Present Status and Prospects for Fuji Electric's IC Technology and Products

Toshio Komori

1. Introduction

Fuji Electric is developing products based on its characteristic technologies and focusing on the power supply control IC (integrated circuit). The integration of power, intelligence and analog technology is a goal of this IC. Special features include high-voltage complementary/double diffused metal oxide semiconductor (C/DMOS) technology and an insulated gate bipolar transistor (IGBT) integration process which relate to power; high performance digital control and sensor-integrated ICs which relate to intelligence; and high-precision reference voltage (±0.5%), high-frequency pulse-width modulation (PWM) control and low-power consumption technology which relate to analog functionality (See Fig. 1).

Applications for power supply control ICs range from AC-DC power supplies such as AC adapters to the DC-DC power supplies for recent popular portable equipment, personal computers and peripheral devices. In addition, Fuji Electric extends flat panel display driver ICs (for plasma and small-sized liquid crystal displays) utilizing high-voltage technology and autofocus ICs for cameras and pressure sensors for automobiles in products.

Semiconductor technology is rapidly advancing. The high integration and high performance of system ICs using sub-micron process and digital ultra large-scale integrated circuits (ULSIs) are remarkable. On the other hand, analog technology is becoming increasingly important for power management, chiefly for power supplies that are critical to the system.

Under these circumstances, Fuji Electric plans to initiate improvements in size, power consumption and performance utilizing analog technology based on CMOS process and device technologies, to concentrate on strengthening and expanding power supply control ICs, and to supply unique ICs that satisfy customer needs.

2. Present Status of Fuji Electric's ICs

2.1 IC process and device technologies

Fuji Electric's process and device technologies have the advantage of high voltage, low power consumption, and high-precision analog/digital mixed technology. CMOS and C/DMOS processes which withstand voltages of 30 to 60 V are the mainstream, and design rules as low as 0.6μm are prepared.

The typical processes are listed in Fig. 2. Power supply ICs mainly use 30V-class C/DMOS with a 1μm rule, and higher precision, higher performance products can be designed using trimming technology and high-precision processing. The bipolar IC process, formerly in widespread use, is rapidly being replaced with the CMOS IC process that is more effective in conserving power. Regarding high voltage technology,

Fig.1 Fuji Electric's IC target technologies

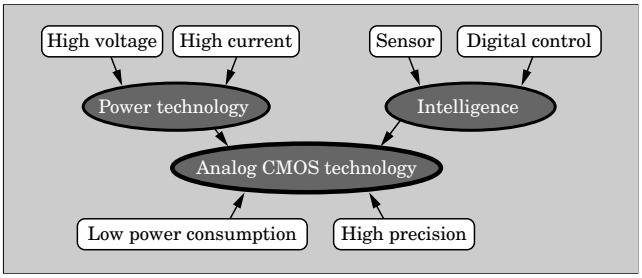
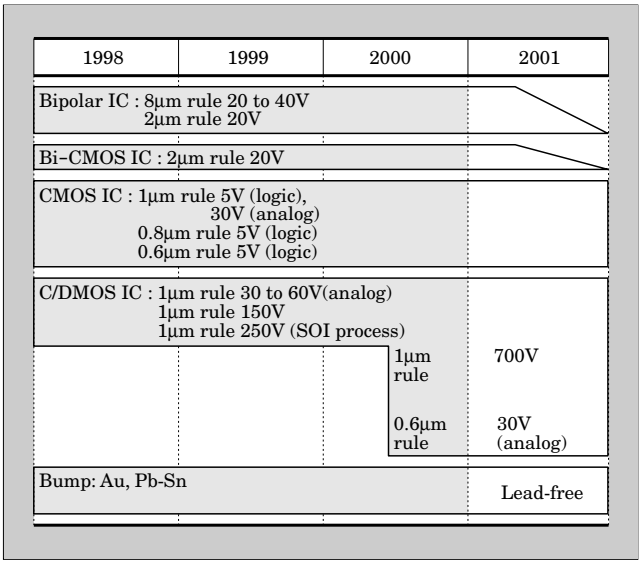


Fig.2 Fuji Electric's IC process technologies



a 700V C/DMOS process based on a 1μm rule is under development, and high quality, single-chip power ICs which can be recommended with confidence, will soon be manufactured. Fuji Electric has also realized a C/DMOS device process for display drivers that can incorporate an IGBT output section using a 250V silicon-on-insulator (SOI) substrate, thereby reducing size and increasing output.

2.2 Analog IC design technology

Power supply control ICs differ from digital ICs in that their design mainly consists of analog technology and design automation is difficult. This is because when creating the IC layout pattern design from a circuit diagram, subtle differences in layout pattern routing often influence IC characteristics, and under the present conditions, manual design based on an engineer's experience is still commonly used. However, design support using computer-aided design (CAD) technology is indispensable to shorten the design period and obtain consistent design quality. Fuji Electric utilizes cell-base design with CMOS analog macro cells, and vigorously promotes analog automatic placement and routing design technology using back-annotation techniques.

2.3 IC packages

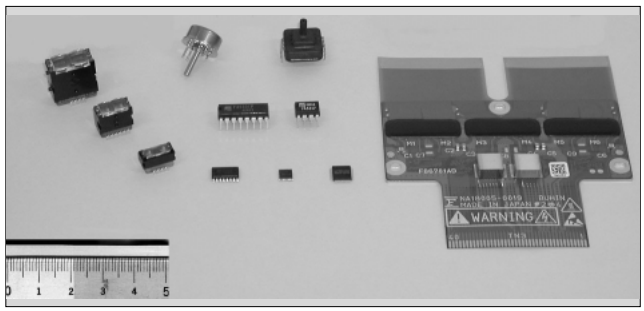
Figure 3 shows examples of the products. Common plastic packages for power supply control ICs are provided in a dual in-line package (DIP), and additionally in thin shrink SOP (TSSOP), chip size package (CSP), and quad flat non-lead (QFN) packages that satisfy recent needs for surface-mounting, fine pitch, and low profile arrangements. This variety of packaging satisfies customer requirements. The clear molding package applied to auto-focus ICs has characteristics suitable for photosensors and is highly rated by customers as a unique and original Fuji Electric technology. Further, a series of module assembly products with bare chips installed on a flexible substrate (chip on film: COF) to reduce size and price has been developed.

3. Current Status of Power Supply Control ICs

Table 1 lists the model names, main features and functions of Fuji Electric general-purpose power supply control ICs. Because the conservation of resources and energy is required for ecological reasons, power supply control CMOS ICs capable of low standby power consumption are attracting attention, instead of the conventional bipolar ICs. Fuji Electric played a leading role in the promotion of CMOS applications and has prepared a series of products.

Fuji Electric developed a PWM control IC for AC-DC converter use that lowers the operating frequency during a light load to reduce switching loss and conserve power. This IC has an 8-pin construction and

Fig.3 Examples of IC products



incorporates various protective functions for overload, low-voltage, etc. This technology greatly contributes to the realization of high-efficiency, energy conserving power supplies that only consume low input power during standby or no load conditions.

For DC-DC converter use, Fuji Electric developed the optimal control IC for portable apparatus power supplies. For on-board use, a multi-channel (6-channel) synchronous-rectification DC-DC converter control IC was developed. This has 2 channels of synchronous rectification with the advantages of independent on/off and soft-start functions for each channel, and built-in output short-circuit protection of the timer latch type. The operating frequency of up to 1 MHz is effective in reducing size of the power supply. Further, to satisfy sophisticated power management requirements, Fuji Electric integrates digital control circuits and peripheral functions into the power supply control IC. A typical example is the power supply control IC for cellular phones. Other developments in power supply control technology include DC-DC converter technology that realizes high frequency switching at 3 MHz and above. For details, please refer to other articles in this special issue.

The above mentioned power supply control ICs are applied to diverse fields as shown in Table 2, and contribute to reducing the size and power consumption in each field.

4. Current Status of High-Voltage ICs and Sensor ICs

In addition to power supply control ICs, Fuji Electric is also developing characteristic products that relate to high-voltage technology and sensor-integrated ICs. An example is the plasma display driver IC. The scanning driver uses a 250V SOI process and the addressing driver uses a 150 to 85V C/DMOS process. The mounting method is modularized by installing bare chips on a flexible film.

An example of sensor-integrated IC is the auto-focus IC for camera use, which is characterized by the integration of photosensors. There are two series of these ICs, a digital type that calculates distance data and an analog type that outputs photosensor signals. The digital or analog type is selected according to

camera construction and performance. Fuji Electric also supplies autofocus modules that integrate an optical system and an IC; these have a long history of good results as a typical passive sensor with the advantages of small size and easy adjustment.

An example of a piezo-sensor application is the

Table 1 List of general-purpose power supply control ICs

(a) AC-DC converters

Item / Classification	Model name	D_{max} (%)	Application circuit			MOS drive	Operating mode		Protective circuit		External form
			Flyback	Forward	Power factor improvement		Voltage	Current	OCP	OVP	
MOS IC	FA13842	96	○			○		○			8-pin
	FA13844	48		○		○		○			8-pin
	FA3641/47	70	○			○	○		○	○	8-pin
	(FA5510/11 14/15)	46/70	○	○		○	○		○	○	8-pin
	(FA5501)				○	○				○	8-pin
Bipolar IC	FA5301B	100	○				○		○		16-pin
	FA5304A	46		○		○	○		○	○	8-pin
	FA5305A	46		○		○	○		○	○	8-pin
	FA5310B	46		○		○	○		○	○	8-pin
	FA5311B	70	○			○	○		○	○	8-pin
	FA5314	46		○		○	○		○	○	8-pin
	FA5315	70	○			○	○		○	○	8-pin
	FA5316	46		○		○	○		○	○	8-pin
	FA5317	70	○			○	○		○	○	8-pin
	FA5332	92			○	○			○	○	16-pin

(b) DC-DC converters

Item / Classification	Model name	No. of channels	D_{max} (%)	Voltage range			Application circuit				MOS drive	External form
				2.5 to 18V	2.5 to 5.5V	10 to 25V	Step-down	Step-up	Inverter	Flyback		
MOS IC	FA3675F	6	Optional setting	○			○	○	○	○	○	48-pin
	FA3676F	6	Optional setting	○			○	○	○	○	○	48-pin
	FA3630V	2	Optional setting		○		○	○	○	○	○	16-pin
	FA13843	1	96			○		○	○	○	○	8-pin
	FA13845	1	48			○		○	○	○	○	8-pin
	(FA3686V)	2	85	○				○	○	○	○	16-pin
	(FA3687V)	2	Optional setting	○			○	○	○	○	○	16-pin
	(FA7700)	1	90	○				○	○	○	○	8-pin
	(FA7701)	1	100	○			○				○	8-pin
Bipolar IC	FA7610C	1	64		○			○	○	○		8-pin
	FA7611C	2	Optional setting		○		○	○	○	○		16-pin
	FA7612C	1	100		○		○					8-pin
	FA7613C	1	Optional setting	○			○		○	○		16-pin
	FA7615C	2	Optional setting		○		○	○	○	○		16-pin
	FA7616C	2	Optional setting			○		○	○	○		16-pin
	FA7617C	1	67		○				○	○		8-pin
	FA7630C	2	Optional setting		○		○		○	○	○	20-pin
MOS IC	FA3629AV	3	Channel1=87		2.5 to 5.8V			○	○	○	Channel N with built-in MOSFET (one channel only)	16-pin
			Channel2=87					○	○	○		
			Channel3=86				○		○			
	FA3635P	1	Optional setting			10 to 45V	○		○		○	8-pin
	FA3685P	1	Optional setting			○	○		○		○	8-pin

Note: Model names enclosed in parenthesis are under development.

Table 2 Applications of power supply control ICs

Item / Group	Model name	Application products
AC-DC converters	FA5301	CRT monitors, etc.
	FA5304A/05A FA531X series	AC adapters, printers, CRT monitors, facsimiles, word processors, servers, general-purpose inverters, stationary VCRs, general-purpose power supplies, chargers, etc.
	FA1384X series	AC adapters, printers, air-conditioners, CRT monitors, etc.
	FA5332	CRT monitors, general-purpose power supplies, air-conditioners, refrigerators, workstations, plasma display panels, projectors, monitor cameras, AC adapters, etc.
	FA3647/41	Printers, facsimiles, AC adapters, plain paper copiers, game machines, etc.
DC-DC converters	FA76XX series	Personal computers, word processors, LCD back light inverters, digital cameras, printers, car navigation systems, stationary VCRs, projectors, VCR cameras, etc.
	FA3675/76	VCR cameras, digital cameras, etc.
	FA3629/30	LCD panels, digital cameras, etc.
	FA3635/85	Printers

pressure sensor for automobiles. Please refer to the separate article entitled “EMI-Prevention Pressure Sensor” in this special issue.

5. Future Prospects

Fuji Electric will focus its efforts on power management for portable apparatus in connection with information technology (IT), which is expected to develop more and more in the future, and to develop unique products to satisfy market needs by adding power and intelligence to the core technologies of high-voltage and analog CMOS.

6. Conclusion

Emphasizing the power supply control IC, the present status and future prospects for Fuji Electric’s ICs have been outlined. To survive as a future supplier of characteristic products that satisfy customer needs in advance, Fuji Electric will build-up its core technologies and supply high-quality products.

References

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(2) Sumida, H. et al.: “Circuit Design and a High-Voltage Device Structure for an Advanced PDP Scan Driver IC”. The 6th International Display Workshops. p. 739-742 (1999)