Power Management System IC for Cellular Phones

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1. Introduction

Today, cellular phones are achieving increasingly widespread use among consumers because they are easily portable, have smaller sizes and lower prices, and consume less power enabling extended operation time. Various types of LSIs play important roles in reducing the size, cost and power consumption.

The power supply IC used for cellular phones has transitioned from a bipolar IC to a CMOS IC of lower power consumption, and integrates two or more regulator circuits on a single IC chip to achieve smaller size.

The power supply IC is designed to provide necessary and stable power for various electronic devices and to reduce power consumption during standby.

Fuji Electric has developed the FA3678F, a 48-pin package power management system IC for cellular phones, which incorporates eight LDO (low dropout) regulators, a negative voltage regulator for gate bias of a transmission power amplifier, and an operational amplifier. This paper presents an overview of the FA3678F.

2. Features

The FA3678F, a power management system IC developed for cellular phones, incorporates eight 2.8V-output voltage circuits, LDO regulators of up to 90mA, a negative regulator whose output voltage can be set with an external resistor, an operational amplifier for an ALC (automatic level control) circuit, and a reference voltage output circuit.

Each LDO regulator and operational amplifier can be individually turned on and off, as required, to meet the demand for lower power consumption of the cellular phones, thereby conserving the battery power.

Features are summarized below.

- ○ Built-in eight LDO regulators
- ○ Built-in negative regulator circuit
- ○ Built-in reference voltage circuit
- ○ Low power consumption: 1μA (standard value during standby)
- ○ CMOS silicon gate 1μm process
- ○ 48-pin package LQFP

Fig.1 Photograph of FA3678F chip

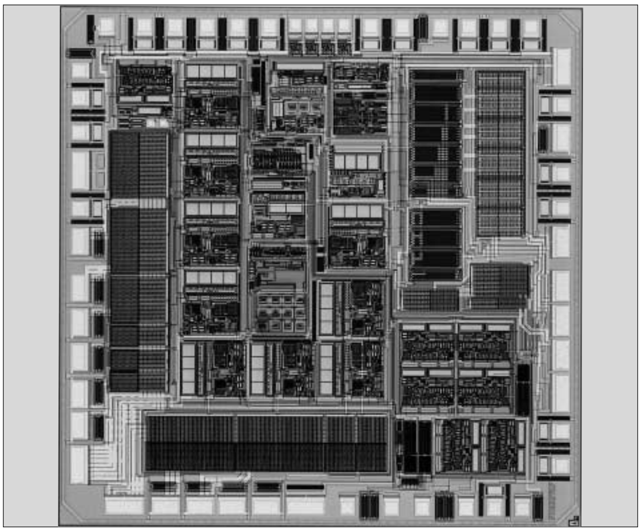


Figure 1 shows a photograph of the FA3678F chip.

Near the periphery of the pads are placed p-channel MOS transistors, which act as pass transistors for the regulators. The wiring of the FA3678F is as short and thick as possible to reduce parasitic serial resistance, and the layout is optimized.

Each circuit component is provided as a cell block as shown in Fig. 1 to reduce the time needed for design.

3. Specifications

3.1 LDO regulator

- ○ Ripple rejection rate: −40dB
- ○ Current consumption: 40μA (standard value per circuit)
- ○ Output voltage: 2.80V±60mV

3.2 Negative voltage regulator

- ○ Output current: 4mA
- ○ Ripple rejection rate: −25dB
- ○ Rise time: 5ms (maximum value)
- ○ Charge pump oscillation frequency: 12kHz (standard value)

3.3 Current consumption

○ When all signals are made off:
1μA (standard value)

4. Main Circuit Characteristics

Figure 2 shows a block diagram of the FA3678F.

4.1 LDO regulator

In the FA3678F, the LDO regulator consists of CMOS transistors, which consume a smaller current than bipolar transistors and have a lower dropout voltage, allowing operation with low battery voltage.

The LDO regulator features a high ripple rejection rate of less than −60dB (Fig. 3), low dropout voltage of 100mV (at I_O = 20mA) (Figs. 4 and 5), low supply current of 40μA per circuit and stable operation with an output capacitor as low as 1μF.

The LDO regulator rated at 90mA is provided with a built-in overcurrent limiter to prevent overheating or damage when output lines are grounded.

4.2 Negative voltage regulator

The negative voltage regulator can supply an output current of up to 4mA, suitable for use in the gate bias power supply of a GaAs power amplifier.

Oscillation frequencies for a charge pump can be selected by the value of external capacitance (Fig. 6). By simply mounting an external resistor, the regulation function added to a voltage doubler can change and adjust the output voltage of the regulator corresponding to the characteristics of a power amplifier (Fig. 7).

Fig.2 Block diagram of the FA3678F

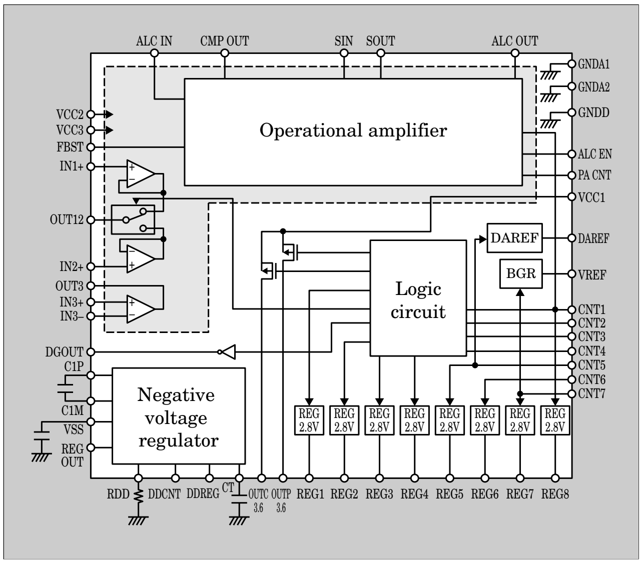


Fig.4 Dropout voltage of the REG7

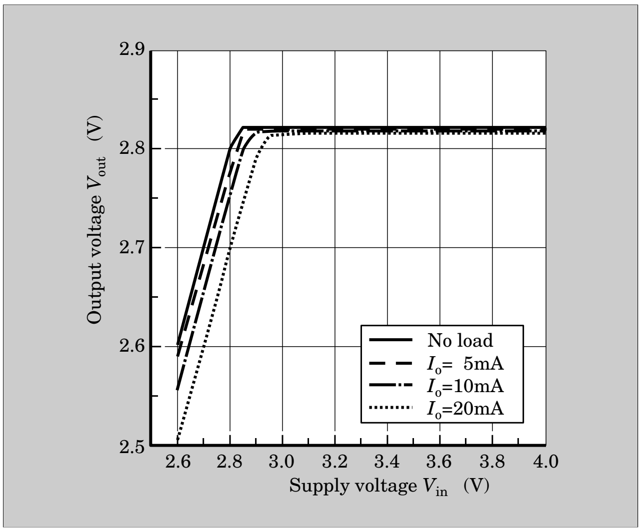


Fig.3 Ripple rejection rate of the REG7
(V_{cc} = 4V, I_O = 20mA, C_{out} = 4.7μF, C_{vref} = 1.0μF)

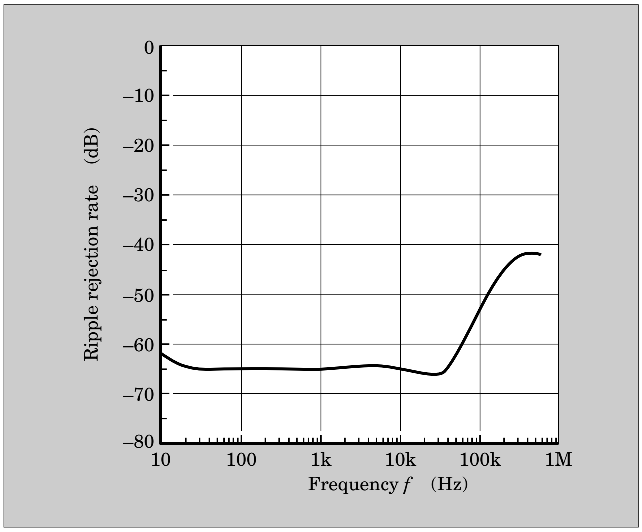


Fig.5 Temperature dependence of the dropout voltage characteristic of the REG7

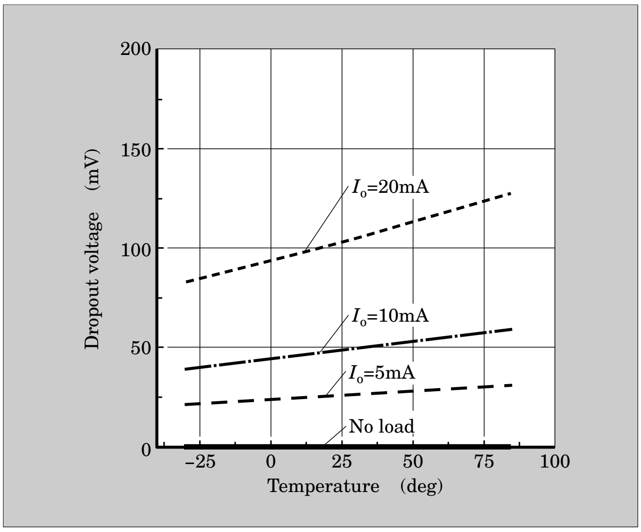


Fig.6 Oscillation frequency for charge pump circuit

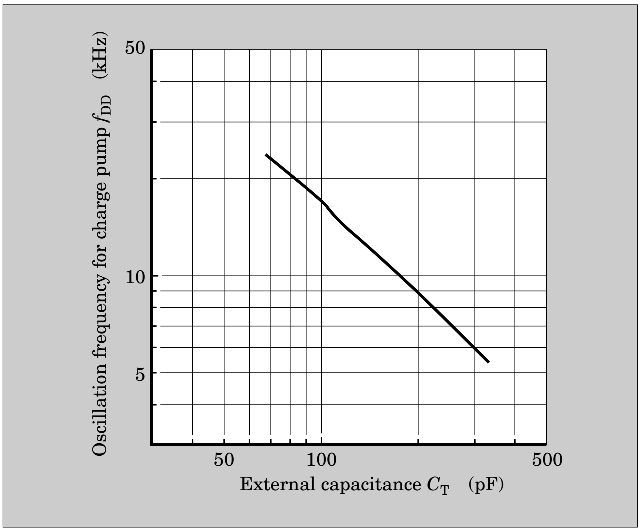
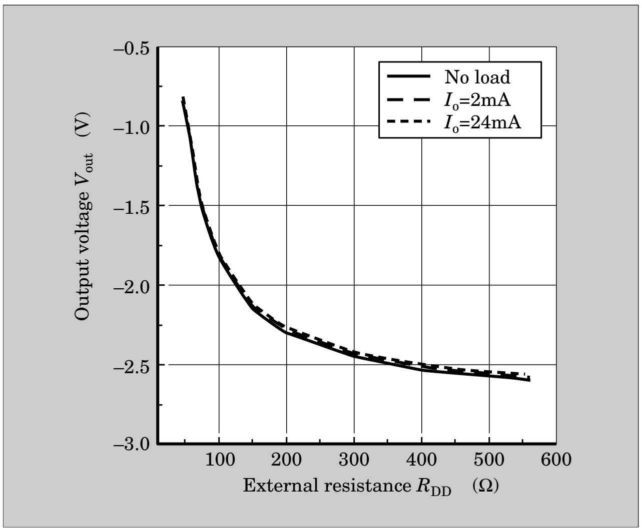


Fig.7 The relationship between negative voltage regulator output voltage and external resistance



5. Conclusion

This paper has presented an overview of the newly developed FA3678F, a power management system IC for cellular phones.

In keeping with the trend toward increasingly integrated LSIs, Fuji Electric is determined to develop lower-power consuming, smaller-sized and enhanced-function power management system ICs.