

Low-Noise High Efficiency Bias Generation Circuits and Method

BACKGROUND

[001] This application claims priority to copending U.S. application number 61/135,279 filed July 18, 2008 and entitled "Low Noise Charge Pump with Common-Mode Tuning Op Amp", attorney docket number PER-027-PROV-1, the entire contents of which are hereby incorporated by reference herein, and hereby incorporates by reference the entire contents of copending U.S. Patent Application 10/658,154 filed September 8, 2003 and entitled "Low Noise Charge Pump Method and Apparatus".

1. Field

[002] The present disclosure is widely applicable to electronic integrated circuits ("ICs").

2. Related Art

[003] It is usually desirable for an IC to operate from a single voltage supply. However, many ICs require two or more different voltage supplies, for example to provide internal bias supplies, for ideal operation. Such different supplies can be provided externally to the integrated circuit, but this is undesirable from a user standpoint. Providing additional supplies is not only inconvenient for the user, but may also cause the conductors coupling such external supplies to the IC to be unduly long, which among other difficulties may cause undesired emissions if noise is present on the supply. As such, it is a common practice to provide auxiliary circuitry on ICs to generate such additional bias generation voltages, or other voltage supplies, as may be required for circuit operation needed. Charge pumps are one of the most common of such auxiliary voltage-generating circuits used in ICs.

[004] However, charge pumps have characteristics that have rendered them difficult to use in certain applications. In particular, charge pumps have invariably created a substantial amount of electrical noise. Regulations have been promulgated to prevent electronic devices from interfering with each other, and such regulations establish maximums for allowable emissions. In some applications the noise generated by a charge pump may cause the IC or system in which such IC is disposed to exceed such maximum permitted noise emissions.

[005] For example, most radios, cell phones, TVs, and related equipment today require an "RF switch" to control connections between various transmitter and receiver circuits ("RF" is used generically herein to mean any reasonably high frequency ac signal). At least one auxiliary voltage generator is often needed to satisfactorily bias the FETs that comprise a semiconductor RF switch. Many of the products that employ RF switches are transceivers, such as cell phones, that are subject to stringent regulatory limitations on the electrical signals that it is permitted to emit. Because such RF switches are directly connected to the transceiver antenna, even very small amplitude noise signals generated by the bias generator of the RF switch will be all too efficiently radiated. It has been found that the noise generated by a conventional charge pump may be sufficient to cause a cell phone employing an RF switch using such charge pump to exceed the maximum noise emissions permitted by applicable regulations. As such, a noisy charge pump can render such a cell phone unsuitable for its commercial purpose.

[006] Consequently, bias generation circuits, such as charge pumps that generate far less noise than conventional charge pumps are crucial for certain applications. Low noise bias generation circuits will find advantageous employment in a wide range of integrated circuits, whether to satisfy regulatory spurious emission