

## Thin Film Applications

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Thin film is the preferred generic description for the field of micro-electronics in which conductive, resistive, and/or insulating films are deposited or sputtered on a ceramic or other insulating substrate. The films can be deposited either in a required pattern or as a complete film layer and photoprocessed and etched to form the required pattern.

The term "thin film" is derived from the fact that the deposited films are of the order of a few micrometers in thickness compared with the 10 to 50 micrometers for thick film. Often, thin film conductors are plated to improve conductivity.

### Thin Film Applications

Thin film resistor networks typically find application in the analog world. The number one use of thin film is in controlling the gain on operational amplifiers. Some other applications are as a stable reference, stable voltage division, stable feedback loops and analog to digital or digital to analog conversion. These networks may also be used for "wire-OR" pull-up, ECL output pull-down, TTL input pull-down, power down pull-up, open collector pull-up, digital pulse squaring, current summing amplifiers, TTL unused gate pull-up, TTL/MOS interfacing, coding and decoding, and telemetry.

Thin film resistors in a network form offer additional benefits in performance. The resistors in a network are more closely matched in resistance and TCR and actually see reduced differentials of temperature in the end use application. These combine to provide improved tracking in networks. This improved tracking would be an advantage to the instrumentation and industrial control markets.

Potential target markets for thin film include harsh environmental conditions as well as the need for precision resistors. The improved ability to be stable at extended temperatures and the increased ability to handle moist environments are both benefits of the thin film offering. Target applications such as automotive and telecommunications will benefit from these capabilities.

### Thin Film Vs. Thick Film

The basic distinction between thick film and thin film is the method of deposition of the metallization. In thick film, specially formulated pastes are applied and fired onto a substrate. The pastes are usually applied with a silk screen method and the substrate is of 96% alumina ceramic. In thin film, a layer of metallization is sputtered onto a substrate and then a pattern is etched into the previously applied metal layer, the substrates are often 99.5% alumina ceramic, silicon, or glass. Thick film is an additive process where layers of termination and resistor material are added to the substrate, while thin film is a subtractive process where the unwanted material is etched away in a succession of selective photoetching processes. The use of photolithographic processes to form thin film patterns produce much

finer lines and traces than thick film processes. Thin film is very appropriate for high density and high frequency applications.

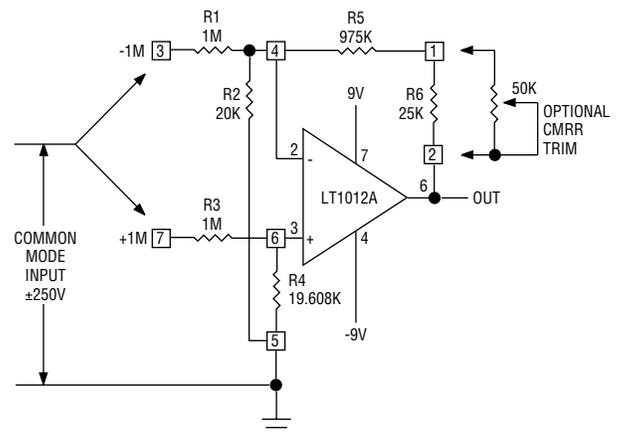
Thick and thin film technologies are well suited for low to medium volume custom circuits. Thick film has the advantages of lower cost (both of tooling up new designs and of production runs), of being able to handle more power, and of being able to service a higher range of ohmic values. Thin film has the advantages of tighter absolute and ratio tolerances and more environmentally stable components with lower noise and tighter TCR than thick film.

Thin film technology is used wherever precision resistors are needed.

### Differential Op-amp Input

Differential Op Amps are needed in electrically dirty environments to reject noise transients that are picked up by wires. The differential Op Amps subtracts the noise out of the two signal wires.

Thin film tracking capabilities are needed in these circuits to ensure that the input resistors do not affect the contents of the incoming signal.



TYPICAL PERFORMANCE:  
COMMON MODE REJECTION RATIO = 74dB (RESISTOR LIMITED)  
WITH OPTIONAL TRIM = 130dB  
OUTPUT OFFSET (TRIMMABLE TO ZERO) = 500µV  
OUTPUT OFFSET DRIFT = 10µV/°C  
INPUT RESISTANCE = 1M (CM)  
2M (DIFF)  
BANDWIDTH = 13KHz  
BATTERY CURRENT = 370µA

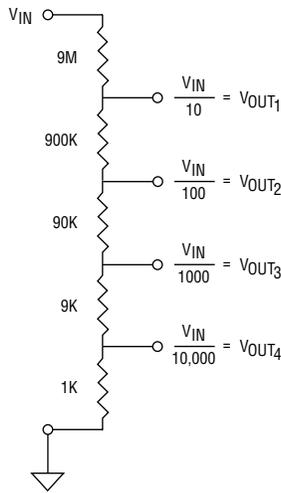
±250V Common Mode Range Instrumentation Amplifier ( $A_v=1$ )

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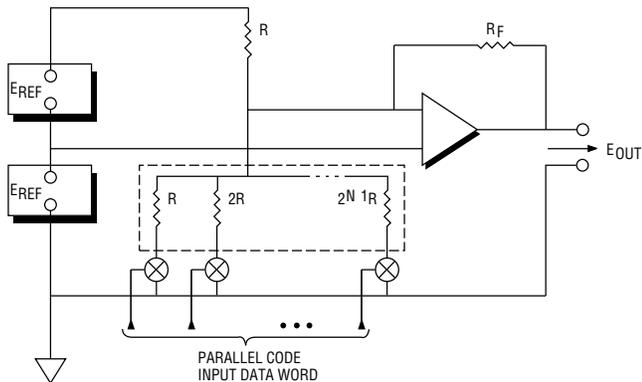
### Voltage Divider

Voltage dividers are used to step down voltages for analog processing. Applications are found in multi-meters, oscilloscopes, oscillator stage of voltage control oscillators, etc. The application needs precise resistors to ensure that errors are not added during the conversion process.



### Data Conversion

Data converters are used to convert digital data to analog signals or vice versa. The precision of the high bit affects the overall precision of the data converter. Thus, thick film resistors are used in the lower bits while the thin film or bulk foil resistors are used in the high order bits.



Parallel bit conductance switching D/A converter.

### THICK FILM VS. THIN FILM STANDARD VS. PRECISION

Parameter	Thick Film Circuits	Thin Film Circuits
Resistance	3 Ω to 20MΩ	10Ω to 100KΩ
Resistance Tolerance	.5%, 1%, 2%, 5%	.1%, .2%, .5%
TCR	±100ppm/°C	±25ppm/°C
TCR Tracking	100ppm/°C	5ppm/°C
Operating Temperature	-55°C to +125°C	-55°C to +125°C
Max. Operating Voltage	100 volts	50 volts
Resistor Power	.125W to .5W	.1W to .2W