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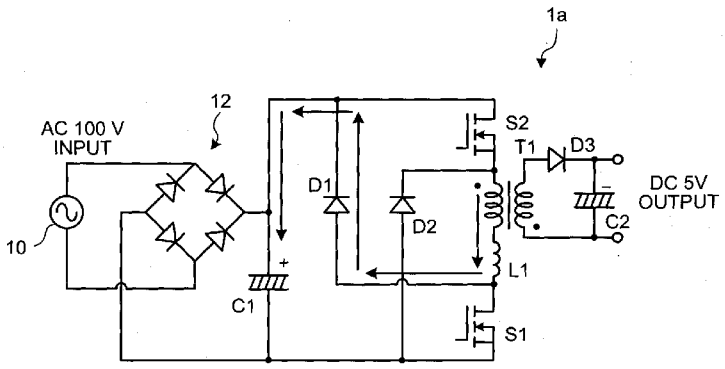
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(54) **Title**: POWER SUPPLY DEVICE, IMAGE FORMING DEVICE, AND ELECTRONIC APPLIANCE

FIG.7



(57) **Abstract**: This invention is concerning a power supply device(1a, 1b) that includes a cut-off unit(S1, S2) configured to cut off voltage to be applied to a primary winding of a transformer(T1) and a coil(L1) added in series with the primary winding of the transformer(T1), a first circuit(D1) configured to cause, in a case where the voltage to be applied is cut off by the cut-off unit(S1, S2), current to flow in such a way that energy accumulated in the transformer(T1) is led to a capacitor(C1), and a second circuit(D2) configured to clamp, in a case where the voltage to be applied is cut off by the cut-off unit(S1, S2), voltage of the primary winding and the coil(L1).

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DESCRIPTION

POWER SUPPLY DEVICE, IMAGE FORMING DEVICE, AND ELECTRONIC APPLIANCE

TECHNICAL FIELD

[0001] The present invention relates to a power supply device, an image forming device, and an electronic appliance.

BACKGROUND ART

[0002] With respect to a switching power supply used as a power supply of an electronic appliance, there is a demand for a reduction in the loss (heat generation) and an increase in the efficiency. Moreover, also with respect to an image forming device for which load variation is great and which stays in a wait state for a long time, an increase in the efficiency of the power supply device is being studied.

[0003] For example, Patent document 1 discloses a switching power supply device which includes a flyback circuit of a diode and a capacitor on a secondary side of a forward converter transformer, and which switches to a flyback method when a load current drops to or below a predetermined value, and extracts energy accumulated in the converter transformer as flyback output.

[0004] However, there is a problem that it is difficult to achieve both higher efficiency and miniaturization of the power supply device.

[Citation List]

[Patent Literature]

[0005] [PTL 1] Patent document 1: Japanese Patent Application Laid-open No. 2006-062568

DISCLOSURE OF INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0006] The present invention is made in consideration of the above, and its object is to provide a power supply device capable of achieving both higher efficiency and miniaturization, an image forming device, and an electronic appliance.

MEANS FOR SOLVING PROBLEM

[0007] To achieve the object, a power supply device according to the present invention comprises: a cut-off unit configured tor cut off voltage to be applied to a primary winding of a transformer and a coil added in series with the primary winding of the transformer; a first circuit configured to cause, in a case where the voltage to be applied is cut off by the cut-off unit, current to flow in such a way that energy accumulated in the transformer is led to a capacitor; and a second circuit configured to clamp, in a case where the voltage to be applied is cut off by the cut-off unit, voltage of the primary winding and the coil.

[0008] An image forming device according to the present invention comprises an image forming unit configured to form an image, a control unit configured to control the image forming unit, and the above-mentioned power supply device.

[0009] An electronic appliance according to the present invention comprises the above-mentioned power supply device.

EFFECT OF THE INVENTION

[0010] According to the present invention, an effect that both higher efficiency and miniaturization may be achieved is obtained.

BRIEF DESCRIPTION OF DRAWINGS

[0011] [Fig. 1] FIG. 1 is a diagram illustrating an example of calculation of a TEC value of an image forming

device;

[Fig. 2] FIG. 2 is a graph illustrating a TEC value of the rating and a TEC value in a power saving period;

[Fig. 3] FIG. 3 is a graph illustrating an example of a change in voltage in the case where an electronic switch of a flyback converter not including a snubber circuit is operated;

[Fig. 4] FIG. 4 is a graph illustrating in detail drain-source voltage c illustrated in FIG. 3;

[Fig. 5] FIG. 5 is a graph illustrating an example of a change in voltage in the case where an electronic switch of a flyback converter including a snubber circuit is operated;

[Fig. 6] FIG. 6 is a graph illustrating in detail drain-source voltage f illustrated in FIG. 5;

[Fig. 7] FIG. 7 is a diagram illustrating a structure example of a power supply device according to a first embodiment;

[Fig. 8] FIG. 8 is a graph illustrating an example of a change in voltage in the case where a first electronic switch and a second electronic switch of the power supply device are operated;

[Fig. 9] FIG. 9 is a graph illustrating in detail drain-source voltage i illustrated in FIG. 8;

[Fig. 10] FIG. 10 is a graph illustrating a switching mechanism of the power supply device;

[Fig. 11] FIG. 11 is a diagram illustrating a structure example of a power supply device according to a second embodiment;

[Fig. 12] FIG. 12 is a diagram illustrating a comparative example of a power supply device, of a flyback method, including a snubber circuit;

[Fig. 13] FIG. 13 is a graph illustrating a first example

of efficiency improved by the power supply device according to the second embodiment (output current: 0 A to 12 A);

[Fig. 14] FIG. 14 is a graph illustrating a second example of efficiency improved by the power supply device according to the second embodiment (output current: 0 A to 0.2 A); and

[Fig. 15] FIG. 15 is a block diagram exemplarily illustrating a structure of an image forming device.

BEST MODES FOR CARRYING OUT THE INVENTION

[0012] Background

First, a background leading to the present invention will be described. Currently, power consumption of an electronic appliance is being visualized by a typical electricity consumption (TEC) value. The TEC value is a value indicating the amount of power consumption (kWh) per week in a model case. Moreover, the TEC value is a criterion value for complying with "International Energy Star Program" of the Energy Conservation Center, Japan".

[0013] FIG. 1 is a diagram illustrating an example of calculation of a TEC value of an image forming device. With respect to an image forming device such as a printer or a multifunction peripheral, a mode of use in an average office where one weekday is divided into 8 hours of operation time (job time) and 16 hours of sleeping is assumed, for example.

[0014] In the job time, the image forming device performs two jobs (JOB 1), first thing in the morning and after the lunch break, for example. Here, the image forming device performs an operation of consuming power in recovery and a job, and falling into sleep after a ready state. Additionally, the image forming device is at the rated power during a job, is in standby power during ready, and saves power in sleep.

[0015] Then, the image forming device performs JOB 2, 3 and 4 at 15-minute intervals, repeats the same ten times, and performs 30 jobs in total. In the three measurements of power for JOB 2, 3 and 4, an average value of power consumption is calculated. Also, in a printing operation, power consumption is specified by a function regarding a specified number of sheets indicated by ppm (paper per minute).

[0016] Then, the TEC value is calculated by a sum of power for five times the weekday (five weekdays) and power for sleep in Saturday and Sunday (24h × 2).

[0017] As described above, the power usage of the image forming device spans over a wide range from a light load to a heavy load. Also, the period of sleep (light load of about 50 mA to 200 mA) of the image forming device is extremely long. That is, to improve the TEC value, a wide load range of 100 times or more, from a job (about 12 A to 20 A) to sleep (about 50 mA to 200 mA), has to be highly efficiently maintained.

[0018] FIG. 2 is a graph illustrating a TEC value of the rating and a TEC value in a power saving period. As illustrated in FIG. 2, the weekly amount of power consumption in a power saving period is greater than the weekly amount of power consumption of the rating. That is, to improve the TEC value, the efficiency especially in the sleep period, which is long, has to be increased. Also, the standard amount of CO_2 emissions is calculated from the TEC value based on the basic unit of the Ministry of the Environment "0.555kg-CO_2/1kWh". That is, the TEC value is directly related to environmental issues.

[0019] Next, an operation example of a flyback converter will be described. The flyback converter is simple, with a small number of components, and has an advantage that the

input voltage range is wide. FIG. 3 is a graph illustrating an example of a change in voltage in the case where an electronic switch (FET) of a flyback converter (see FIG. 12) not including a snubber circuit is operated. As illustrated in FIG. 3, when the electronic switch (FET) is turned off (gate voltage a is switched from High to Low), high voltage of 572 V is generated as drain-source voltage c.

[0020] FIG. 4 is a graph illustrating in detail the drain-source voltage c illustrated in FIG. 3. As illustrated in FIG. 4, Vds (drain-source voltage c) is 572 V, and includes powerful surges and spikes.

[0021] FIG. 5 is a graph illustrating an example of a change in voltage in the case where an electronic switch (FET) of a flyback converter including a snubber circuit is operated. As illustrated in FIG. 5, if a provided snubber circuit suppresses the surges, drain-source voltage f is suppressed to 310 V. That is, damage to the electronic switch itself or peripheral electronic components is prevented, and the electromagnetic noises are minimized. However, in this case, the surge energy is merely dissipated as heat, and the efficiency is not improved.

[0022] FIG. 6 is a graph illustrating in detail the drain-source voltage f illustrated in FIG. 5. As illustrated in FIG. 6, Vds (drain-source voltage f) is 310 V. Here, the surges are clamped and removed, but the spikes remain. Also, the surge energy is dissipated as heat, but the efficiency is not improved.

[0023] First Embodiment

Next, a first embodiment of the power supply device will be described in detail. FIG. 7 is a diagram illustrating a structure example of a power supply device 1a according to the first embodiment. As illustrated in

FIG. 7, the power supply device 1a is a flyback power supply device including a bridge rectifier (diode) 12 to which an AC power supply 10 of input of 100 V, for example, is connected, and a power converter transformer (flyback transformer) T1.

[0024] An electrolytic capacitor C1, a first diode D1, a second diode D2, a first electronic switch S1, a second electronic switch S2, and a coil L1 are provided on the primary side of the power converter transformer T1. Also, a third diode D3 and an electrolytic capacitor C2 are provided on the secondary side of the power converter transformer T1.

[0025] The coil L1 is a coil for generating energy, added in series with a primary winding of the power converter transformer T1. Additionally, the inductor of the coil L1 is set to a value that would not be affected by leakage inductance. The electrolytic capacitor C1 is provided to recover (accumulate) surge energy.

[0026] The first electronic switch S1 is provided at one end of the primary winding of the power converter transformer T1. The second electronic switch S2 is provided at one end of the coil L1. Furthermore, the first electronic switch S1 and the second electronic switch S2 form a cut-off unit for cutting off voltage to be applied to the primary winding and the coil L1 of the power converter transformer T1. Also, at least one of the first electronic switch S1 and the second electronic switch S2 also includes a function for turning on the switch so as to accumulate energy.

[0027] In the case where the voltage to be applied to the primary winding and the coil L1 of the power converter transformer T1 is cut off by the first electronic switch S1 and the second electronic switch S2, the first diode D1

causes current to flow in such a way that energy accumulated in the power converter transformer T1 is led to the electrolytic capacitor C1.

[0028] In the case where the voltage to be applied to the primary winding and the coil L1 of the power converter transformer T1 is cut off by the first electronic switch S1 and the second electronic switch S2, the second diode D2 clamps the voltage of the primary winding and the coil L1 of the power converter transformer T1.

[0029] The third diode D3 and the electrolytic capacitor C2 are provided on the secondary side of the power converter transformer T1. The third diode D3 is a Schottky barrier diode, for example. The output voltage on the secondary side of the power converter transformer T1 is DC 5 V.

[0030] As described above, the power supply device 1a has a single-stage structure (one converter type). Also, the power supply device 1a is capable of highly efficiently supplying power for a wide voltage range from a power-saving mode to a rated mode. Moreover, the power supply device 1a can be miniaturized to about 1/5 the capacity of a double-stage structure (two converter type), for example.

[0031] Next, an operation of the power supply device 1a will be described. FIG. 8 is a graph illustrating an example of a change in voltage in the case where the first electronic switch S1 and the second electronic switch S2 of the power supply device 1a are operated.

[0032] As illustrated in FIG. 8, drain-source voltage i of the power supply device 1a is about 1/4 (158 V) of the drain-source voltage c (572 V) of the flyback converter, illustrated in FIG. 4, not including a snubber circuit. Also, the drain-source voltage i of the power supply device 1a is about 1/2 (158 V) of the drain-source voltage f (310

V) of the flyback converter, illustrated in FIG. 6, including a snubber circuit.

[0033] Additionally, a recovered current j that flows through the first diode D1 is current to be recovered by the electrolytic capacitor C1.

[0034] FIG. 9 is a graph illustrating in detail the drain-source voltage i illustrated in FIG. 8. As illustrated in FIG. 9, the spikes are clamped by the first diode D1 and the second diode D2, and the Vds (drain-source voltage i) is about 158 V and is approximately the same as input voltage Vin. Accordingly, it is assumed that the power supply device 1a reduces the stress on the peripheral devices, and that the surge and spike energy is recovered.

[0035] FIG. 10 is a graph illustrating a switching mechanism of the power supply device 1a. In stage 1, the power supply device 1a turns on the first electronic switch S1 and the second electronic switch S2 at the same time, causes current to flow to the primary side of the power converter transformer T1, and causes the power converter transformer T1 to accumulate energy. At this time, an output current does not flow because the third diode D3 is provided in a direction opposite the flow of the current on the secondary side of the power converter transformer T1.

[0036] In stage 2, the power supply device 1a turns off the first electronic switch S1 and the second electronic switch S2 at the same time. At this time, since a current of the power converter transformer T1 is abruptly cut off, the self-inductance voltage of the power converter transformer T1 is drastically raised. However, since current flows through the first diode D1 and the second diode D2, current (energy) is recovered by the electrolytic capacitor C1. The output current of the power supply device 1a flows at this time.

[0037] In stage 3, the power supply device 1a keeps dissipating the energy accumulated in the inductance on the primary side of the power converter transformer T1. The output current of the power supply device 1a flows at this time.

[0038] In stage 4, the output voltage flows although the power supply device 1a is in an idle period. Here, the power supply device 1a may realize stable efficiency properties despite the variation in the leakage inductance.

[0039] Second Embodiment

Next, a second embodiment of the power supply device will be described in detail. FIG. 11 is a diagram illustrating a structure example of a power supply device 1b according to the second embodiment. As illustrated in FIG. 11, the power supply device 1b includes a synchronous rectifier circuit D, a fourth diode D4, and a control circuit (synchronous rectifier controller) 14 on the secondary side of the power converter transformer T1. Additionally, with respect to the power supply device 1b illustrated in FIG. 11, portions substantially the same as those of the power supply device 1a illustrated in FIG. 7 are denoted with the same reference signs.

[0040] The synchronous rectifier circuit D is structured by a power MOSFET, for example, and causes the output current of the power converter transformer T1 to flow, in synchronization with the first electronic switch S1 and the second electronic switch S2 cutting off the voltage. The power MOSFET acts as if there is a diode (parasitic diode) inside. The fourth diode D4 is a Schottky barrier diode that is provided in parallel with the parasitic diode of the synchronous rectifier circuit D. The control circuit 14 performs control to cut off the synchronous rectifier circuit D according to the size of a load connected to the

power converter transformer T1.

[0041] With the power supply device 1b, the operating current of the synchronous rectifier circuit D negatively affects the efficiency when the load current is 50 mA (power-saving mode), for example. Accordingly, when a power-saving mode signal indicating that a power-saving mode is specified is received, the control circuit 14 performs control to cut off the synchronous rectifier circuit D. In the case where the synchronous rectifier circuit D is cut off, the fourth diode D4 performs rectification.

[0042] The fourth diode D4 is significantly superior to the parasitic diode of the synchronous rectifier circuit D in the forward voltage drop characteristic. Accordingly, the power supply device 1b has improved efficiency in both cases of the rated (heavy-load) driving and the power-saving (light-load) driving. For example, the voltage drop in the forward direction of the fourth diode D4 is preferably 0.6 V or less. Also, a plurality of fourth diodes D4 may be provided.

[0043] Next, the efficiency to be improved by the power supply device 1b will be described. FIG. 12 is a diagram illustrating a comparative example of a power supply device 2, of a flyback method, including a snubber circuit. FIG. 13 is a graph illustrating a first example of efficiency improved by the power supply device 1b according to the second embodiment (output current: 0 A to 12 A). FIG. 14 is a graph illustrating a second example of efficiency improved by the power supply device 1b according to the second embodiment (output current: 0 A to 0.2 A). As illustrated in FIGS. 13 and 14, the efficiency of the power supply device 1b is improved compared to the power supply device 2 (comparative example) with respect to both of the

range of the output current 0 A to 12 A and the range of the output current 0 A to 0.2 A.

[0044] Example

Next, an image forming device 3 provided with the power supply device 1b will be described. FIG. 15 is a block diagram exemplarily illustrating a structure of the image forming device 3. The image forming device 3 is a multifunction peripheral, for example, and includes a scanner 30, an image processing unit 32, a printer (image forming unit) 34, a drive unit 36, a control unit 38, and a power supply device 4.

[0045] The scanner 30 reads an image of an original document. The image processing unit 32 performs a predetermined process on the image read by the scanner 30, for example, and outputs the same to the printer 34. The printer 34 prints the image received from the image processing unit 32. The drive unit 36 operates at 24 V, for example, and drives movable portions such as the scanner 30 and the printer 34. The control unit 38 controls each unit structuring the image forming device 3.

[0046] The power supply device 4 includes a first power supply unit 40 and a second power supply unit 42, for example. The first power supply unit 40 is the power supply device 1b (or the power supply device 1a) described above, and converts AC power of 100 V to DC power of 5 V, and applies the voltage of 5 V to the control unit 38 or the like in the image forming device 3 which operates at voltage of 5 V. The second power supply unit 42 applies voltage of 24 V on the drive unit 36. Also, in the case where the power-saving mode described with reference to FIG. 11 is specified, the power supply device 4 has the second power supply unit 42 turned off, and only the drive current of about 50 mA at 5 V (DC) output from the first power

supply unit 40 is obtained.

[0047] As described above, with respect to the image forming device 3, the first power supply unit 40 is the power supply device 1b (or the power supply device 1a), and thus, both the higher efficiency and the miniaturization for the power supply device 4 are achieved. Also, the power supply device 1a and the power supply device 1b may be used in an electronic appliance and the like which require power supply of a wide output range from heavy load to light load, such as rated driving, standby driving, and sleep driving, without being restricted to the image forming device 3.

Although the invention has been described with respect to specific embodiments for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

EXPLANATION OF LETTERS OR NUMERALS

[0048]

1a, 1b	Power supply device
12	Bridge rectifier (Diode)
14	Control circuit
C1	Electrolytic capacitor
C2	Electrolytic capacitor
D1	First diode
D2	Second diode
D3	Third diode
D4	Fourth diode
D	Synchronous rectifier circuit
S1	First electronic switch
S2	Second electronic switch
L1	Coil

T1	Power converter transformer
3	Image forming device
30	Scanner
32	Image processing unit
34	Printer (Image forming unit)
36	Drive unit
38	Control unit
4	Power supply device
40	First power supply unit
42	Second power supply unit

CLAIMS

1. A power supply device comprising:

a cut-off unit configured tor cut off voltage to be applied to a primary winding of a transformer and a coil added in series with the primary winding of the transformer;

a first circuit configured to cause, in a case where the voltage to be applied is cut off by the cut-off unit, current to flow in such a way that energy accumulated in the transformer is led to a capacitor; and

a second circuit configured to clamp, in a case where the voltage to be applied is cut off by the cut-off unit, voltage of the primary winding and the coil.

2. The power supply device according to claim 1, wherein the cut-off unit includes two electronic switches provided at one end of the primary winding and one end of the coil.

3. The power supply device according to claim 2, wherein at least one of the two electronic switches includes a function for turning on the switch so as to accumulate energy.

4. The power supply device according to any one of claims 1 to 3, further comprising:

a synchronous rectifier circuit configured to cause an output current of the transformer to flow, in synchronization with the cut-off unit cutting off voltage; and

a Schottky barrier diode that is provided in parallel with a parasitic diode of the synchronous rectifier circuit.

5. The power supply device according to any one of claims

1 to 4, further comprising:

a control circuit configured to perform control to cut off the synchronous rectifier circuit according to a size of a load connected to the transformer.

6. An image forming device comprising:

an image forming unit configured to form an image;

a control unit configured to control the image forming unit; and

the power supply device according to any one of claims 1 to 5.

7. An electronic appliance comprising:

the power supply device according to any one of claims 1 to 5.

FIG.1

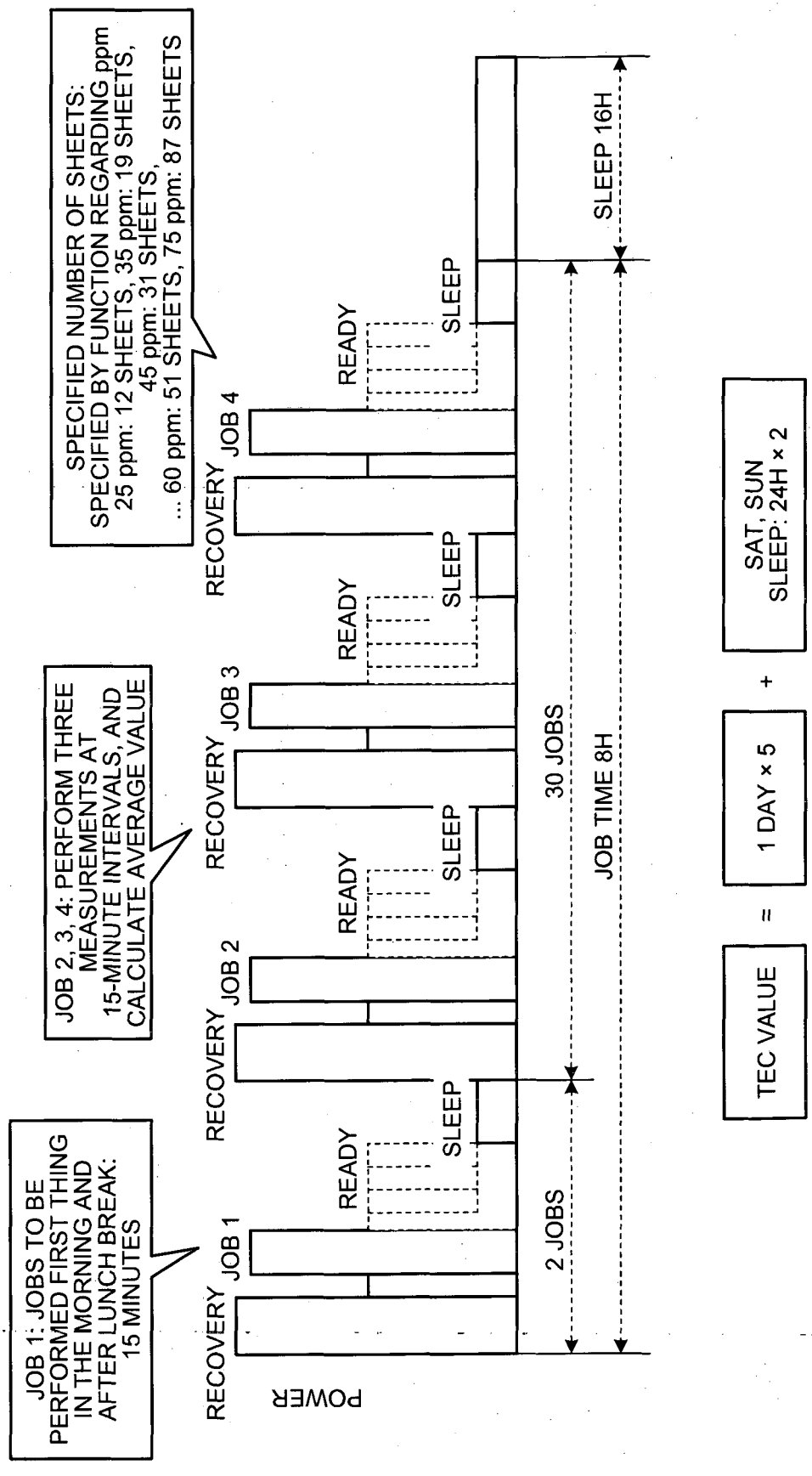

JOB 1: JOBS TO BE PERFORMED FIRST THING IN THE MORNING AND AFTER LUNCH BREAK: 15 MINUTES
JOB 2, 3, 4: PERFORM THREE MEASUREMENTS AT 15-MINUTE INTERVALS, AND CALCULATE AVERAGE VALUE
SPECIFIED NUMBER OF SHEETS:
SPECIFIED BY FUNCTION REGARDING ppm
25 ppm: 12 SHEETS, 35 ppm: 19 SHEETS,
45 ppm: 31 SHEETS,
... 60 ppm: 51 SHEETS, 75 ppm: 87 SHEETS
POWER
RECOVERY
JOB 1
READY
SLEEP
RECOVERY
JOB 2
READY
SLEEP
RECOVERY
JOB 3
READY
SLEEP
RECOVERY
JOB 4
READY
SLEEP
SLEEP 16H
2 JOBS
30 JOBS
JOB TIME 8H
TEC VALUE
=
1 DAY × 5
+
SAT, SUN
SLEEP: 24H × 2
UNIT (kWh)

FIG.2

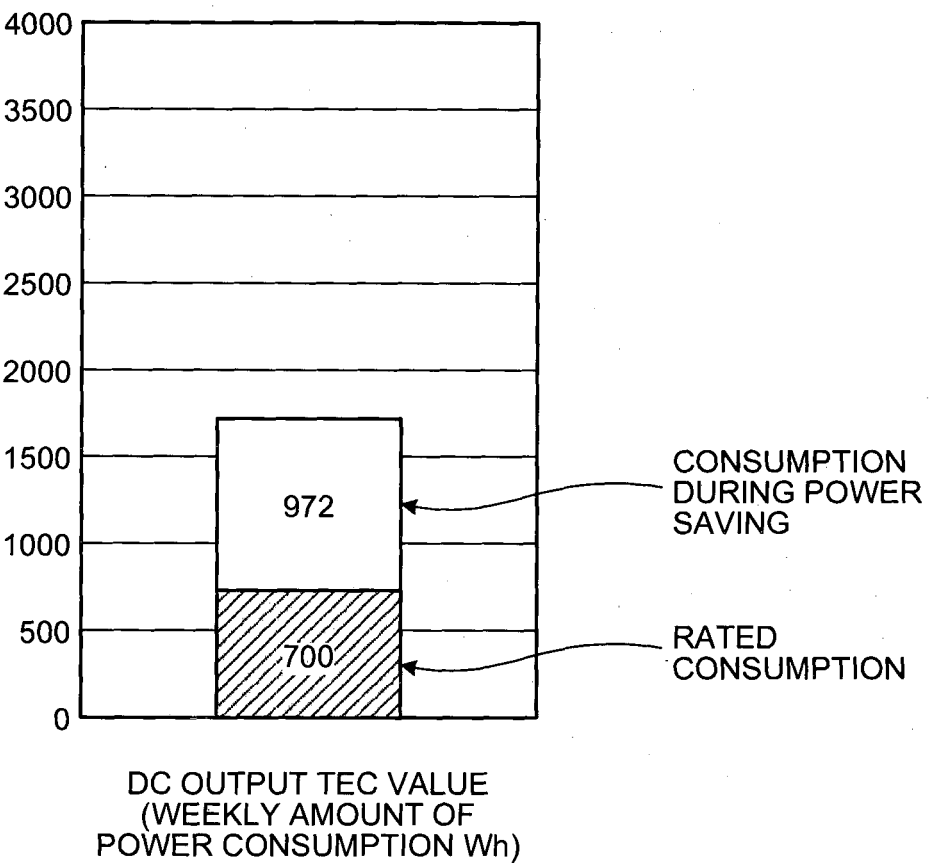

4000
3500
3000
2500
2000
1500
1000
500
0
972
700
CONSUMPTION DURING POWER SAVING
RATED CONSUMPTION
DC OUTPUT TEC VALUE (WEEKLY AMOUNT OF POWER CONSUMPTION Wh)

FIG.3

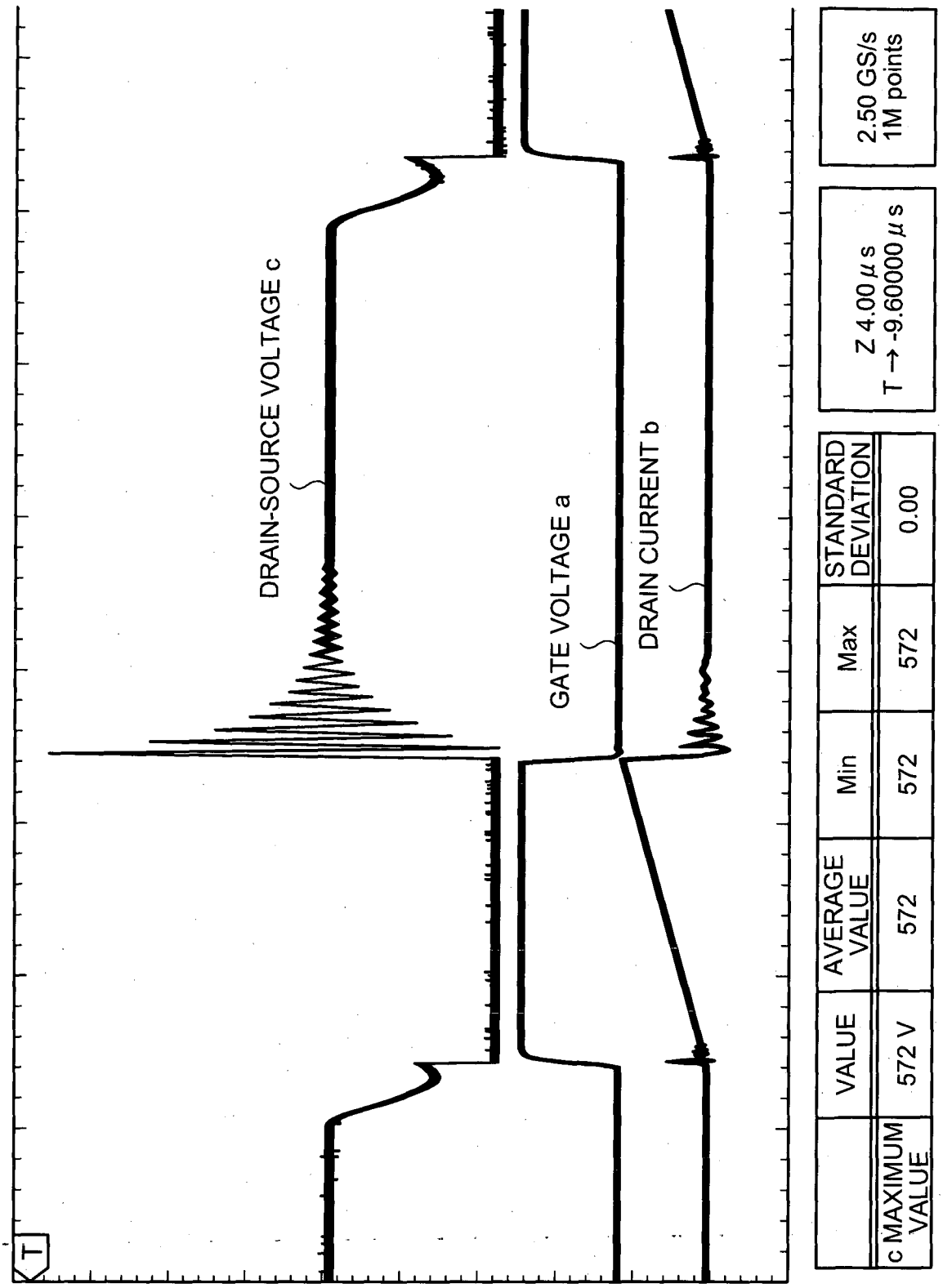

DRAIN-SOURCE VOLTAGE c
GATE VOLTAGE a
DRAIN CURRENT b
T
Z 4.00 μs
T → -9.60000 μs
2.50 GS/s
1M points
c MAXIMUM VALUE
VALUE
572 V
AVERAGE VALUE
572
Min
572
Max
572
STANDARD DEVIATION
0.00

FIG.4

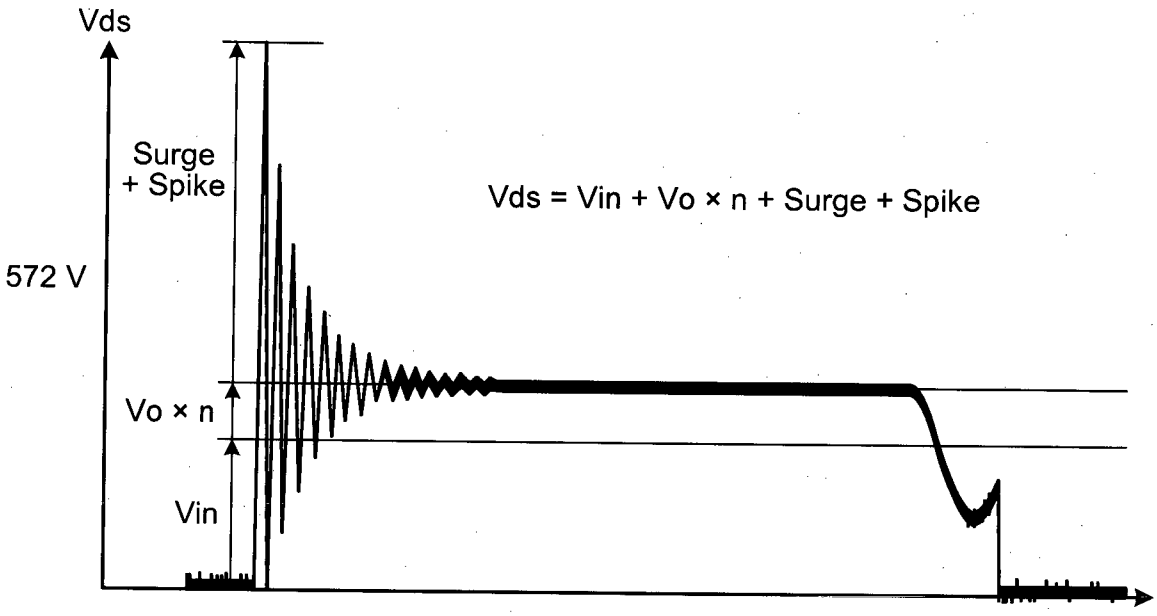
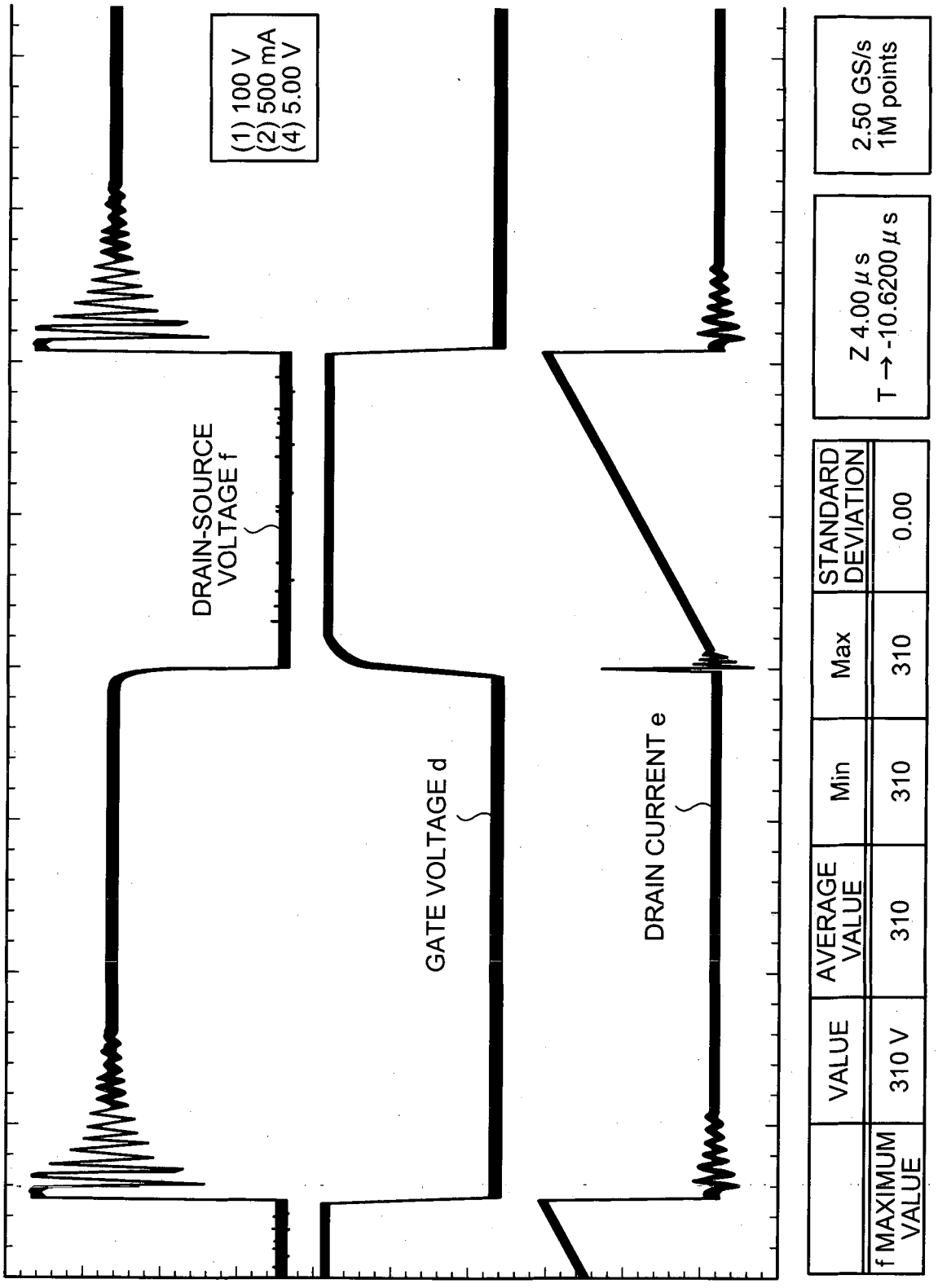


FIG.5



	VALUE	AVERAGE VALUE	Min	Max	STANDARD DEVIATION
f MAXIMUM VALUE	310 V	310	310	310	0.00

FIG.6

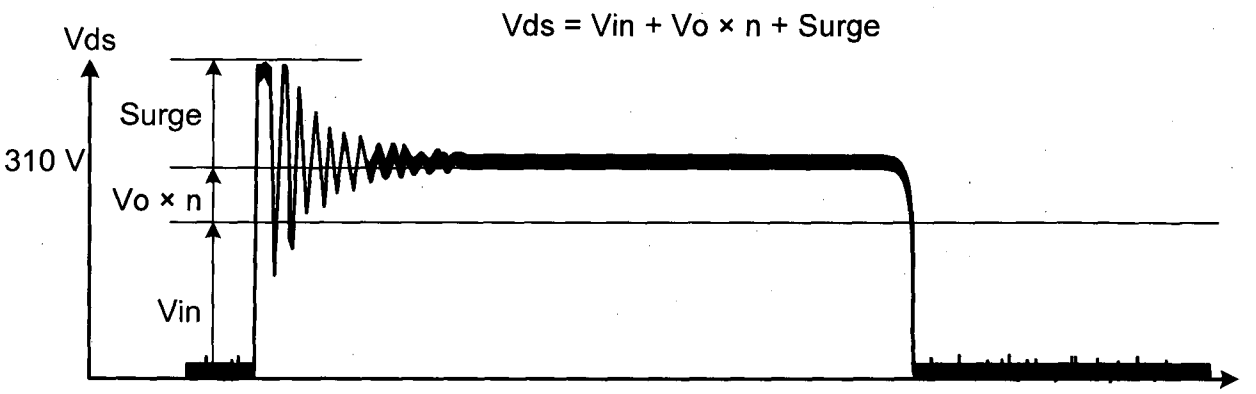

Vds = Vin + Vo × n + Surge
Vds
Surge
310 V
Vo × n
Vin

FIG.7

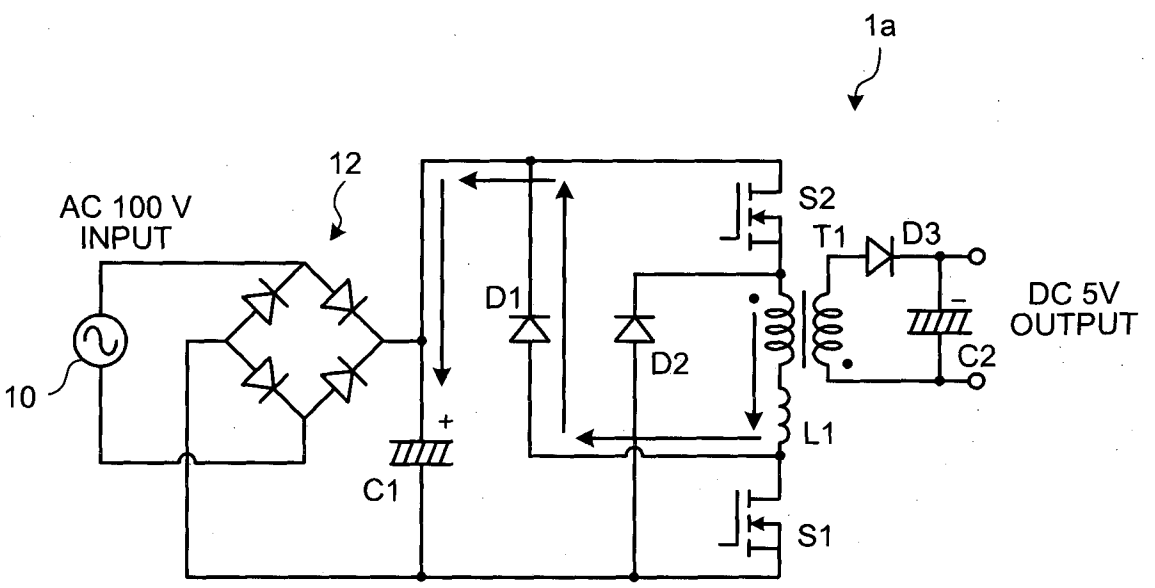
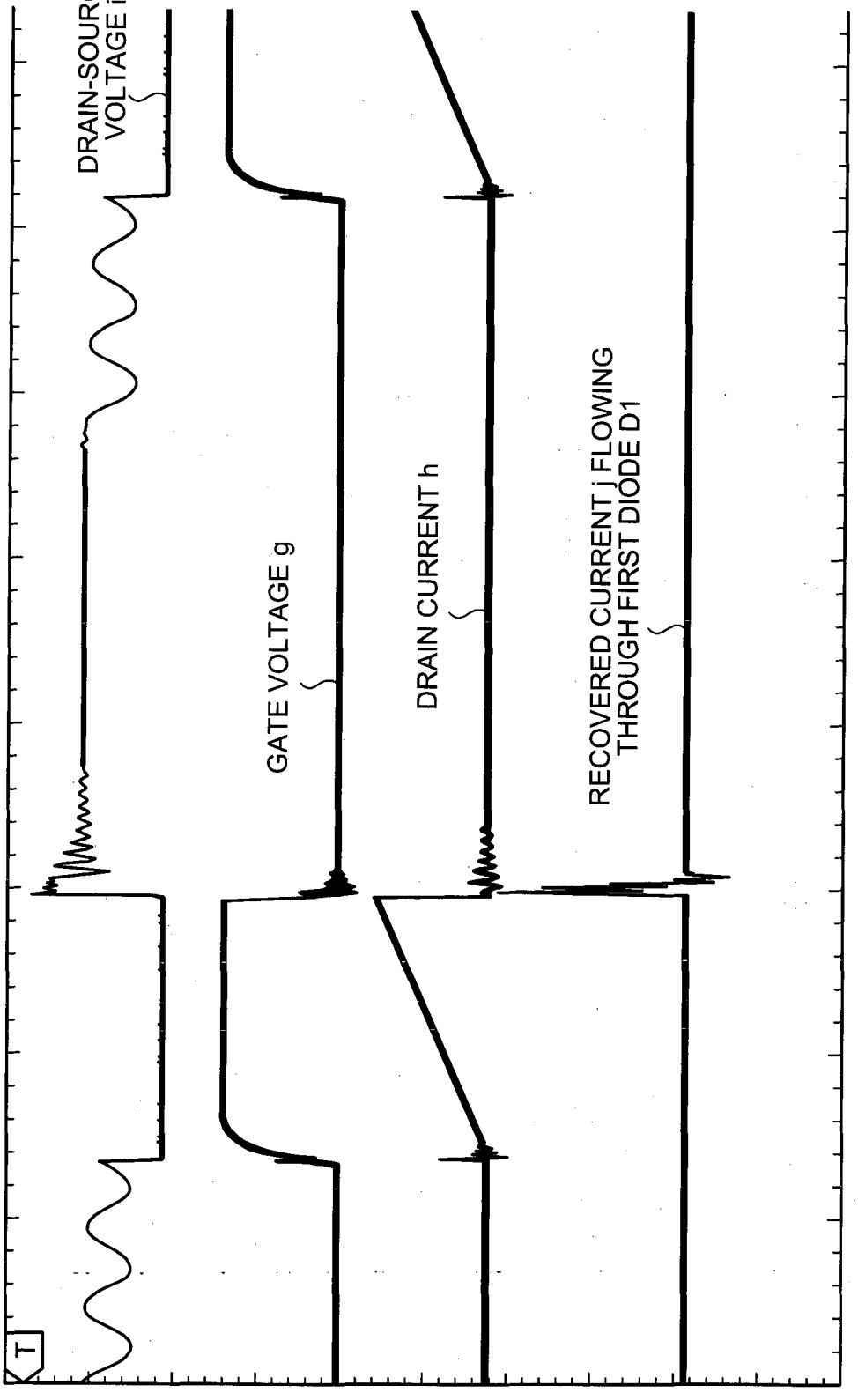

1a
12
AC 100 V
INPUT
10
D1
D2
C1
+
S2
T1
D3
DC 5V
OUTPUT
C2
L1
S1

FIG.8



	VALUE	AVERAGE VALUE	Min	Max	STANDARD DEVIATION
i MAXIMUM VALUE	158 V	POSITIVE CLIPPING			

FIG.9

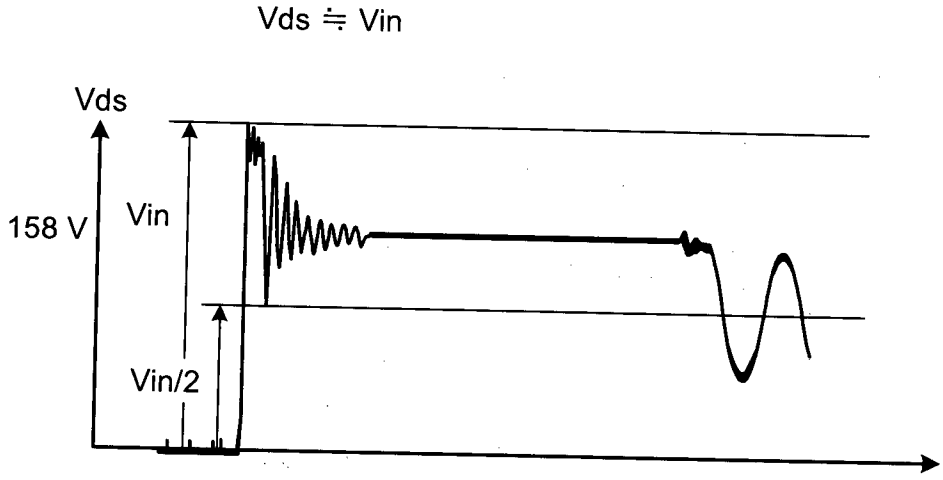


FIG.10

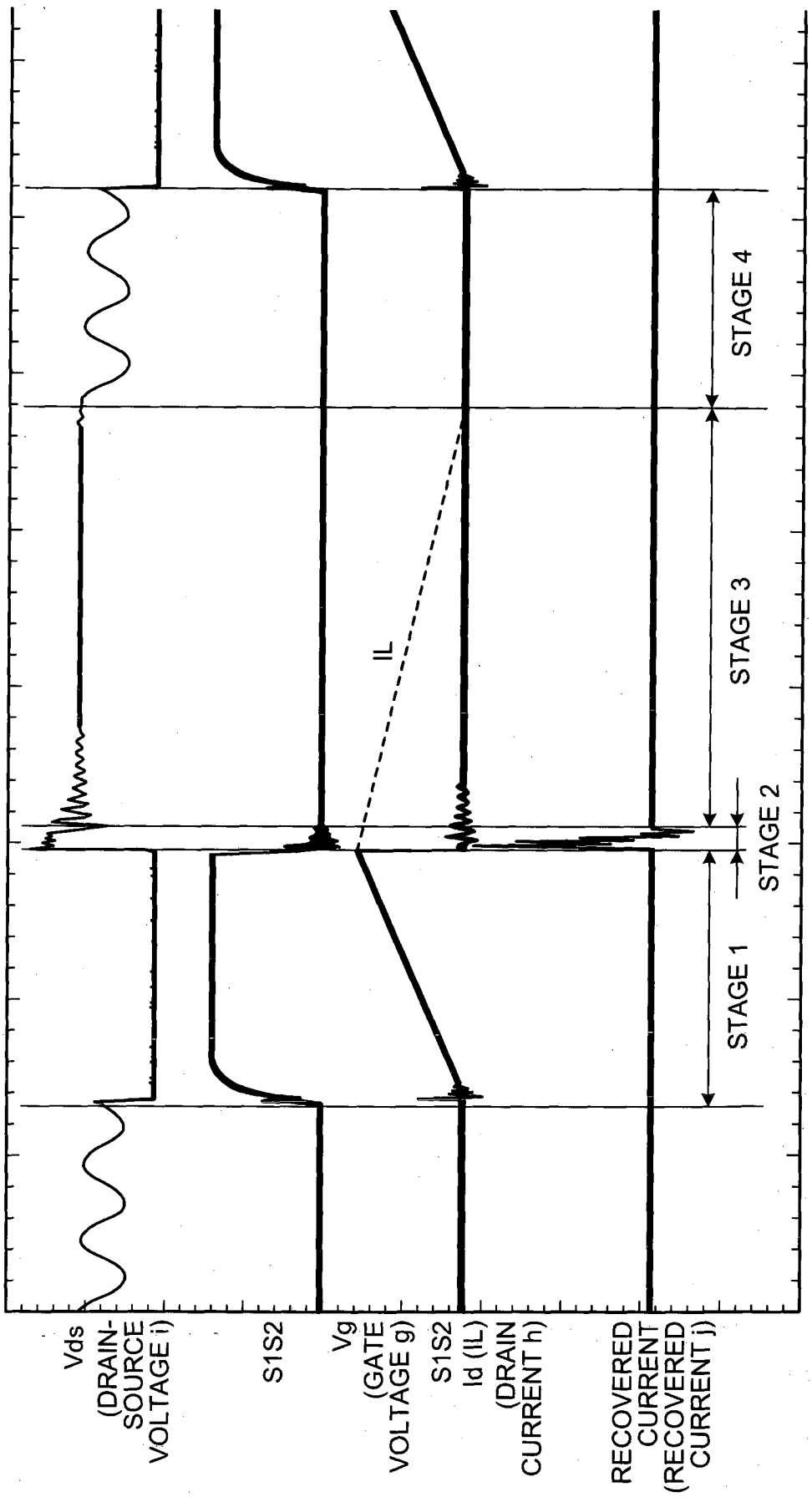

Vds
(DRAIN-SOURCE VOLTAGE i)
S1S2
Vg
(GATE VOLTAGE g)
S1S2
Id (IL)
(DRAIN CURRENT h)
RECOVERED CURRENT
(RECOVERED CURRENT j)
IL
STAGE 1
STAGE 2
STAGE 3
STAGE 4

FIG.11

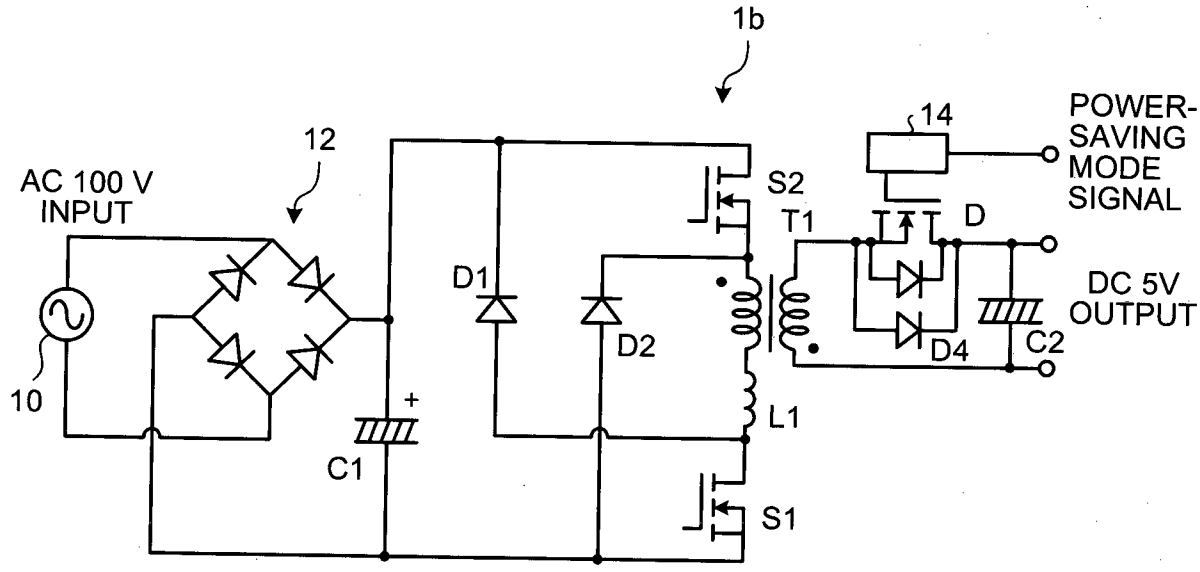

1b
12
14
POWER-
SAVING
MODE
SIGNAL
AC 100 V
INPUT
S2
T1
D
D1
D2
DC 5V
OUTPUT
D4
C2
10
+
L1
C1
S1

FIG.12

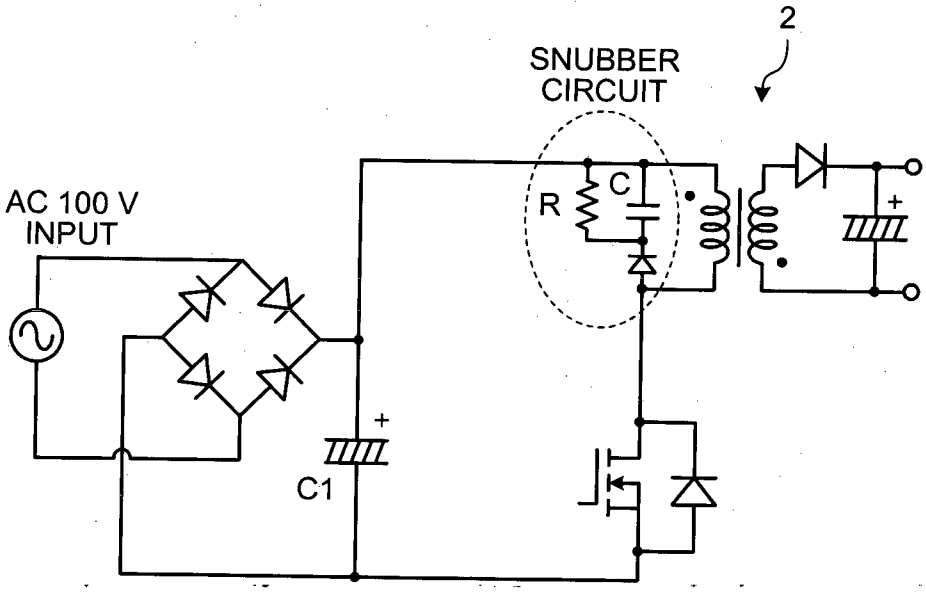

2
SNUBBER
CIRCUIT
AC 100 V
INPUT
R
C
+
+
C1

FIG.13

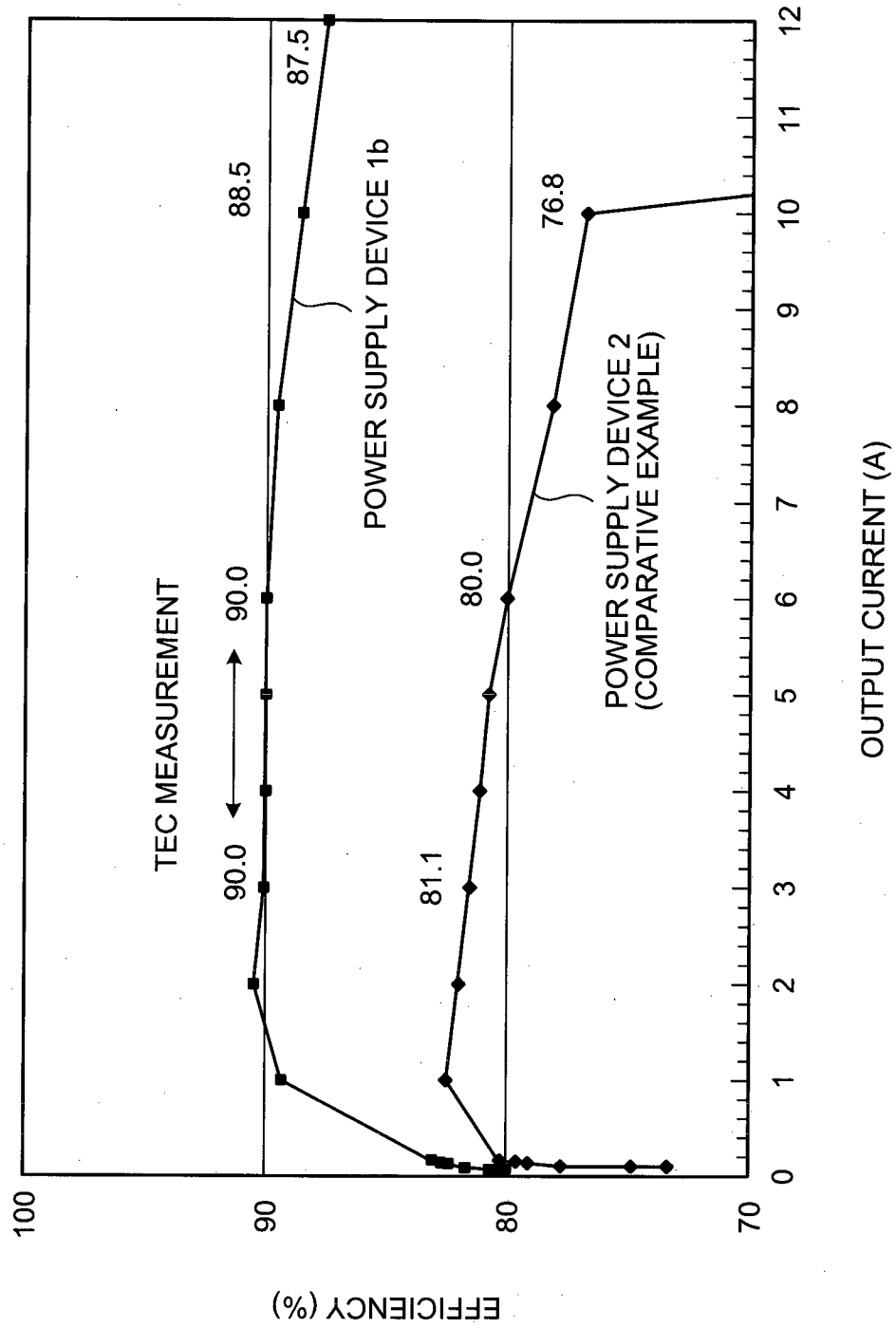

EFFICIENCY (%)
100
90
80
70
0
1
2
3
4
5
6
7
8
9
10
11
12
OUTPUT CURRENT (A)
TEC MEASUREMENT
90.0
90.0
88.5
87.5
POWER SUPPLY DEVICE 1b
81.1
80.0
76.8
POWER SUPPLY DEVICE 2
(COMPARATIVE EXAMPLE)

FIG.14

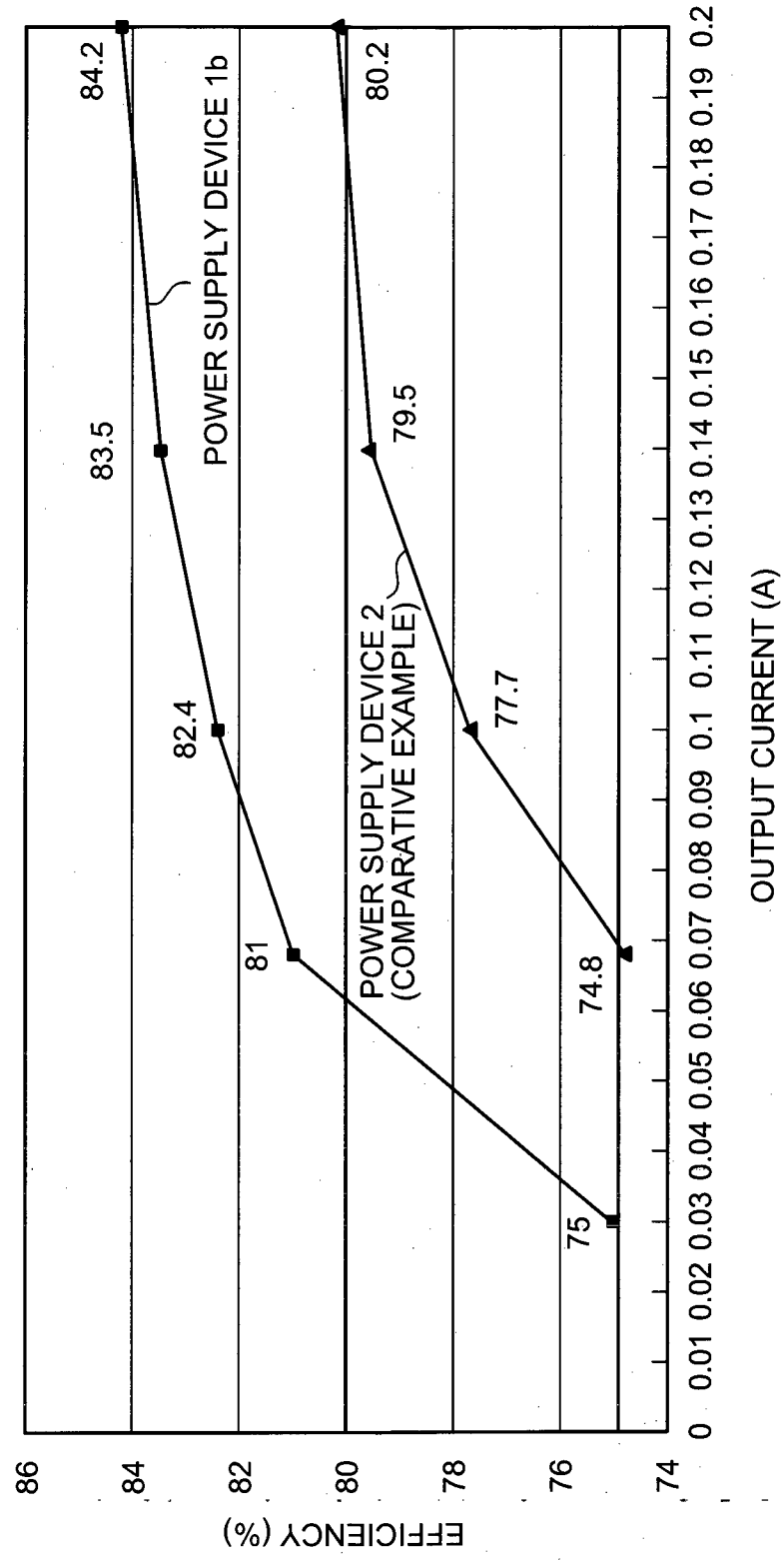
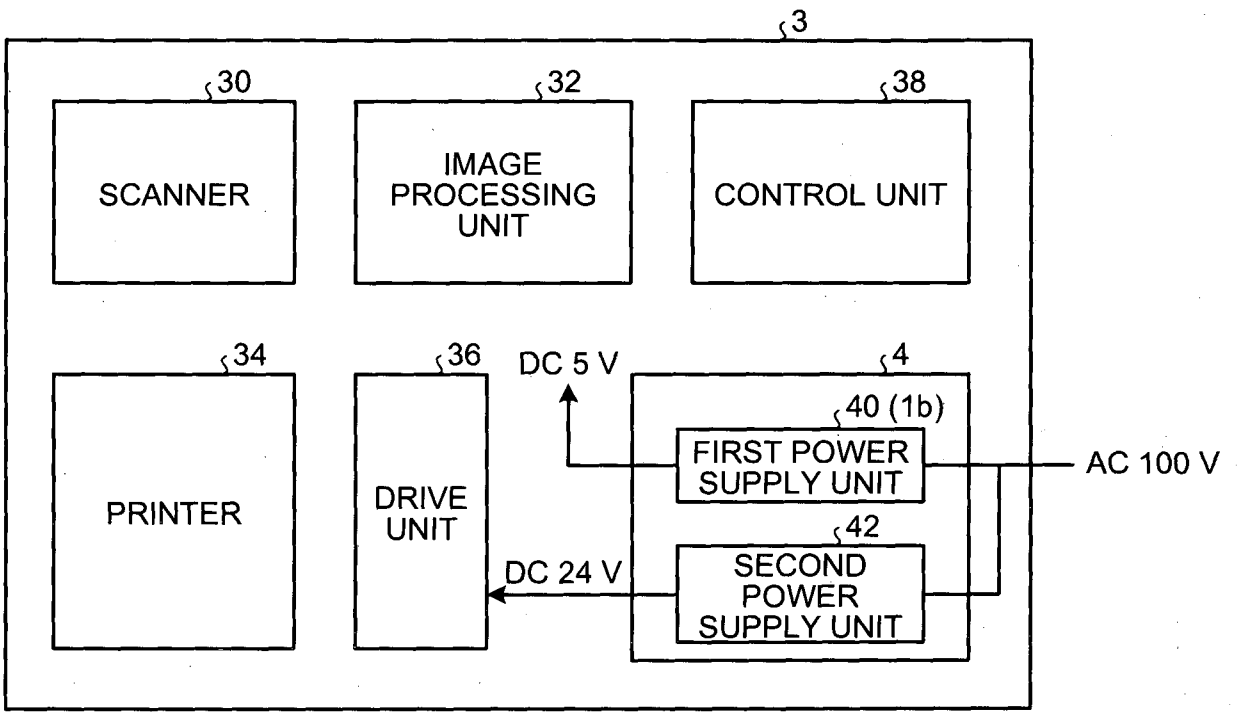

EFFICIENCY (%)
86
84
82
80
78
76
74
0 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18 0.19 0.2
OUTPUT CURRENT (A)
POWER SUPPLY DEVICE 1b
84.2
83.5
82.4
81
75
POWER SUPPLY DEVICE 2
(COMPARATIVE EXAMPLE)
80.2
79.5
77.7
74.8

FIG.15


3
30
SCANNER
32
IMAGE PROCESSING UNIT
38
CONTROL UNIT
34
PRINTER
36
DRIVE UNIT
DC 5 V
4
40 (1b)
FIRST POWER SUPPLY UNIT
AC 100 V
42
SECOND POWER SUPPLY UNIT
DC 24 V

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/062209

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H02M3/28(2006.01)i, G03G21/00(2006.01)i, H02M7/21(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H02M3/28, G03G21/00, H02M7/21

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2014
Registered utility model specifications of Japan 1996-2014
Published registered utility model applications of Japan 1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2008-535470 A (SIEMENS AG OESTERREICH) 2008.08.28, paragraph[0029], Fig.2 & US 2009/0175054 A1 & EP 1867035 A1 & WO 2006/106040 A1 & KR 10-2007-0121827 A & CN 101156305 A & RU 2007141478 A	1-7
Y	DE 4008652 A1 (LICENTIA PATENT-VERWALTUNGS-GMBH) 1991.09.19, column 4 lines 12-16, Fig.2 (No Family)	1-7
Y	JP 60-91863 A (HITACHI, LTD.) 1985.05.23, page 3 upper right column lines 12-20, Fig.4 (No Family)	1-7

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25.06.2014	08.07.2014

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/062209

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 11-178335 A (NAGANO JAPAN RADIO CO., LTD.) 1999.07.02, paragraphs[0013],[0018]-[0019], Fig.3 (No Family)	4-7
Y	JP 2012-120399 A (TAMURA CORPORATION) 2012.06.21, paragraph[0028], Fig.1 (No Family)	4-7
Y	JP 2001-112245 A (NIPPON TELEGRAPH AND TELEPHONE CORPORATION) 2001.04.20, paragraphs[0018],[0037],[0042], Fig.5 (No Family)	5-7
A	US 2011/0317454 A1 (SYSTEM GENERAL CORP.) 2011.12.29, paragraphs[0003]-[0005], Fig.1 & CN 102223072 A & TW 201203827 A	1-7