Multimeter for current measurement

V_{pv} ; V_b and V_L are :
- Digital Multimeter for voltage measurement

6. Test Results

The test is done for 2 (two) samples of APPLE 10, noted as sample 1 and sample 2

6.1. Pre-test

- Enclosure (box of BCR)   : Plastic with circular shape
- Terminals   : Has a good quality that capable to draw
                               10.0 Amps current
- Components on PCB   : SMD (Surface Mounted Devices)

Documentation   : Consists of:
                               - Test parameters

6.2. Function Test:

Set up for the function test is as follows:
- PV Simulator current = 5.0 Amps and PV simulator voltage = 18.0 volts
- Load current = 5 Amps

The test results are given in **Table 1** (Apple 10, sample 1) and **Table 2** (for Apple 10, Sample 2). Data filled in Table 1 and Table 2 are the data from manufacture's technical specification and the data from the measurement of the threshold voltage.

Table 1.The Function test data for APPLE 10 Sample 1

Description	Threshold voltage		Remaraks
	Manufacturer's Specification(V)	Measured (V)	
Boost charge voltage	14.30 –14.60	14.30	LED No.11 turns off
PWM Activated PWM High PWM Low	14,00 –14.25 13.6	13,68	
LVD	11.45 –11.70	11.43	Detected after boost charge is reached and LED No.9 turns on
PLVD	11.75 – 12.20	11.82	Detected when boost charge is not reached and LED No.9 turns on
Load Reconnect	12.70 – 13.10	13.06	LED No.9 turns off
Buzz	11.55 – 11.85	11.70	Detected after boost charge is reached
Pbuz	11.90 – 12.35	12.17	Detected when boost charge is not reached

Notes : 1. The LEDs as Battery capacities indicator are tested at $V_{bat} \leq$ 12.66 V and all LED's (8 LED's) turn on by pressing switch S_2

Table 2.The Function test data for APPLE 10 Sample 2

Description	Threshold voltage		Remaraks
	Manufacture's Specification(V)	Measured (V)	
Boost charge voltage	–	14.26	LED No.11 turns off
PWM Activated PWM High PWM Low	14,00 –14.25 13.6	13.67	
LVD	11.45 –11.70	11.43	Detected after boost charge is reached and LED No.9 turns on
PLVD	11.75 – 12.20	11.77	Detected when boost charge is not reached and LED No.9 turns on
Load Reconnect	12.70 –13.10	13.01	LED No.9 turns off
Buz	11.55 – 11.85	11.66	Detected after boost charge is reached
PBuz	11.90 – 12.35	12.10	Detected when boost charge is not reached

Notes : 1. The LEDs as Battery capacities indicator are tested at $V_{bat} \leq$ 12.66 V and all LED's (8 LED's) turn on by pressing switch S_2

6.3. Power Consumption test :

The test set up for the power consumption test is as follows:
- PV Simulator : Off
- Load : Off

The test results are given in **Table 3** (for APPLE 10 , sample 1) and **Table 4** (for APPLE 10 , Sample 2).

Table 3. Result for Power consumption test (APPLE 10 SAMPLE 1)

V_{bat} V (L→H)	I_{bat} MA	Note	V_{bat} V (H→L)	I_{bat} MA	Note
10.00	3.9 – 4.2	LED No. 9 on	15.00	9.8 –10.2	LED No. 9 off
10.50	4.0 – 4.4	idem	14.50	8.8 – 9.4	idem
11.00	4.2 – 4.5	idem	14.00	7.9 – 8.5	idem
11.50	4.3 – 4.7	idem	13.50	7.1 – 8.0	idem
12.00	4.4 – 4.9	idem	13.00	6.6 – 7.4	idem
12.50	4.5 – 5.0	idem	12.50	6.3 – 7.2	idem
13.00	4.7 – 5.2	idem	12.00	6.1 – 6.7	idem
13.50	5.7 – 6.2	LED No. 9 off	11.50	4.3 – 4.7	LED No. 9 on
14.00	6.4 – 7.4	idem	11.00	4.2 – 4.5	idem
14.50	8.8 – 9.5	idem	10.50	4.0 – 4.4	idem
15.00	9.8 – 10.2	idem	10.00	3.9 – 4.2	idem

Table 4. Result for Power consumption test (APPLE 10 SAMPLE 2)

V_{bat} V (L→H)	I_{bat} mA	Note	V_{bat} V (H→L)	I_{bat} MA	Note
10.00	4.0 – 4.3	LED No. 9 on	15.00	9.9 –10.3	LED No. 9 off
10.50	4.1 – 4.5	idem	14.50	8.8 – 9.4	idem
11.00	4.2 – 4.6	idem	14.00	7.8 – 8.5	idem
11.50	4.3 – 4.7	idem	13.50	7.0 – 7.9	idem
12.00	4.4 – 4.9	idem	13.00	6.6 – 7.4	idem
12.50	4.6 – 5.0	idem	12.50	6.3 – 7.2	idem
13.00	4.8 – 5.2	idem	12.00	6.1 – 6.7	idem
13.50	5.7 – 6.2	LED No. 9 off	11.50	4.3 – 4.7	LED No. 9 on
14.00	6.4 – 7.4	idem	11.00	4.2 – 4.5	idem
14.50	8.9 – 9.6	idem	10.50	4.1 – 4.4	idem
15.00	9.9 – 10.3	idem	10.00	4.0 – 4.3	idem

6.4. Switching Test/ Current compensation

6.4.1. Switching test for End of charge:

Set up for the switching test of the end of charge is as follows:
- PV Simulator current is set up at 1.0 Amps; 5.0 Amps and 10.0 Amps.

The test results are given in **Table 5** (for APPLE 10 , sample 1) and **Table 6** (for APPLE 10 , Sample 2).

Table 5. Result for End of Charge test (APPLE 10 SAMPLE 1)

Threshold Voltage	I_{pv} = 1.0 Amp	I_{pv} = 5.0 Amps	I_{pv} = 10 Amps
Boost Charge	14.30 V	14.30 V	14.27 V
PWM activated	13.67 V	13.68 V	13.74 V

Table 6. Result for End of Charge test (APPLE 10 SAMPLE 2)

Threshold Voltage	I_{pv} = 1.0 Amp	I_{pv} = 5.0 Amps	I_{pv} = 10 Amps
Boost Charge	14.26 V	14.26 V	14.24 V
PWM activated	13.65 V	13.67 V	13.70 V

6.4.2. Switching test for the LVD (Low Voltage Disconnect) and LVD reconnect

Set up for the switching test of LVD and the LVD reconnect is as follows:
- Load current is set up at 1.0 Amps; 5.0 Amps and 10.0 Amps.

The test results are given in **Table 7** (for APPLE 10 , sample 1) and **Table 8** (for APPLE 10 , Sample 2).

Table 7. Results for LVD and the LVD reconnect test (APPLE 10 SAMPLE 1)

'Threshold' voltage	I_{Load} = 1.0 Amp	I_{Load} = 5.0 Amps	I_{Load} = 10.Amps
LVD (Low Voltage Disconnect)	11.57 V	11.43 V	11.43 V
BUZ	11.79 V	11.70 V	11.70 V
PLVD	11.94 V	11.82 V	11.82 V
PBUZ	12.23 V	12.17 V	12.17 V
Load reconnect	13,10 V	13.06 V	13.06 V

Table 8. Results for LVD and the LVD reconnect test APPLE 10 SAMPLE 2)

'Threshold' voltage	I_{pv} = 1.0 Amp	I_{pv} = 5.0 mps	I_{pv} = 10 Amps
LVD (Low Voltage Disconnect)	11.52 V	11.43 V	11.43 V
BUZ	11.71 V	11.66 V	11.66 V
PLVD	11.97 V	11.77 V	11.77 V
PBUZ	12.21 V	12.10 V	12.10 V
Load reconnect	13.03 V	13.01 V	13.01 V

6.5. Drop Voltage Test

6.5.1. Drop voltage between PV – Battery terminals test

Set up for the Drop voltage test between PV – Battery terminals is as follows:
- PV Simulator current is set up at : 1.0 Amps; 5.0 Amps and 10.0 Amps
- System voltage = 12.00 Volts

The test results are given in **Table 9** (for APPLE 10 , sample 1) and **Table 10** (for APPLE 10 , Sample 2).

Table 9. Results of Drop voltage test between PV – Battery terminals (APPLE 10 SAMPLE 1)

V_{pv} Volts	I_{pv} Amps	V_{bat} Volts	Drop voltage Volt
12.02	1.0	12.00	0.02
12.08	5.0	12.00	0.08
12.19	10.0	12.00	0.19

Table 10. Results of Drop voltage test between PV – Battery terminals
(APPLE 10 SAMPLE 2)

V_{pv}	I_{pv}	V_{bat}	Drop voltage
Volts	Amps	Volts	Volt
12.03	1.0	12.00	0.03
12.07	5.0	12.00	0.07
12.17	10.0	12.00	0.17

6.5.2. Drop voltage between Battery – Load terminals test

Set up for the drop voltage drop test between Battery – Load terminals is as follows:
- Load current is set up at : 1.0 Amps; 5.0 Amps and 10.0 Amps
- System voltage = 12.00 Volts

The test results are given in **Table 11** (for APPLE 10 , sample 1) and **Table 12** (for APPLE 10 , Sample 2).

Table 11. Results from Drop voltage test between Battery – Load terminals
(APPLE 10 SAMPLE 1)

V_{load}	I_{Load}	V_{bat}	Drop voltage
Volts	Amps	Volts	Volt
11.98	1.0	12.00	0.02
11.91	5.0	12.00	0.09
11.80	10.0	12.00	0.20

Table 12. Results for Drop voltage test between Battery – Load terminals
(APPLE 10 SAMPLE 2)

V_{load}	I_{Load}	V_{bat}	Drop voltage
Volts	Amps	Volts	Volt
11.98	1.0	12.00	0.02
11.89	5.0	12.00	0.11
11.80	10.0	12.00	0.20

6.6. Endurance Test

The test set up for the Endurance Test is as follows:
- PV Simulator is set at : 10.0 Amps
- Load current is set up at : 10.0 Amps
- System Voltage = 12.5 Volt
- Duration of the test = 1 hour
- Temperature is observed on the FET of PV switching

The test results are given in **Table 13** (for APPLE 10 , sample 1) and **Table 14** (for APPLE 10 , Sample 2).

Table 13. Results from Endurance test (APPLE 10 SAMPLE 1)

Minute	V_{bat} (V)	V_{pv} (V)	V_{load} (V)	Temp. (^{0}C)
0	12.50	12.67	12.33	43.0
15	12.50	12.67	12.32	69.2
30	12.50	12.67	12.32	70.1
45	12.50	12.67	12.32	72.5
60	12.50	12.67	12.32	73.0

Note :   There is no damage on the controller after testing

Table 14. The results for Endurance test (APPLE 10 SAMPLE 2)

Minute	V_{bat} (V)	V_{pv} (V)	V_{load} (V)	Temp. (^{0}C)
0	12.50	12.66	12.32	47.3
15	12.50	12.66	12.31	70.4
30	12.50	12.67	12.31	71.2
45	12.50	12.67	12.31	73.0
60	12.50	12.67	12.30	74.0

Note :   There is no damage on the controller after testing

6.7. Electronic Protection Tests

6.7.1. Reverse polarity Test

Set up for Reverse polarity test is as follows:
- Load : Off / Disconnected
- System Voltage = 12.5 Volt
- Polarity of Battery is reversed, but polarity of PV is true
- Polarity of PV is reversed, but polarity of battery is true
- Polarity of battery and polarity of PV are reversed

The results are given in **Table 15** (for APPLE 10 , sample 1) and **Table 16** (for APPLE 10 , Sample 2).

Table 15. Results from Reverse polarity test (APPLE 10 SAMPLE 1)

Condition	V_{pv}	I_{pv}	V_{bat}	V_{load}	Display indicator & Note :
Battery polarity is reversed	+18 V	−	−12.50 V	−12.18 V	
PV polarity is reversed	−18 V	−	+12.50 V	+11.98	
PV and battery polarities are reversed	−18 V	−	−12.50 V	−12.27	
Note : There is no damage on the controller after testing					

Table 16. Results from Reverse polarity test (APPLE 10 SAMPLE 2)

Condition	V_{pv}	I_{pv}	V_{bat}	V_{load}	Display indicator & Note
Battery polarity is reversed	+18 V	−	−12.50 V	−12.18 V	
PV polarity is reversed	−18 V	−	+12.50 V	+11.98	
PV and battery polarities are reversed	−18 V	−	−12.50 V	−12.26	
Note : There is no damage on the controller after testing					

6.7.2 Overload Test:

Set up for the overload test is as follows:
- PV Simulator current = 10.0 Amps and PV simulator voltage = 18.0 volts
- Load current = 10 Amps and then increase until overload protection was occured
- System voltage = 12.5 volts

The results are given in **Table 17** (for APPLE 10 , sample 1) and **Table 18** (for APPLE 10 , Sample 2).

Table 17. Results from Overload test (APPLE 10 SAMPLE 1)

Overload occurs at I_{Load} (A)	V_{Load} (V)	T_{ON} (Second)	T_{OFF} (Second)
12.50	---	---	---
Note : 1.To connect the load someone has to push the switch S1 twice (before it, the load must be reduced to the normal current). 2. There is no damage on the controller after testing			

Table 18. Results from Overload test (APPLE 10 SAMPLE 2)

Overload occure at I_{Load} (A)	V_{Load} (V)	T_{ON} (Second)	T_{OFF} (Second)
12.30	---	---	---
Note : 1.To connect the load someone has to push the switch S1 twice (before it, the load must be reduced to the normal current). 2. There is no damage on the controller after testing			

6.7.3 Short Circuit Test:

Set up for the short circuit test is as follows:
- PV Simulator current = 5.0 Amps and PV simulator voltage = 18.0 volts
- Load current = 5 Amps
- System voltage = 12.5 volts

The results are given in **Table 19** (for APPLE 10 , sample 1) and **Table 20** (for APPLE 10 , Sample 2).

Table 19. Results from Short circuit test (APPLE 10 SAMPLE 1)

Action	Event on the controller
Load short circuited	Load is disconnected immediately
Notes:	1.To connect the load someone has to push the switch S1 twice (before it, the short circiuted must be removed). 2. There is no damage on the controller after testing

Table 20. Results from Short circuit test (APPLE 10 SAMPLE 2)

Action	Event on controller
Load short circuited	Load is disconnected immediately
Notes:	1.To connect the load someone has to push the switch S1 twice (before it, the short circuited must be removed).
	2. There is no damage on the controller after testing

6.8. Function test at the end of the test sequence.

Set up for the function test at the end of the test sequence has the same test set up for the function test at the beginning, those are as follows:

- PV Simulator current = 5.0 Amps and PV simulator voltage = 18.0 volts
- Load current = 5 Amps
- System voltage = 12.5 volts

The results are given in **Table 21** (for APPLE 10 , sample 1) and **Table 22** (for APPLE 10 , Sample 2).

Table 21 Result of function test at the end of the test sequence (APPLE 10 SAMPLE 1)

Description	Threshold voltage	Status
Boost charge voltage	14.37	OK
PWM Activated	13.70	OK
LVD	11.42	OK
PLVD	11.83	OK
Load Reconnect	13.07	OK
Buz	11.73	OK
Pbuz	12.17	OK

Table 22 Result from function test at the end of the test sequence (APPLE 10 SAMPLE 2)

Description	Threshold voltage	Status
Boost charge voltage	14.24	OK
PWM Activated	13.67	OK
LVD	11.43	OK
PLVD	11.77	OK
Load Reconnect	13.01	OK
Buz	11.66	OK
Pbuz	12,10	OK

7. Discussions:

1. Visual test gives the result with a good performance where all components on PCB using SMD(Surface Mounted Devices) and the port using the terminal that good for carrying 10 amperes of current

2. Boost charge voltage measured is 14.30 volt. Although this value is not recommended for Boost charge voltage, but still meet SNI requirement (Standard of SNI-04-6391-2000) as End of Charge.

3. There are two level LVD (Low Voltage Disconnection) and two level Buzzer (the alarm before the load disconnected). The first LVD and Buzzer voltage are 11.45 and 11.72 volt respectively. The second LVD and Buzzer named as Penalty LVD and Penalty Buzzer voltages are 11.75 and 12.80 respectively. The Load reconnect only has one point there is measured at 13.10 volt. These performances meet the SNI requirement (Standard of SNI-04-6391-2000).

4. The Controller type APPLE 10 has a good efficiency in energy supply to consumes the load, because this controller have very small drop voltage between PV and battery, also between battery and the load on carrying maximum input current and maximum output current.
The drop voltage between PV and battery measured is 0.19 volt, so the losses in this point are 1.60 % (or the drop voltage is less than 2% of the nominal voltage). The drop voltage between battery and load measured is 0.2 volt, the losses in this pont are 1.67 %(or the drop voltage is less than 2% of the nominal voltage). Therefore the efficiency of controller type APPLE 10 is about 97 %.
Of course these performances meet the SNI requirement (Standard of SNI-04-6391-2000).

5. Self-power consumption over the range of operating battery is less than 10 mA. This result also meets the SNI requirement (Standard of SNI-04-6391-2000).

6. Overload measured at 12,5 A (125 % of maximum load current) and immediately cut off the load by electronic protection. To connect the load someone has to push the switch S1 twice (before it, the load must be reduced to the normal current).
   Short circuit protection test is done by short circuited the controller at the load terminals and immediately cut off the load by electronic protection. To connect the load someone has to push the switch S1 twice (before it, the short circuit condition must be removed).
   So the controller Aplle-10 has the overload and short circuit protection that meet the SNI requirement (Standard of SNI-04-6391-2000).

7. Reverse polarity is done by reversed the polarity of PV and the polarity of battery is true; then reversed the polarity of battery and polarity of PV is true and the last, polarity of PV and Battery are reversed.
   At each test, there are no damage on the controller, that means the controller have the PV and battery reverse polarity protection and meet the SNI requirement (Standard of SNI-04-6391-2000).

8. The controller APPLE 10 has the indicator for load cut-off, charging condition, PV cut-off and level battery capacity. All of these meet the SNI requirement (Standard of SNI-04-6391-2000).

Date: August 10, 2004
Supervisor:

Ir. Zanggischan Udin
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