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EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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Declarations under Rule 4.17:

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- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

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(54) Title: HIGH VOLTAGE ESD PROTECTION FEATURING PNP BIPOLAR JUNCTION TRANSISTOR

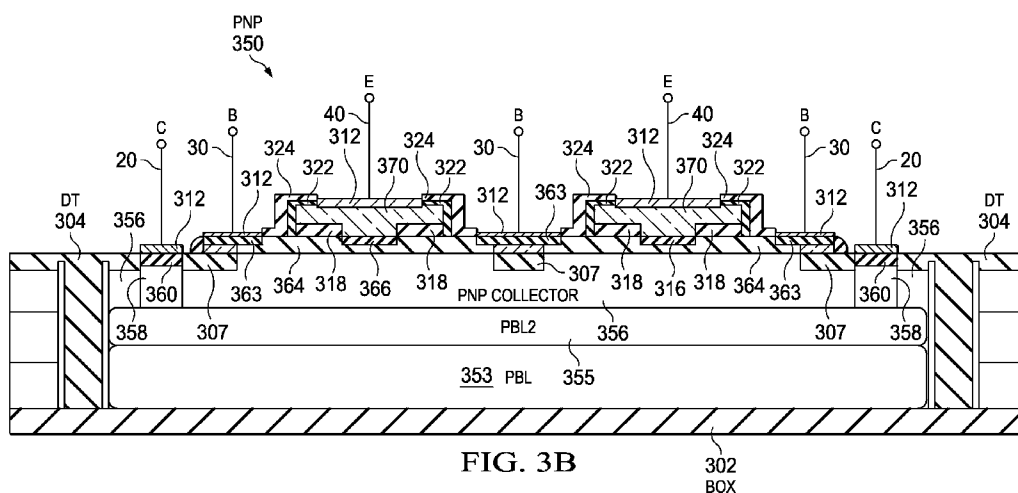


FIG. 3B

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BOX

(57) Abstract: A protection circuit is disclosed that protects a semiconductor device from damage due to an electrostatic discharge. One such protection circuit comprises a vertical pnp hetero-junction bipolar transistor (HBT) (350) connected between terminals such as supply terminals of the device, configured to conduct during an electrostatic discharge. The protection circuit also comprises a trigger circuit, such as a transient activated RC circuit connected between the terminals to detect the electrostatic discharge and control the transistor based on the detected electrostatic discharge. A Darlington transistor pair in the trigger circuit can be used to multiply the effective capacitance and HBT drive current. The HBT transistor absorbs energy from the electrostatic discharge and clamps the over-voltage across the terminals. The protection circuit may also be used across other VO terminals of the device.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/066864**A. CLASSIFICATION OF SUBJECT MATTER****H01L 27/04(2006.01)i, H01L 21/822(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)

IPC 8 G11C 11/407, H01L 21/822, H01L 23/56, H01L 27/04, H01L 29/78, H01L 31/072, H02H 9/00, H03K 19/0175, H03K 19/094, H03K 17/16

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

Korean Utility models and applications for Utility models since 1975
Japanese Utility models and applications for Utility models since 1975Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
e-KIPASS(KIPO internal) " ESD(electrostatic discharge)", "transistor", "trigger", "clamp", "capacitor", "over voltage"**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5237395 A (Western Digital Corp) 17 Aug. 1993 see the abstract, claims 1-20, column 4 line 48 - column 9 line 65, figures 1-8	1-3, 16-18
X	US 7123054 B2 (Kabushiki Kaisha Toshiba) 17 Oct. 2006 see the abstract, claims 1-16, figures 1-9	1-3, 16-18
X	US 2006/0209479 A1 (Peter Grombach et. al) 21 Sep. 2006 see the abstract, claims 1-14, figures 1-5	1-3, 16-18
X	KR 10-2000-0065514 A (SAMSUNG ELECTRONICS CO) 15 Nov. 2000 see the abstract, claims 1-3, figures 1-2 (English version is available on K-PION: http://kposd.kipo.go.kr:8088/up/kpion/)	1-3, 16-18

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2008/066864

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 4-15
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2008/066864

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2006-0020849 A (HYNIX SEMICONDUCTOR INC) 07 Mar. 2006 see the abstract, claims 1-8, figures 1-5 (English version is available on K-PION: http://kposd.kipo.go.kr:8088/up/kpion/)	1-3, 16-18
A	Albert Z. H. Wang et. Al., "A Review on RF ESD Protection Design" 2005 IEEE Transactions on Electron Device, Vol. 52, No. 7 , Jul. 2005	1-3, 16-18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2008/066864

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5237395 A	17.08.1993	NONE	
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KR 10-2006-0020849 A	07.03.2006	KR 10-0772693 B1	02.11.2007