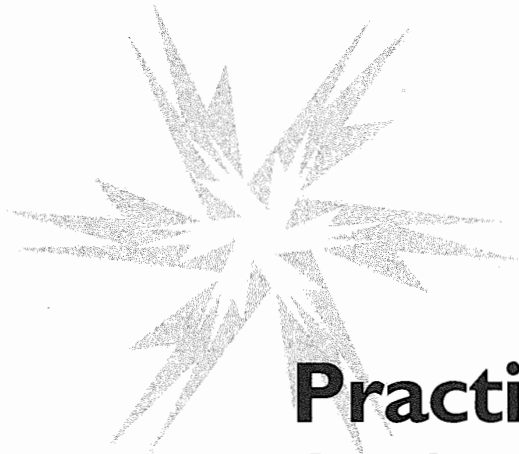


PRACTICAL
ELECTRONICS

for

INVENTORS

Paul Scherz



Practical Electronics for Inventors

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Integrated Circuits

An *integrated circuit* (IC) is a miniaturized circuit that contains a number of resistors, capacitors, diodes, and transistors stuffed together on a single chip of silicon no bigger than your fingernail. The number of resistors, capacitors, diodes, and transistors within an IC may vary from just a few to hundreds of thousands in number. The trick to cramming everything into such a small package is to make all the components out of tiny *n*-type and *p*-type silicon structures that get imbedded into the silicon chip during the production phase. To connect the little transistors, resistors, capacitors, and diodes together, aluminum plating is applied along the surface of the chip. Here is a magnified cross-sectional view of an IC showing how the various components are imbedded and linked together.

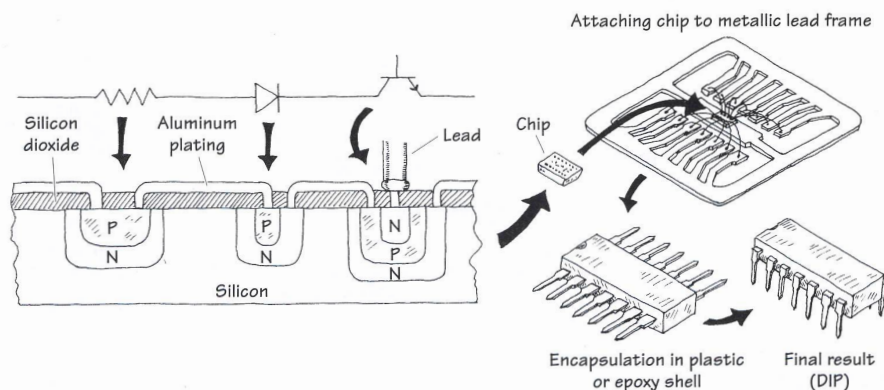


FIGURE 6.1

ICs come in either analog, digital, or analog/digital form. Analog (or linear) ICs produce, amplify, or respond to varying voltages. Digital (or logic) ICs respond to or produce signals having only high and low voltage states, whereas analog/digital ICs share properties common with both analog and digital ICs. Some common analog ICs include voltage regulators, operational amplifiers,

comparators, timers, and oscillators. Common digital ICs include logic gates (e.g., AND, OR, NOR, etc.), flip-flops, memories, processors, binary counters, shift registers, multiplexers, encoders and decoders, etc. Analog/digital ICs may take on a number of different forms. For example, such an IC may be designed primarily as an analog timer but may contain a digital counter. Alternatively, the IC may be designed to read in digital information and then use this information to produce a linear output that can be used to drive, say, a stepper motor or LED display.

6.1 IC Packages

ICs are housed most frequently in dual in-line packages (DIPs). These packages consist of a plastic or ceramic box with metal pins sticking out of its sides. Each pin has a specific function and an identification number. The number 1 pin is located to the left of an index marker (see Fig. 6.2), while the succeeding pins are counted off in a counterclockwise direction. A manufacturer's logo, manufacturer's prefix, part number, and date code are almost always printed on an IC package. Other numbers and symbols found on ICs are often used to specify production process, temperature range, package type, etc. Here are a few deciphered ICs to get you going.

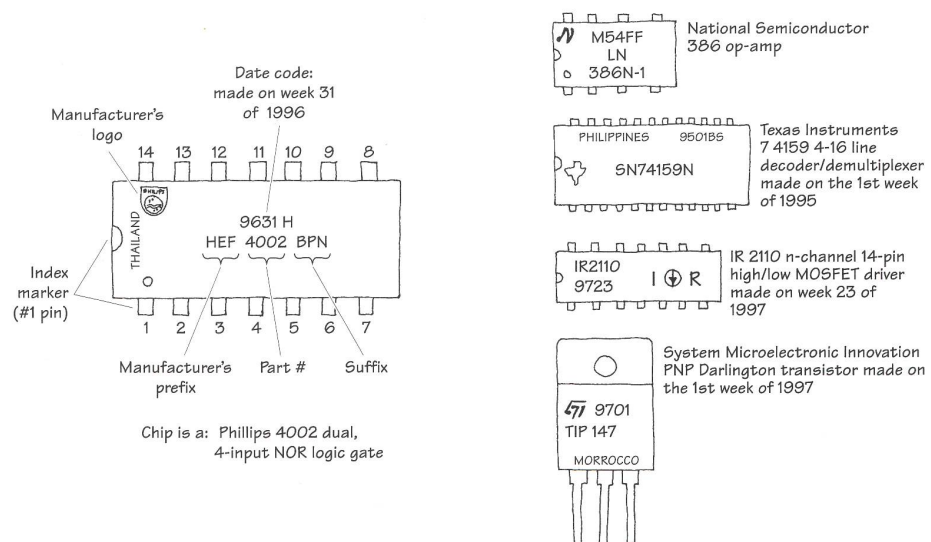


FIGURE 6.2

Notably, some IC labeling systems use an "xx44c55p-1" format. "xx" represents the manufacturer's prefix, "44" represents the chip family code, "c" represents the fabrication process (e.g., c = CMOS, f = fast, hc = high speed CMOS, hct = high speed CMOS TTL compatible, ls = low power schottky, etc.), "pp" (the suffix) represents the package code (specific to an individual manufacturer), and "1" represents the speed of the device.

Table 6.1 presents a partial list of company prefixes. It is important to note that the prefixes may not always be helpful in determining the actual manufacturer. As it turns out, a number of different manufacturers use similar prefixes. For example, the prefix "P" is used by the following companies: ASD, Harris, Hewlett-Packard, Intel, Mitsubishi, Motorola, NEC, Phillips, SGS, and Temic. If you are not sure which company the prefix belongs to, check out the manufacturer's logo.

TABLE 6.1 Company Prefixes

MANUFACTURER	PREFIX	MANUFACTURER	PREFIX
Allegro	A, μ PA, UCX	Siliconix	L, LD
Analog Devices	AD	Linear Technology	LT
Advanced Micro Devices	Am, A, AO	Mitsubishi	M
Panasonic	An	Fugitsu	MB, FTU
General Instrument	AY, GIC, GP, GI, FE, GF, W, GI	MOS Technology	MCS
Sony	Bx, Cx, GI	Microsystems International	MIL
Intel	B, C, I, M, IR, A, AP, AT	Mostek	MK
RCA (now Harris)	CA, CD, CDP	Plessey	MN, SL, SP
TRW	CA, TDC, MPY, CMP, DAC, MAT, OP	Signetics	N, NE, S, SE, SP
Precision Monolithics	PM, REF, SSS	Next	Nx
National Semiconductor	DM, LF, LFT, LH, LM, NH, NA, NDx	NTE	NTE
Sanyo	DSK	Precision Monolithics	PM
Fairchild (now National Semiconductor)	F μ A, μ L, Unx	Quality Semiconductor	QS
Ferranti	FSS, ZLD, Zn	Raytheon	R, RAY, RC, RM
GE	GEL	Silicon General	SG
Harris	HA	Shanghai Belling Micro	SGS
Hitachi	HA, HD, HG, HI, HZ	Siemens	B, BB, BF
Motorola	HEP, M, MC, MCC, MCM, MFC, MM, MWM, HEF, HEED, T, CH, J	Texas Instruments	SN, TL, TMS, TEX
Intersil	ICH, ICL, ICM, IM	Toshiba	T, TC, HZ, M, TA, TH, JT
IR	IR, IRB, IRxx	Sprague	ULN, ULS
Sharp	IR	NEC	μ P, μ TD, NRA, NRB, NRx
ITT	ITT, MIC	Westinghouse	WC, WM
Philips	HEF, HCF, M, AD, AJ, J, B, BB, BA, ON, OT	Exar	XR
Samsung	KA, IR, K Kxx	Yamaha	YAC, YM, YMF, YSS
		Hewlett-Packard	5082-nnnn, AT

Another problem when deciphering IC labels is figuring out what the suffixes mean. Often a manufacturer will place a suffix at the end of a part number to indicate the type of package (e.g., ceramic dual-in-line, plastic dual-in-line package, etc.) or to indicate temperature range. The frustrating thing with suffixes is that there is no standard convention used. Each manufacturer's suffix may have its own unique meaning.

A more complete and up-to-date listing of company prefixes can be found in the Chip Directory's Web site (www.hitex.com/chipdir/index.htm). If this link does not work, run a search using "Chip Directory" as your keyword. The Chip Directory also provides listings of company logos, company abbreviations, suffix meanings, chips by number, chips by name, chips by family, chip manufacturers, and links to manufacturers' Web sites.

6.2 Some Basic ICs to Get You Started

TL783 Three-Terminal Adjustable Voltage Regulator

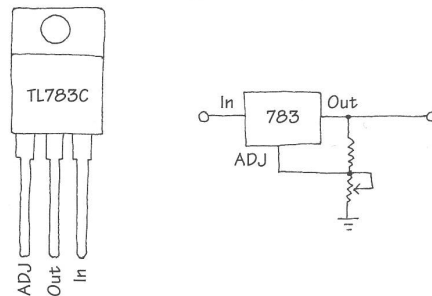


FIGURE 6.3

This device is used as an adjustable voltage regulator for high-voltage applications. Output can be adjusted from 1.25 to 125 V, with a maximum output current of 700 mA. Two external resistors are required to program the output voltage. Voltage regulators will be covered in greater detail in Chap. 10.

741CD Op Amp

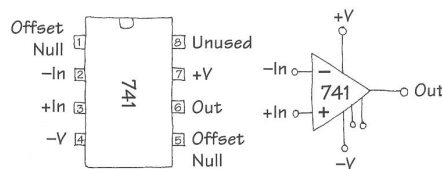


FIGURE 6.4

A 741 op amp is a very popular high-performance linear amplifier IC. When a feedback resistor is connected from its output to its inverting input, the device can be made to do some amazing things. For example, you can use op amps to build inverting and noninverting amplifiers, oscillators, integrators, differentiators, adders, and subtractors. Without feedback, the device acts as a comparator. The 741 op amp is made by a number of different manufacturers. To learn more about op amps, see Chap. 7.

555 Timer

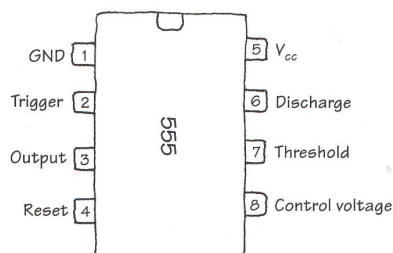


FIGURE 6.5

This is a very versatile IC that acts as a kind of smart on/off switch that can be made to turn on and off at a rate you set by wiring resistors and capacitors between its leads and to and from supply voltages. These devices are used in timer circuits, oscillator circuits, logic clock generators, and tone generators. The 555 timer is described in detail in Chap. 8.

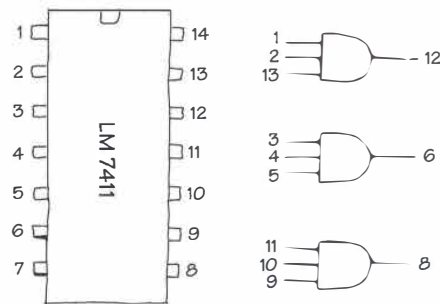
LM7411 Three-Input AND Gate

FIGURE 6.6

The 7411 contains three functionally independent three-input AND gates. All three gates are powered through a common supply pin. NAND gates, OR gates, NOR gates, memories, microprocessors, microcontrollers, and other logic ICs are discussed in Chap. 12.

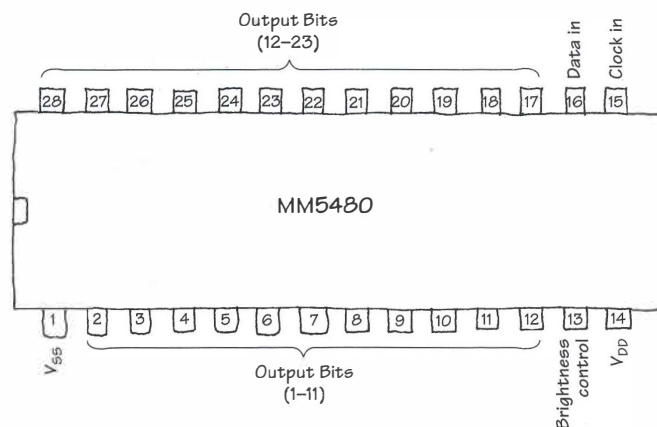
MM5480 LED Display Driver

FIGURE 6.7

This IC is designed to drive common-anode, separate-cathode LED displays. A single pin connected to a supply voltage through a variable resistor controls the LED display's brightness. Some features include continuous brightness control, serial data input, no load signal requirement, TTL compatibility, 3½-digit displays, and wide dc power supply operation. The MM5480 can be used in industrial control indicators, digital clocks, thermometers, counters, and voltmeters. LED displays and display drivers are discussed in Chap. 12.

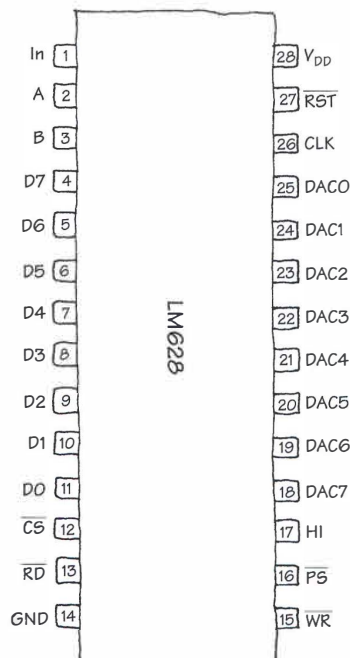
LM628 Precision Motion Controller

FIGURE 6.8

The LM628 is a motion-control processor that uses a quadrature incremental position feedback signal from dc motors, brushless dc servo motors, and other servo mechanisms. The device has an 8-bit output that can drive an 8-bit or 12-bit DAC, which in turn makes it possible to construct a servo system that includes using a dc motor, an actuator, an incremental encoder, a DAC, and a power amplifier. Features include 32-bit position, velocity and acceleration registers, position and velocity modes of operation, real-time programmable host interrupts, an 8-bit parallel asynchronous host interface, and a quadrature incremental encoder.