SENSORES Y ACONDICIONADORES

TEMA 15

CIRCUITOS ACONDICIONADORES DE SENSORES ANALÓGICOS (3)

CIRCUITOS ACONDICIONADORES REALES

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CIRCUITOS ACONDICIONADORES REALES

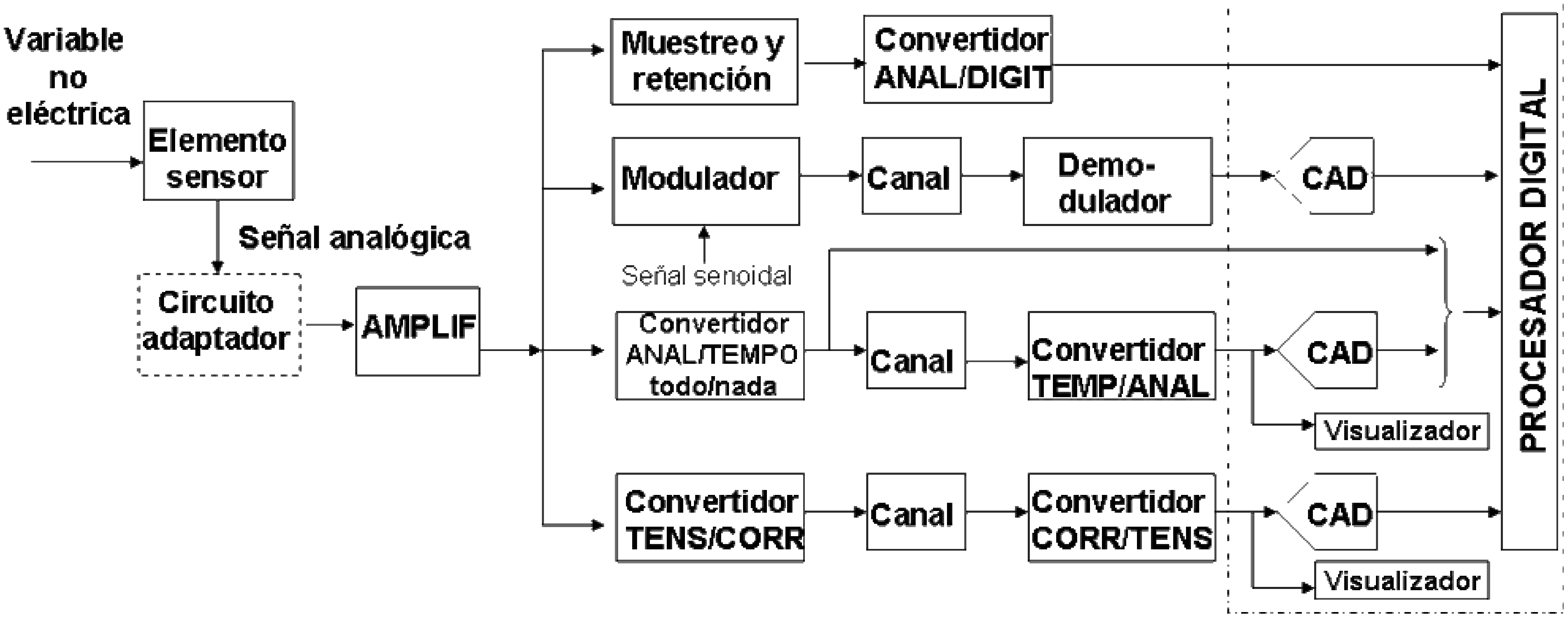
INTRODUCCIÓN

Los circuitos acondicionadores están en la práctica, formados en general por dos o más de los tipos de los circuitos analizados en los apartados anteriores. Por otra parte, la señal de salida del acondicionador se tiene , en la mayoría de los casos, que transmitir a un procesador digital.

Existen numerosas variantes que dificultan su análisis sistemático, pero resulta conveniente tratar de clasificarlas en función del tipo de señal generada por el elemento sensor (y el excitador asociado con él en su caso).

CIRCUITOS ACONDICIONADORES REALES

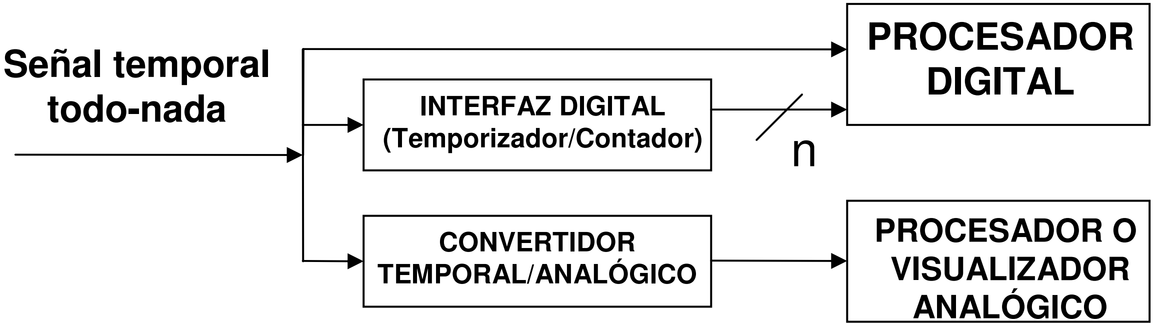
CIRCUITOS ACONDICIONADORES ENTRE SENSORES DE SALIDA ANALÓGICAY UN PROCESADOR DIGITAL



CIRCUITOS ACONDICIONADORES REALES

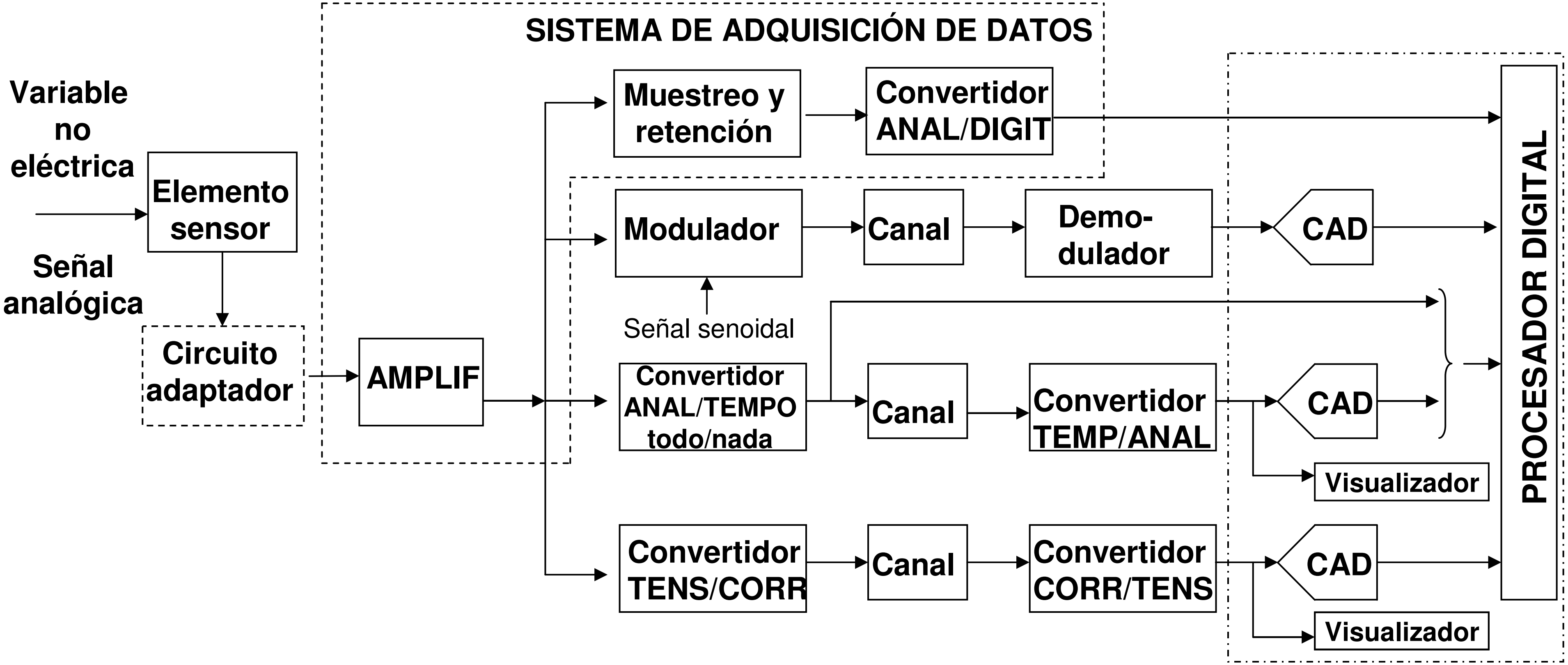
CIRCUITOS ACONDICIONADORES ENTRE SENSORES DE SALIDA DIGITAL Y UN PROCESADOR DIGITAL

CIRCUITOS ACONDICIONADORES ENTRE SENSORES DE SALIDA TEMPORAL TODO-NADA Y UN PROCESADOR



CIRCUITOS ACONDICIONADORES REALES

Muchos de los elementos de las figuras anteriores constituyen bloques funcionales que han sido realizados en circuitos integrados monolíticos. Las combinaciones de varios de ellos constituyen a su vez bloques funcionales más complejos, entre los que cabe destacar los sistemas de adquisición de datos.



CIRCUITOS ACONDICIONADORES REALES

SISTEMA DE ADQUISICIÓN DE DATOS (*DATA ACQUISITION SYSTEM*)

[PERE 04, pag. 707]

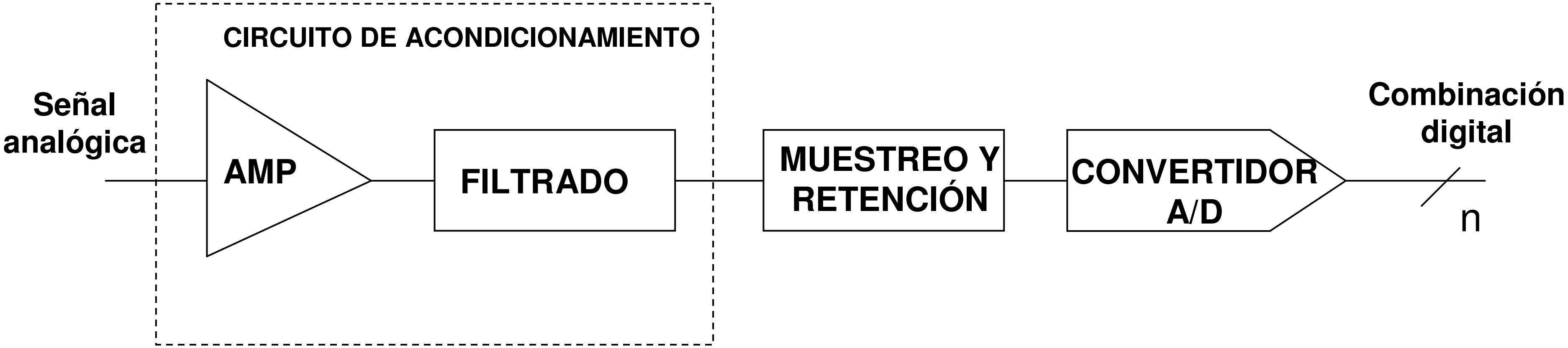
Sistema electrónico que convierte corrientes o tensiones analógicas en digitales para aplicarlas a un procesador digital.

Para ello realiza las siguientes funciones:

- Adaptación de la señal analógica, amplificación y filtrado.
- Almacenamiento de la señal: circuito de muestreo y retención (***Sample & hold***).
- Conversión de variables analógicas en digitales.

CIRCUITOS ACONDICIONADORES REALES

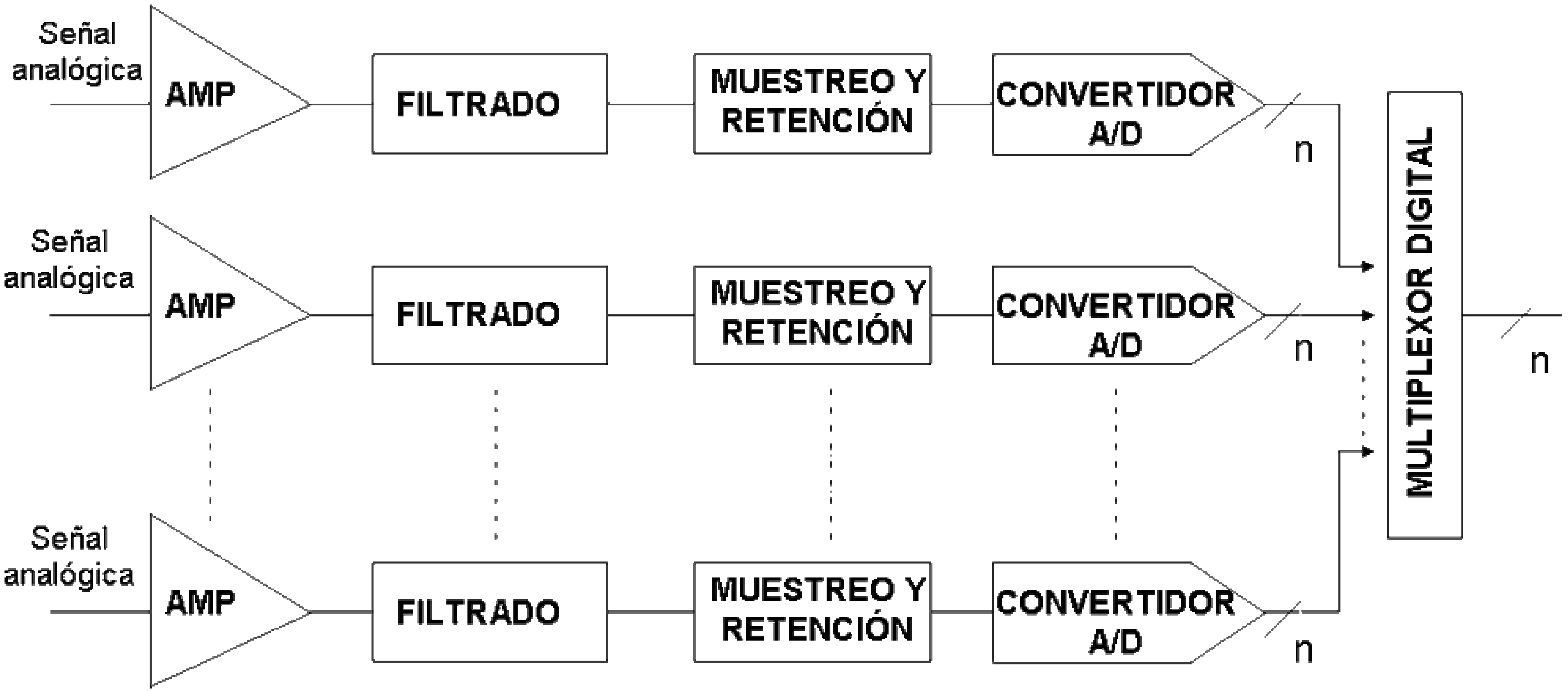
SISTEMA DE ADQUISICIÓN DE DATOS
(*DATA ACQUISITION SYSTEM*)



Esquema básico de un sistema de adquisición de datos

CIRCUITOS ACONDICIONADORES REALES

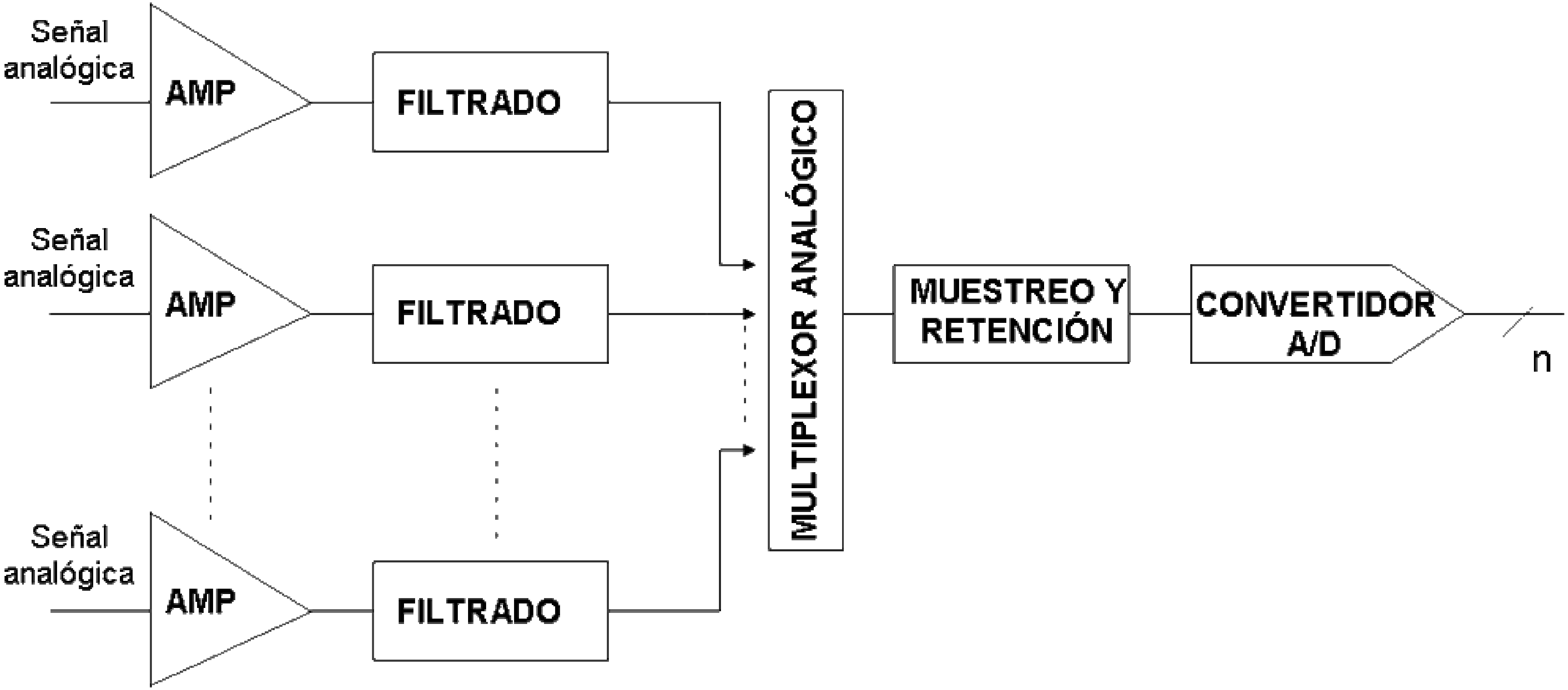
SISTEMA DE ADQUISICIÓN DE DATOS
(*DATA ACQUISITION SYSTEM*)



Esquema con varias señales analógicas y un DAC por cada una

CIRCUITOS ACONDICIONADORES REALES

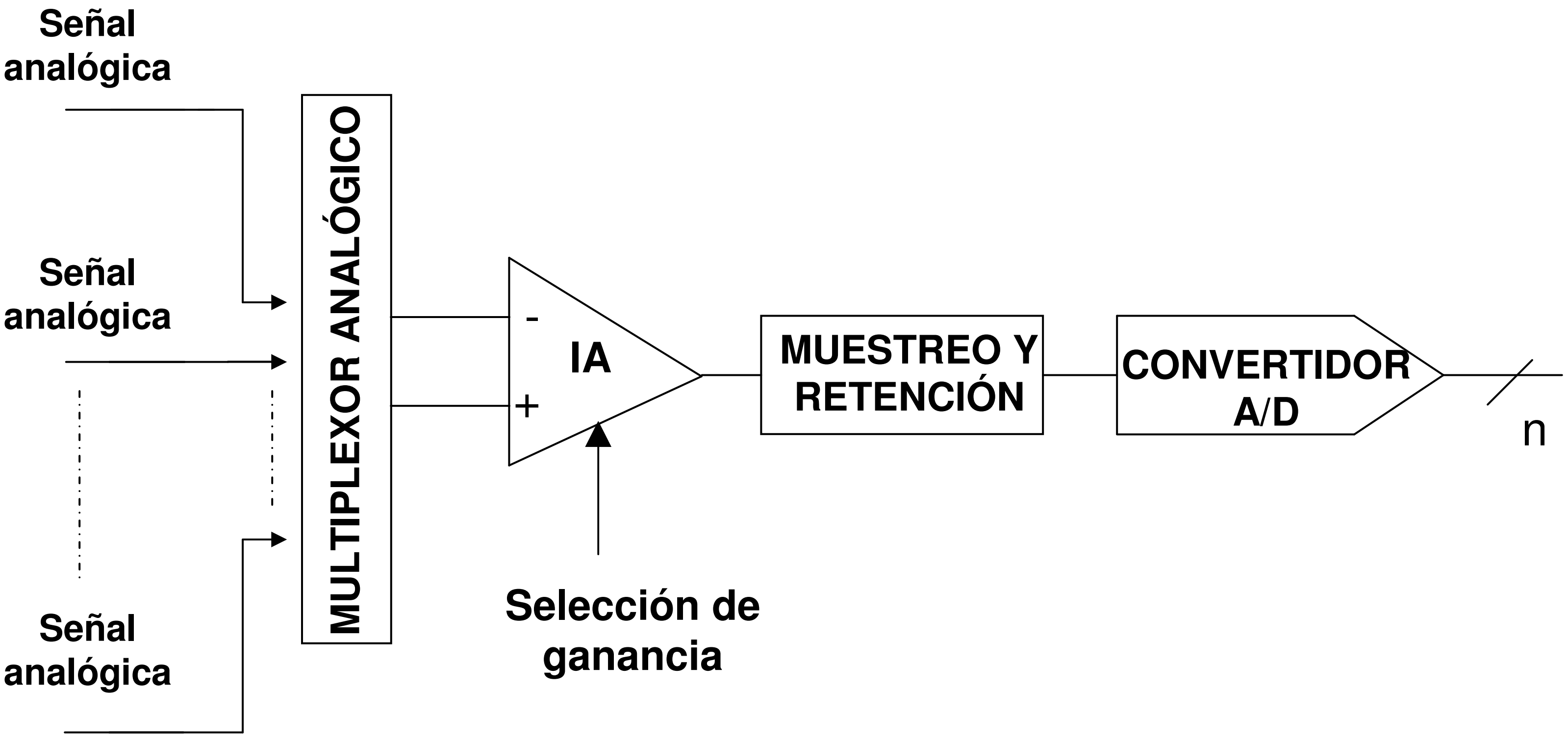
SISTEMA DE ADQUISICIÓN DE DATOS
(*DATA ACQUISITION SYSTEM*)



Esquema con varias señales analógicas y un multiplexor analógico

CIRCUITOS ACONDICIONADORES REALES

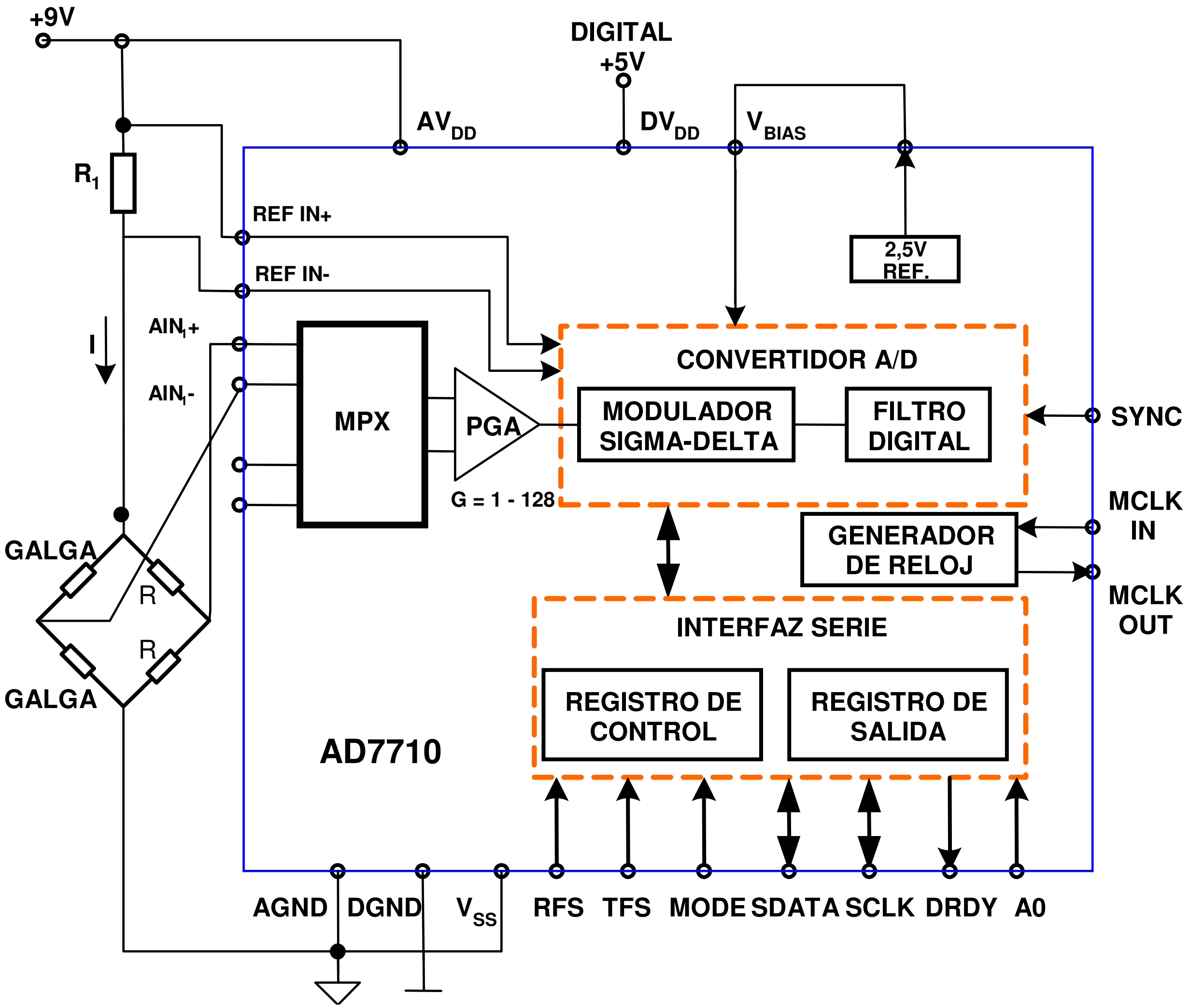
SISTEMA DE ADQUISICIÓN DE DATOS
(*DATA ACQUISITION SYSTEM*)



Esquema con múltiples señales analógicas, multiplexor analógico y IA

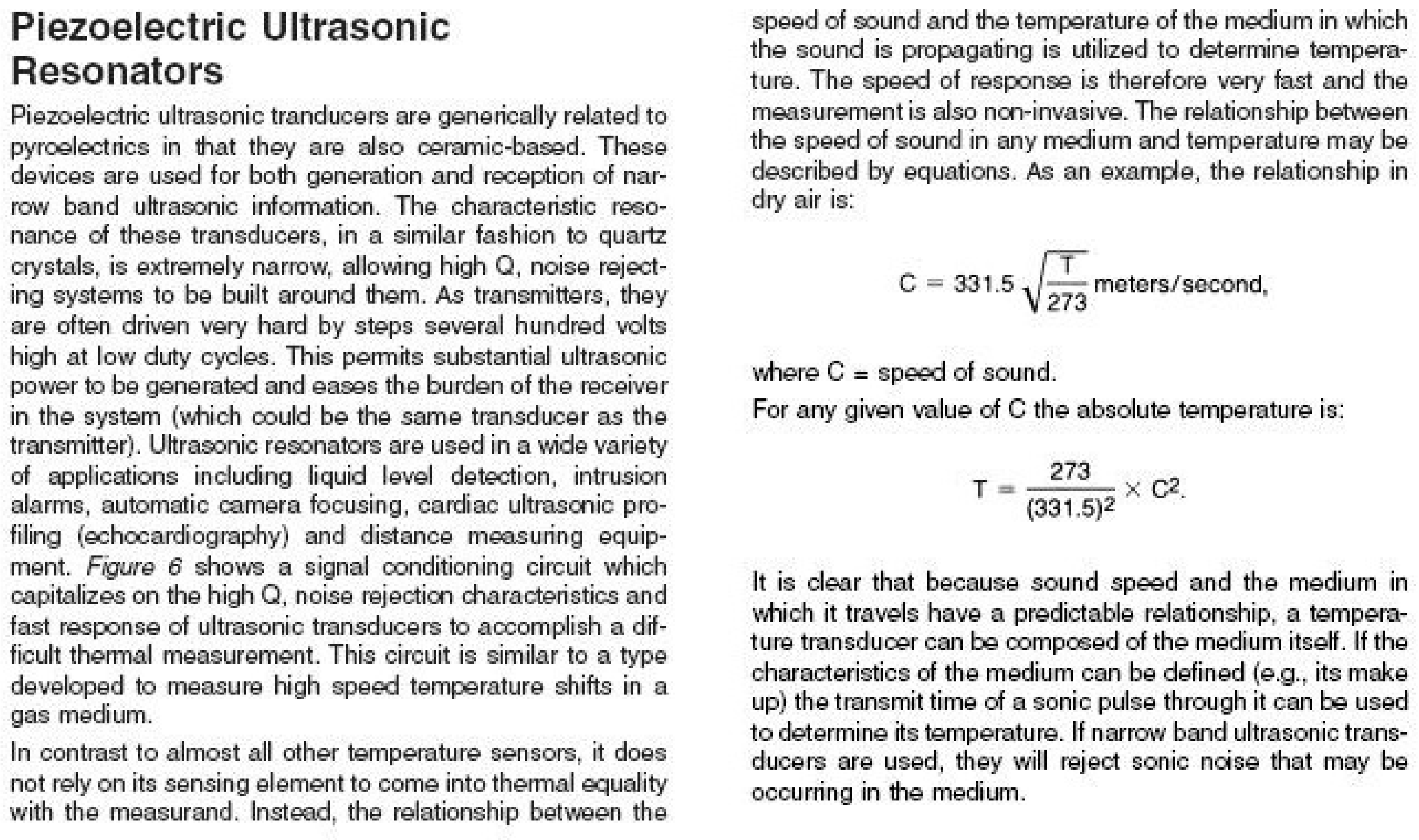
CIRCUITOS ACONDICIONADORES REALES

SISTEMA DE ADQUISICIÓN DE DATOS (DATA ACQUISITION SYSTEM)



CIRCUITOS ACONDICIONADORES REALES

Resonador ultrasónico piezoeléctrico



Piezoelectric Ultrasonic Resonators

Piezoelectric ultrasonic tranducers are generically related to pyroelectrics in that they are also ceramic-based. These devices are used for both generation and reception of narrow band ultrasonic information. The characteristic resonance of these transducers, in a similar fashion to quartz crystals, is extremely narrow, allowing high Q, noise rejecting systems to be built around them. As transmitters, they are often driven very hard by steps several hundred volts high at low duty cycles. This permits substantial ultrasonic power to be generated and eases the burden of the receiver in the system (which could be the same transducer as the transmitter). Ultrasonic resonators are used in a wide variety of applications including liquid level detection, intrusion alarms, automatic camera focusing, cardiac ultrasonic profiling (echocardiography) and distance measuring equipment. *Figure 6* shows a signal conditioning circuit which capitalizes on the high Q, noise rejection characteristics and fast response of ultrasonic transducers to accomplish a difficult thermal measurement. This circuit is similar to a type developed to measure high speed temperature shifts in a gas medium.

In contrast to almost all other temperature sensors, it does not rely on its sensing element to come into thermal equality with the measurand. Instead, the relationship between the speed of sound and the temperature of the medium in which the sound is propagating is utilized to determine temperature. The speed of response is therefore very fast and the measurement is also non-invasive. The relationship between the speed of sound in any medium and temperature may be described by equations. As an example, the relationship in dry air is:

$$C = 331.5\sqrt{\frac{T}{273}}\ \text{meters/second,}$$

where C = speed of sound.

For any given value of C the absolute temperature is:

$$T = \frac{273}{(331.5)^2} \times C^2.$$

It is clear that because sound speed and the medium in which it travels have a predictable relationship, a temperature transducer can be composed of the medium itself. If the characteristics of the medium can be defined (e.g., its make up) the transmit time of a sonic pulse through it can be used to determine its temperature. If narrow band ultrasonic transducers are used, they will reject sonic noise that may be occurring in the medium.

CIRCUITOS ACONDICIONADORES REALES

Resonador ultrasónico piezoeléctrico

El circuito está formado por una parte analógica y una parte digital.

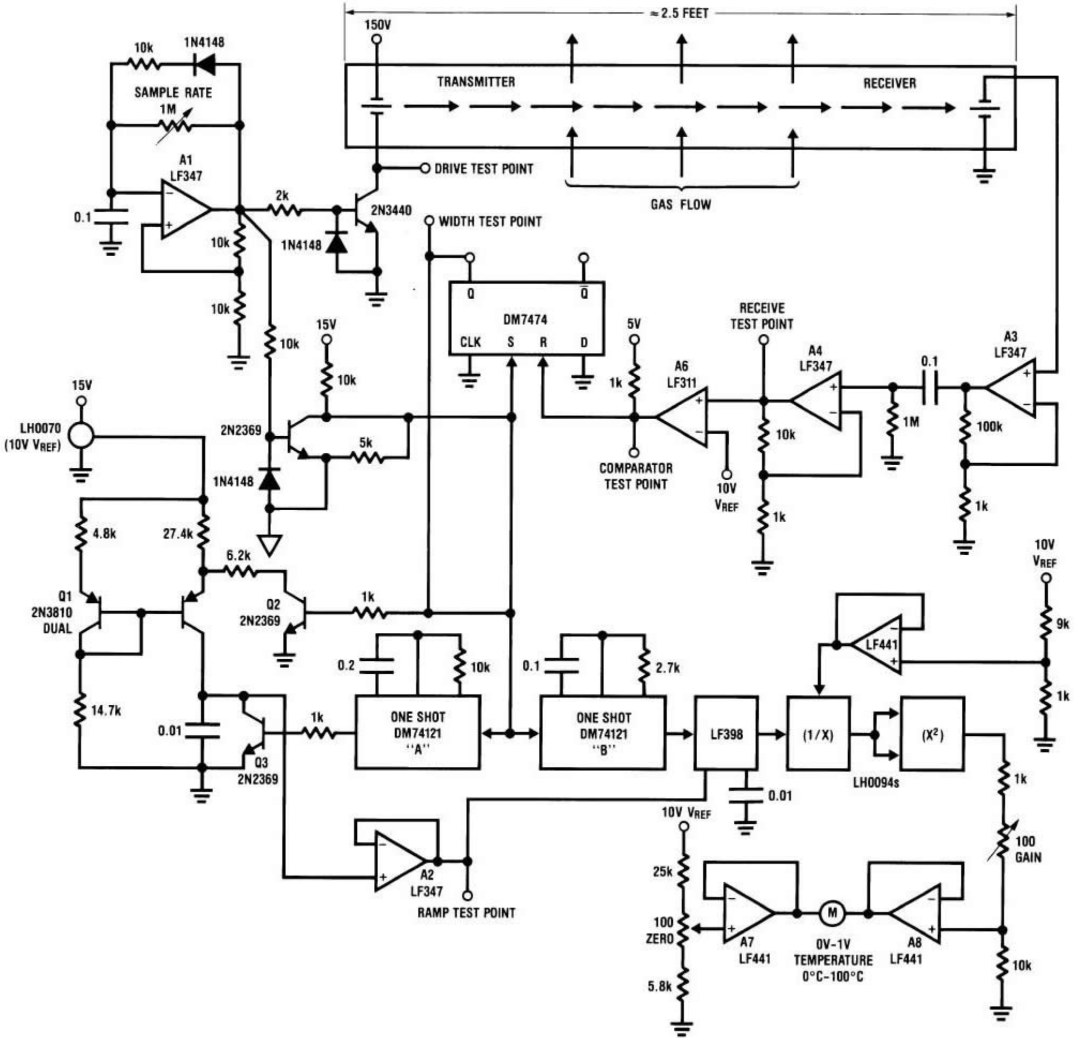
La parte analógica contiene:

- Una fuente de tensión de referencia (LH0070)
- Un generador de impulsos A1 (LF347)
- Un circuito de espejo de corriente del que forman parte los dos transistores del circuito 2N3810

La parte digital está realizada con biestables y monoestables pero puede ser sustituida con ventaja por un microcontrolador.

CIRCUITOS ACONDICIONADORES REALES

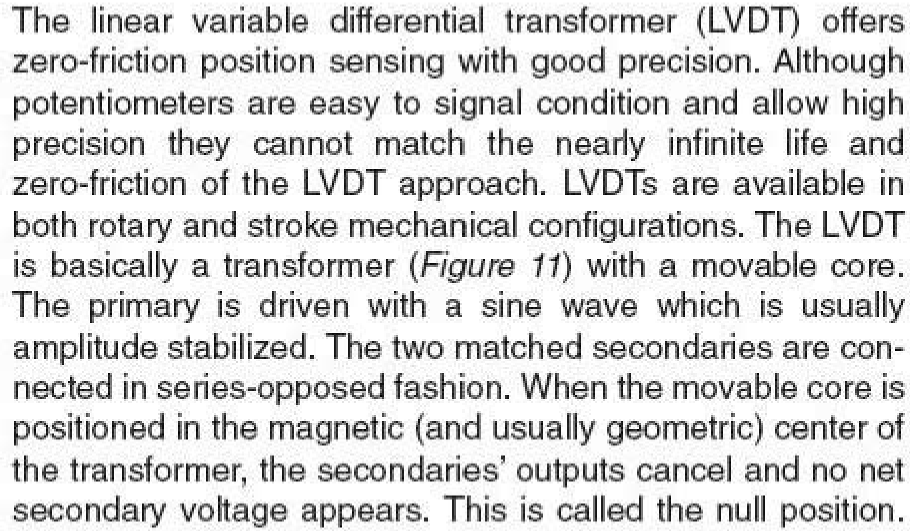
Resonador ultrasónico piezoeléctrico



CIRCUITOS ACONDICIONADORES REALES

Sensor de posición realizado con una LVDT

Es un ejemplo de circuito acondicionador que utiliza un oscilador senoidal y un procesador analógico que proporciona a su salida una señal analógica continua proporcional al desplazamiento del núcleo de un transformador diferencial.



The linear variable differential transformer (LVDT) offers zero-friction position sensing with good precision. Although potentiometers are easy to signal condition and allow high precision they cannot match the nearly infinite life and zero-friction of the LVDT approach. LVDTs are available in both rotary and stroke mechanical configurations. The LVDT is basically a transformer (*Figure 11*) with a movable core. The primary is driven with a sine wave which is usually amplitude stabilized. The two matched secondaries are connected in series-opposed fashion. When the movable core is positioned in the magnetic (and usually geometric) center of the transformer, the secondaries' outputs cancel and no net secondary voltage appears. This is called the null position.

CIRCUITOS ACONDICIONADORES REALES

Sensor de posición realizado con una LVDT

As the core is moved from null, the differential in flux coupled to the two secondaries produces a net voltage difference across them.

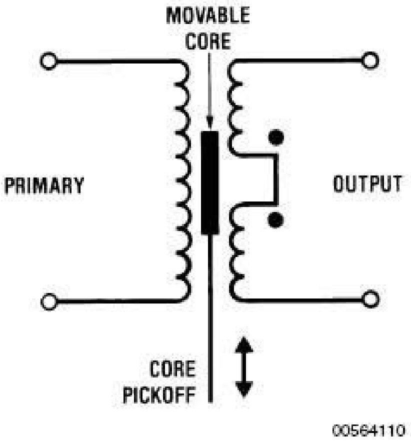


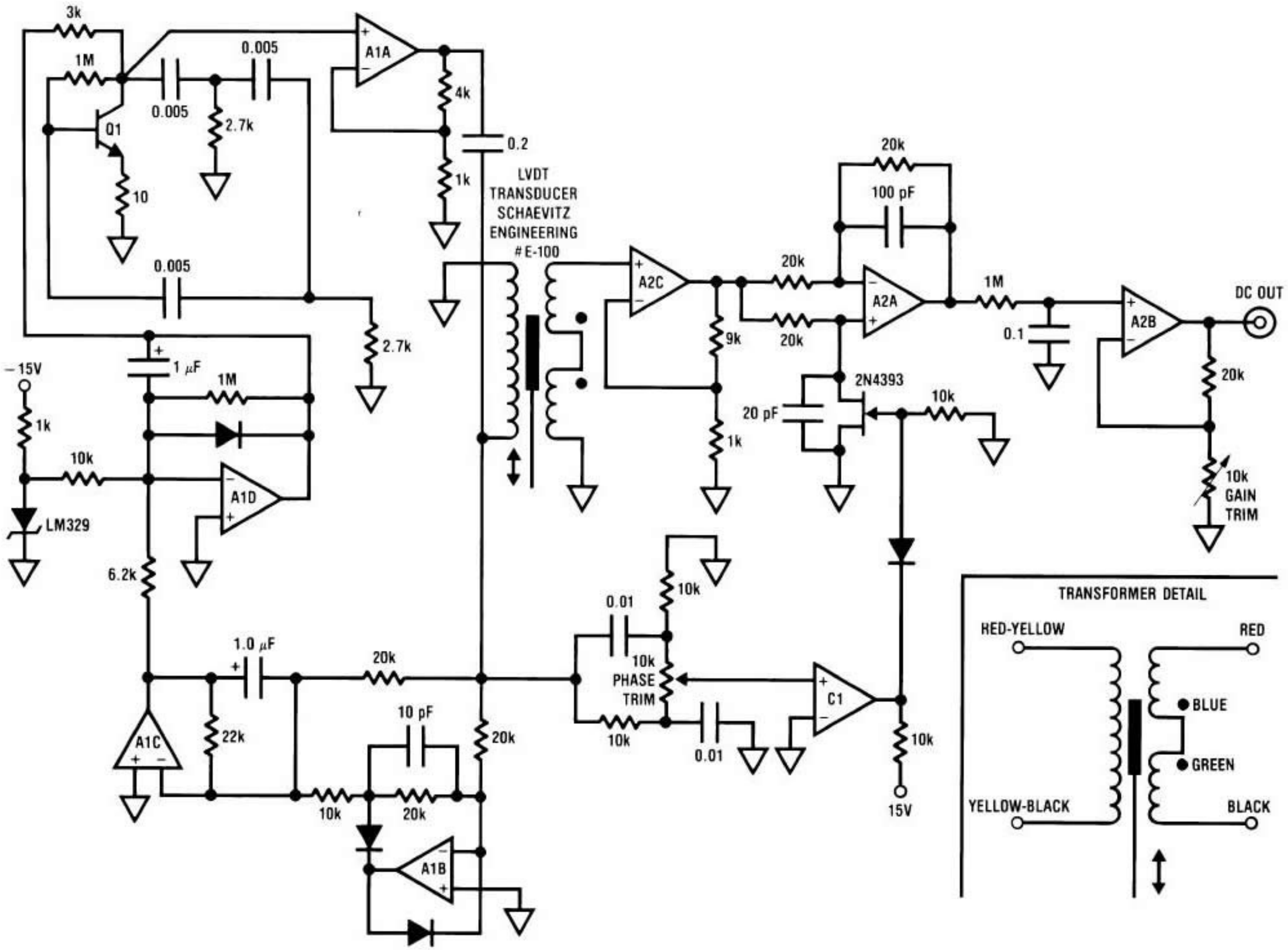
FIGURE 11.

This is the output of transducer. Good transducer performance (e.g., null cancellation characteristics, linearity, etc.) requires manufacturer attention to winding techniques, magnetic shielding, material choices and other issues. Rectifying and filtering the output signal will yield only amplitude information. Optimum signal conditioning requires a phase sensitive demodulation scheme. This gives the amplitude and also polarity information necessary to determine on which side of null the LVDT core is.

Figure 12 shows a circuit which does this. Waveforms of operation are given in *Figure 13*. In this circuit, Q1 and its associated components from a phase shift oscillator which runs at 2.5 kHz, the manufacturer's specified transducer operating frequency. A1A amplifies and buffers Q1's output and drives the LVDT (waveform A, *Figure 13*). Since the transducer's output will vary with drive level, feedback is used to stabilize the 2.5 kHz amplitude. A1C and A1D full wave rectify a sample of the drive waveform. A1C's filtered output is applied to A1D, a servo amplifier. A1D compares A1C's output to the LM329 reference and drives the Q1 oscillator to complete an amplitude stabilization loop. The LVDT's output is amplified by A2C and fed to A2A. A2A is a unity gain ampilifer whose sign alternates between "+" and "–". Synchronous switching for A2A comes from C1 (waveform B, *Figure 13*), which is driven by the modulation sine wave output via a phase shift network. The phase trim network compensates phase shift in the LVDT and ensures that C1 switches at the zero crossings relative to A2A's output. When C1's output is low, the 2N4393 FET is off and A2A's positive input (waveform C, *Figure 13*) receives signal. When the sine wave reverses polarity, C1's output goes high, turning on the FET, which grounds A2A's "+" input. Under these conditions A2A is always switching its amplification's sign from "+" to "–" in synchronism with the sine wave output from the LVDT. A2A's phase sensitive output, in this case positive, appears in trace D, *Figure 13*. A2B provides a scaled and filtered DC output. To trim the circuit, set the LVDT to at least ½ physical displacement and adjust the phase trim for maximum output indication. Next, adjust the gain trim for the desired circuit output at full-scale LVDT displacement.

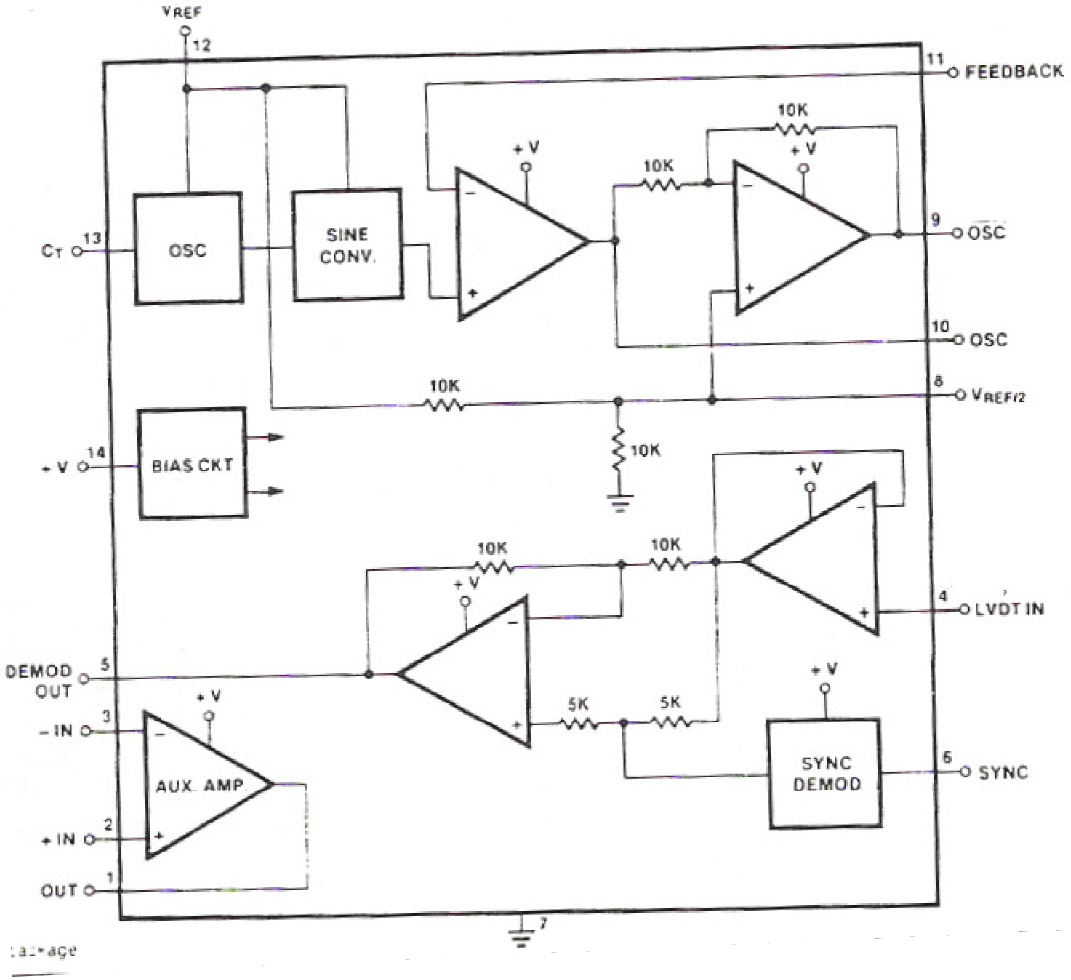
CIRCUITOS ACONDICIONADORES REALES

Sensor de posición realizado con una LVDT



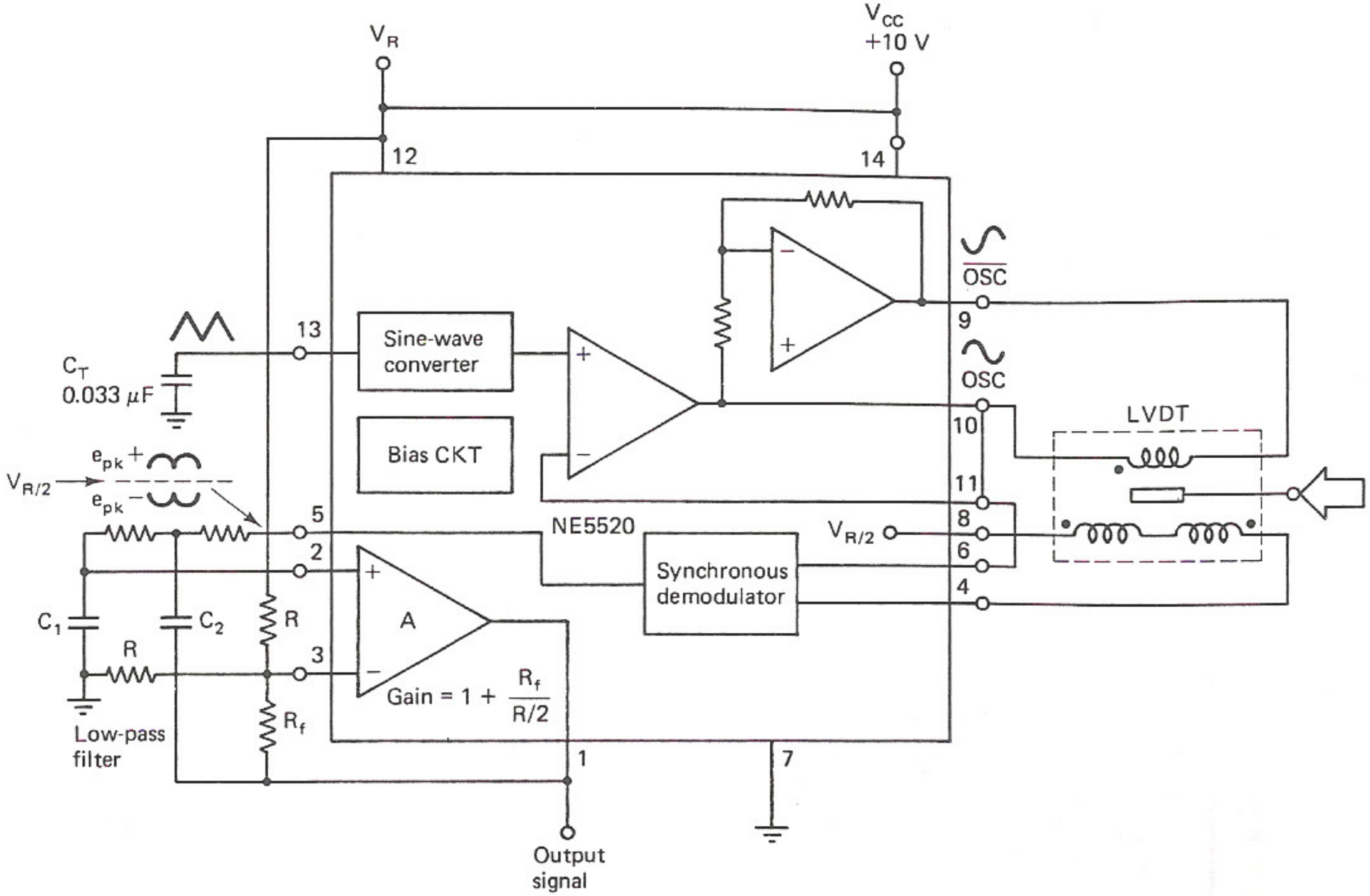
CIRCUITOS ACONDICIONADORES REALES

NE/SE5520: CI de acondicionamiento de señal de una LVDT (*Standard ASIC*)



CIRCUITOS ACONDICIONADORES REALES

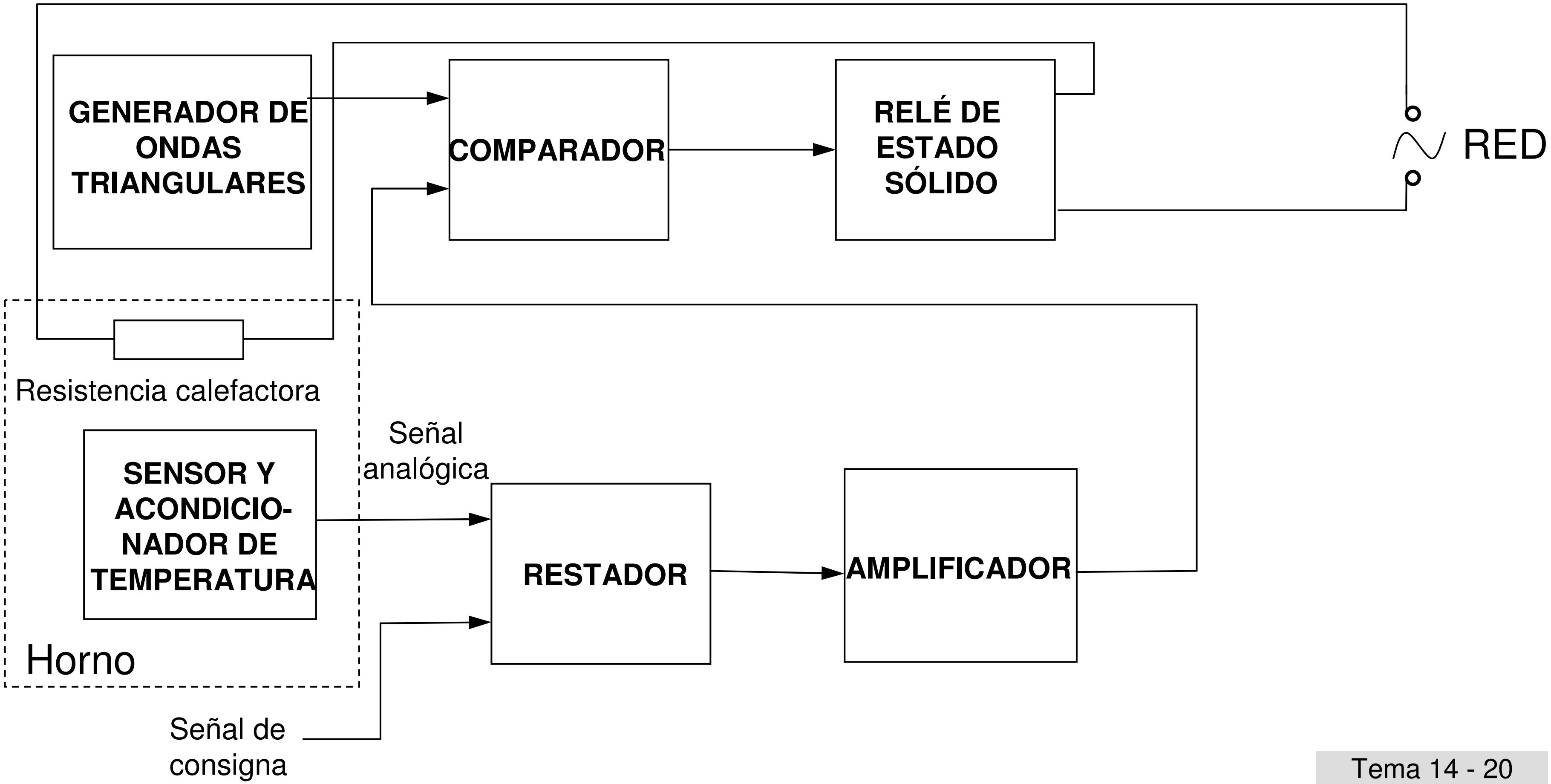
Circuito de aplicación del circuito integrado NE/SE5520



CIRCUITOS ACONDICIONADORES REALES

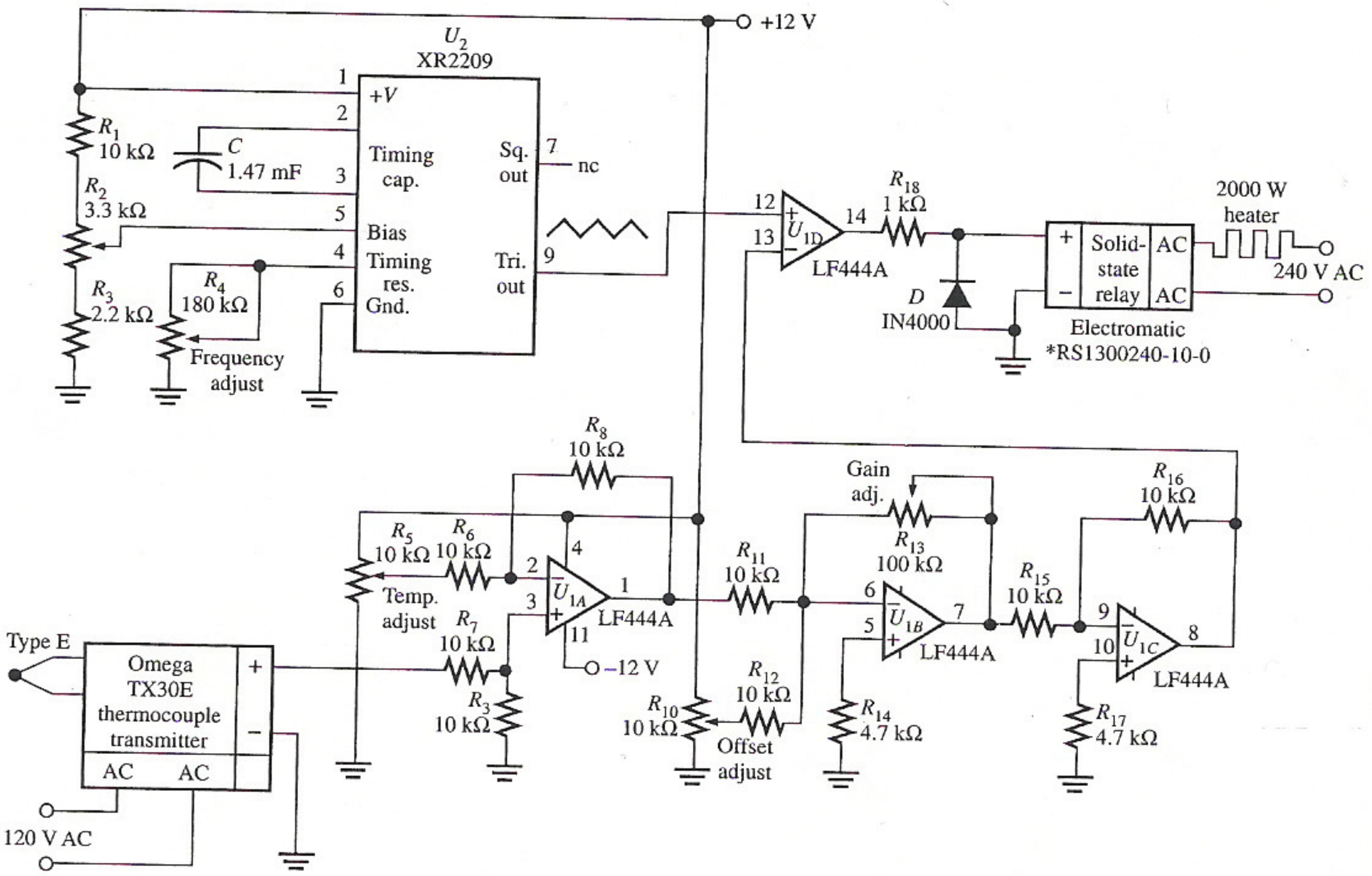
Sistema de control de temperatura que genera una señal PWM

Diagrama de bloques



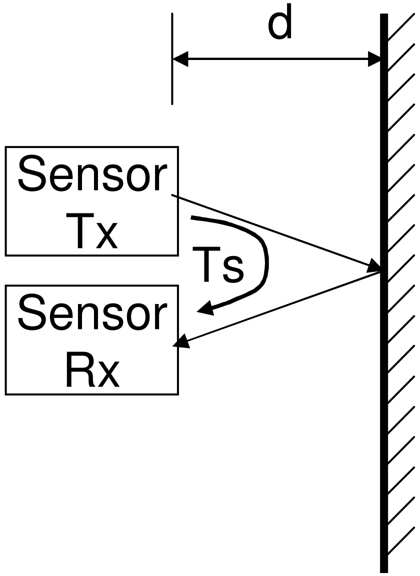
CIRCUITOS ACONDICIONADORES REALES

Implementación del sistema de control de temperatura que genera una señal PWM



CIRCUITOS ACONDICIONADORES REALES

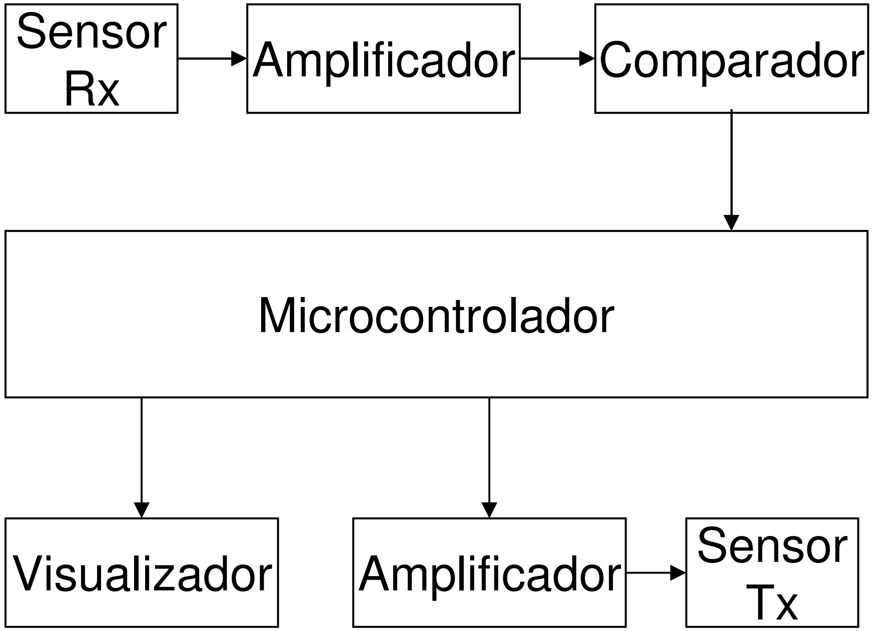
Sistema de medida de la distancia con un sensor de ultrasonidos y un microcontrolador. Principio de funcionamiento (a). Esquema general (b).



$$d = \frac{1}{2} V s T s$$

d: Distancia
Ts: Tiempo de retorno
Vs: Velocidad del sonido (344m/s)

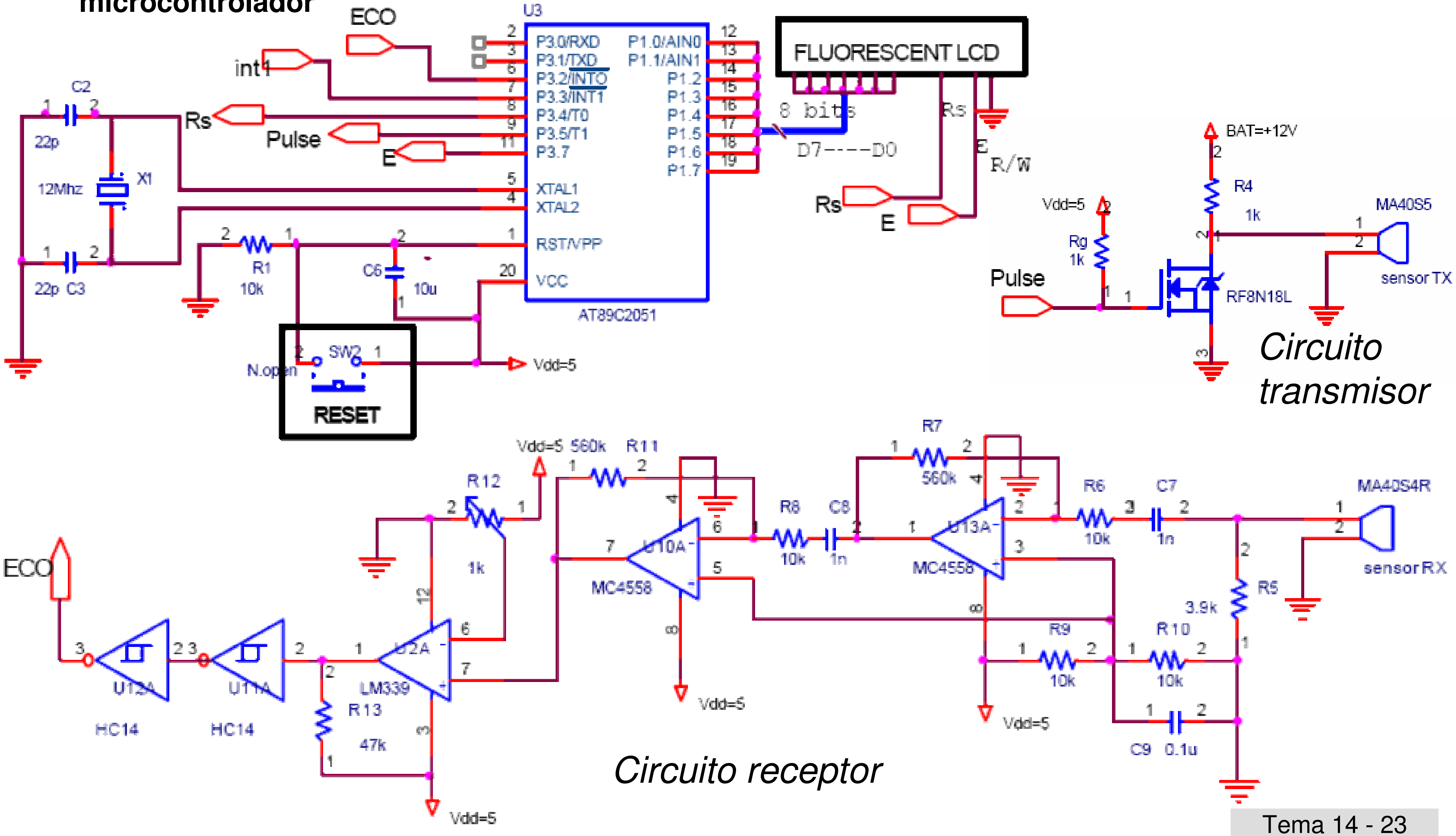
(a)



(b)

CIRCUITOS ACONDICIONADORES REALES

Implementación del sistema de medida de distancia con un sensor de ultrasonidos y un microcontrolador



Circuito transmisor

Circuito receptor