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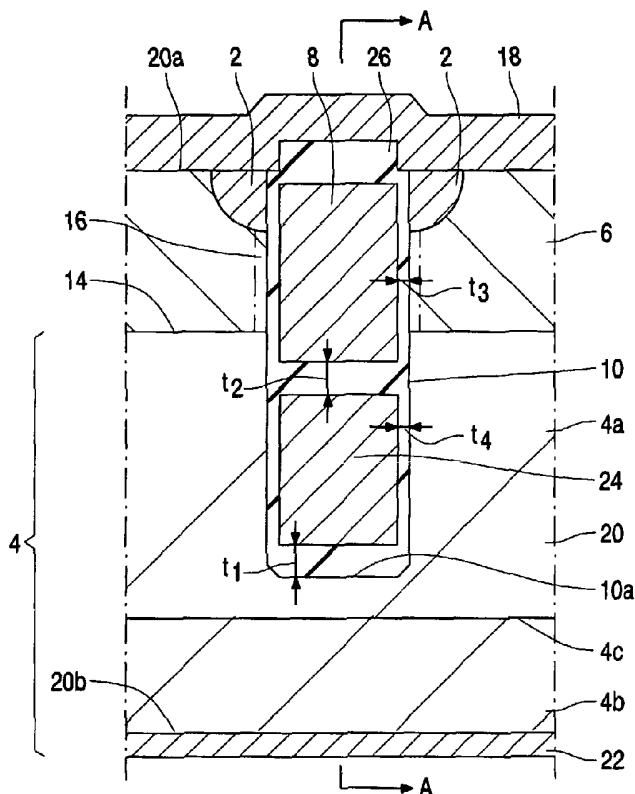
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[Continued on next page]

(54) Title: TRENCH-GATE SEMICONDUCTOR DEVICE, CORRESPONDING MODULE AND APPARATUS, AND METHOD OF OPERATING THE DEVICE



(57) Abstract: A trench-gate semiconductor device, for example a MOSFET or IGBT, includes a semiconductor body (20) having a drain region (4) comprising a drain drift region (4a) and a drain contact region (4b). An insulated field plate (24) is included in the trench (10) between the gate (8) and the drain contact region (4b), wherein the field plate (24) is for connection to a bias potential greater than the gate potential and near to the bulk breakdown voltage of the drain drift region (4a). The field plate (24) causes the potential drop across the drain drift region (4a) to be spread considerably more evenly, particularly at applied voltages greater than the bulk breakdown voltage, thereby substantially increasing the breakdown voltage of the device.

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A. CLASSIFICATION OF SUBJECT MATTER
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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 7 H01L

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
 EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	EP 1 170 803 A (SILICONIX INC) 9 January 2002 (2002-01-09) page 3, paragraph 8; claims 1,19,21; figures 5,6	1,2,5-9 4 3,10-12
X A	--- WO 02 13257 A (TIHANYL JENOE ;HIRLER FRANZ (DE); WERNER WOLFGANG (DE); INFINEON T) 14 February 2002 (2002-02-14) abstract; figure 1 page 3, line 30 -page 4, line 8 --- -/--	1,2,5-9 3,10-12

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 998 833 A (BALIGA BANTVAL JAYANT) 7 December 1999 (1999-12-07) column 3, line 1 - line 55; figure 2 column 4, line 39 - line 44; figure 3	4
A	---	3,10-12
E	DE 102 12 149 A (INFINEON TECHNOLOGIES AG) 16 October 2003 (2003-10-16) abstract; figure 1 paragraph '0030! -----	1,2,5-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern	Application No
PCT/IB	03/02233

Patent document cited in search report	A	Publication date	Patent family member(s)	Publication date
EP 1170803	A	09-01-2002	EP 1170803 A2	09-01-2002
			JP 2002110984 A	12-04-2002
			TW 495857 B	21-07-2002
WO 0213257	A	14-02-2002	DE 10038177 A1	21-02-2002
			WO 0213257 A2	14-02-2002
US 5998833	A	07-12-1999	AU 1213600 A	15-05-2000
			EP 1145327 A2	17-10-2001
			JP 2002528916 T	03-09-2002
			WO 0025365 A2	04-05-2000
			US 6388286 B1	14-05-2002
			US 2002036319 A1	28-03-2002
DE 10212149	A	16-10-2003	DE 10212149 A1	16-10-2003
			CN 1445861 A	01-10-2003
			US 2003178676 A1	25-09-2003