



(51) International Patent Classification:
G01R 19/25 (2006.01) **G06F 1/32** (2006.01)
G01R 19/252 (2006.01)

(21) International Application Number:
PCT/US2017/059532

(22) International Filing Date:
01 November 2017 (01.11.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
15/358,494 22 November 2016 (22.11.2016) US

(71) Applicant: **QUALCOMM INCORPORATED** [US/US];
ATTN: International IP Administration, 5775 Morehouse
Drive, San Diego, California 92121-1714 (US).

(72) Inventors: **ZHONG, Guoan**; 5775 Morehouse Drive, San
Diego, California 92121-1714 (US). **ZHANG, Junmou**;
5775 Morehouse Drive, San Diego, California 92121-1714
(US). **CHEN, Nan**; 5775 Morehouse Drive, San Diego,
California 92121-1714 (US).

(74) Agent: **FOUNTAIN, George**; Loza & Loza, LLP, 305
North Second Avenue #127, Upland, California 91786
(US).

(81) Designated States (*unless otherwise indicated, for every
kind of national protection available*): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every
kind of regional protection available*): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,
TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,
KM, ML, MR, NE, SN, TD, TG).

(54) Title: APPARATUS AND METHOD FOR SENSING DISTRIBUTED LOAD CURRENTS PROVIDED BY POWER GATING CIRCUIT

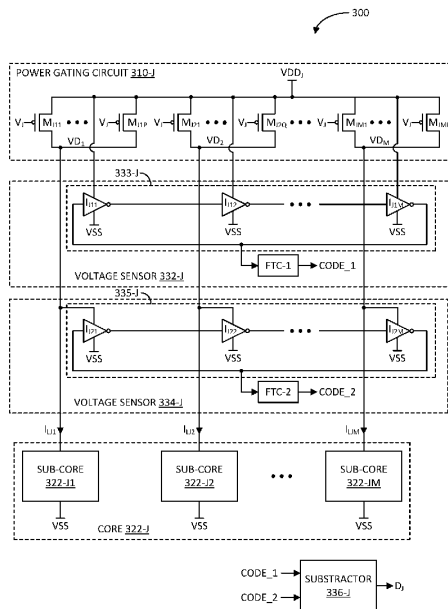


FIG. 3

(57) Abstract: Apparatus for sensing distributed load currents provided by power gating circuit. The apparatus includes a power gating circuit including a set of bulk transistors coupled in series with a set of circuits between a first and second voltage rails. The apparatus includes a current sensor with a first ring oscillator, a first frequency-to-code (FTC) converter, a second ring oscillator, a second FTC converter, and a subtractor. The first ring oscillator includes a first set of one or more inverters configured to receive a first voltage at a node between the power gating circuit and the first circuit, and a second set of one or more inverters configured to receive a second voltage at a second node between the power gating circuit and the second circuit. The first ring oscillator is configured to generate a signal including a frequency related to the voltage drops across the first and second sets of transistors.

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

- *with international search report (Art. 21(3))*