

## Endüstriyel Otomatik Kontrol Sistemleri

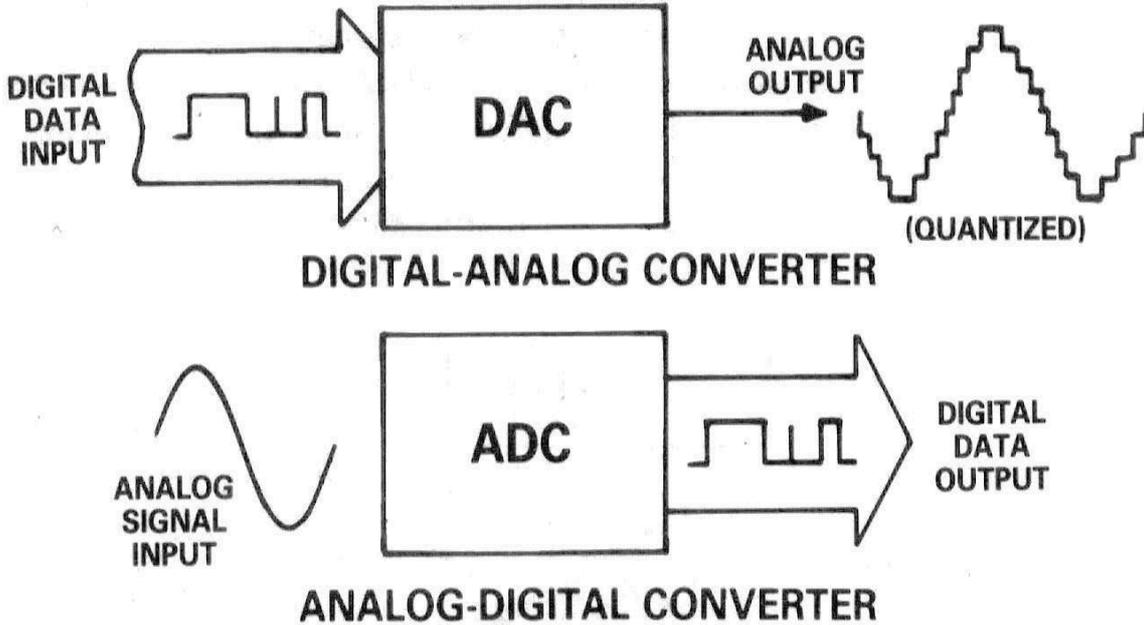
Y.Doç.Dr. Tuncay UZUN, EHM 6105

### Dersin Konusu: Veri Dönüştürücüler (ADC,DAC,F/V,V/F) ve Uygulamaları

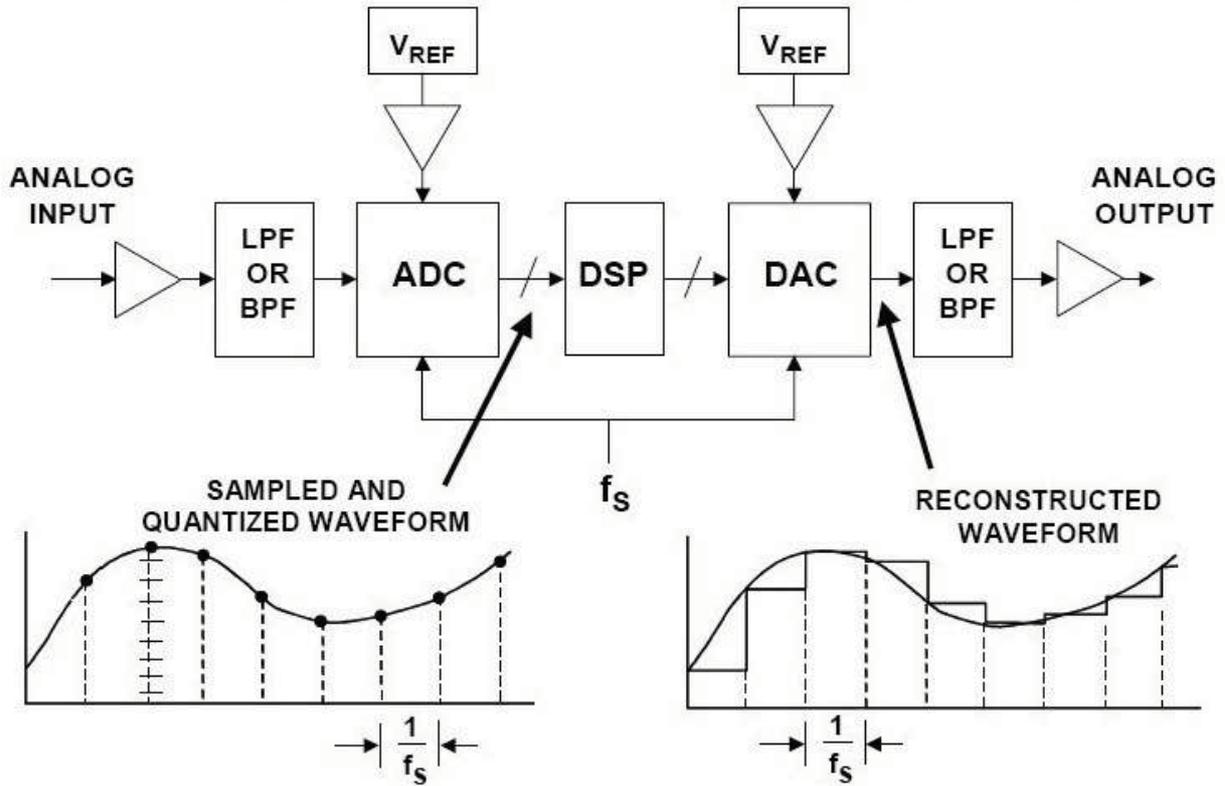
#### Dersin Amacı:

Endüstriyel otomatik kontrol sistemlerinde kullanılan veri dönüştürücülerin özellikleri, iç donanımı ve elektronik devrelerinin incelenmesi, uygulama devrelerinin analizi, incelenmesi ve tasarlanmasının öğretilmesidir.

### Veri Dönüştürücüler

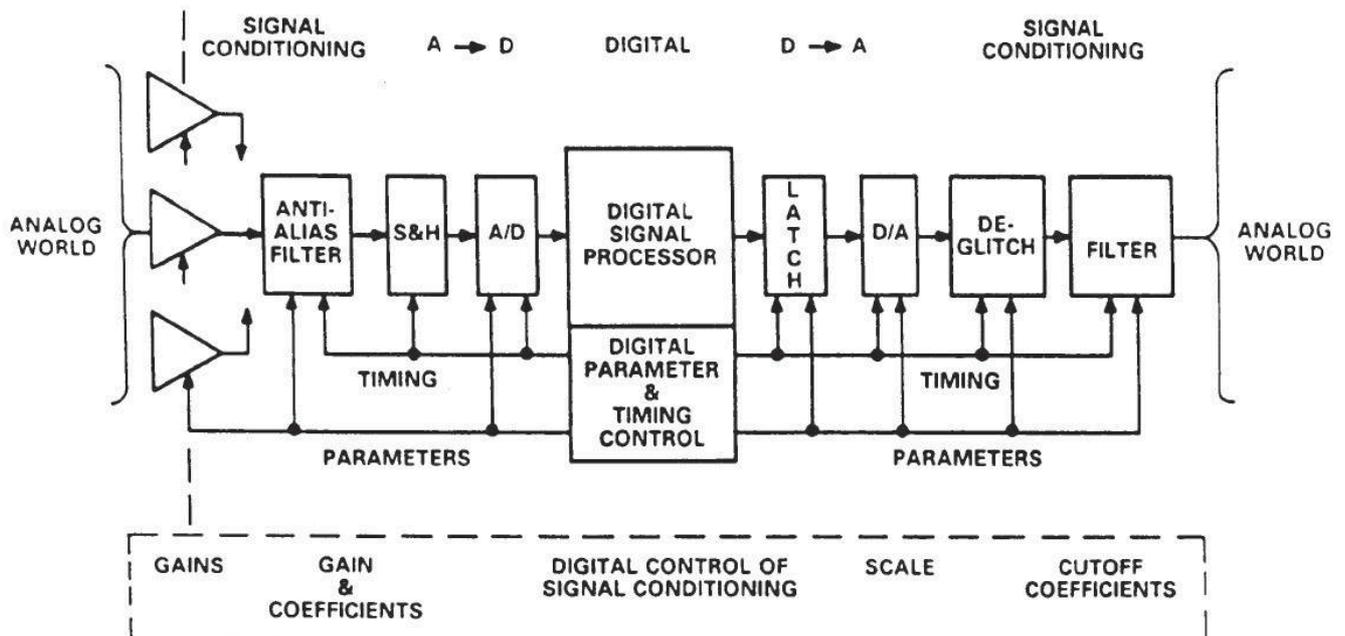


## ÖRNEKSEL (ANALOG) SAYISAL (DIGITAL) VERİ İŞLEME



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## ÖRNEKSEL SAYISAL VERİ İŞLEME (DEVAM)



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# SAYISAL ÖRNEKSEL DÖNÜŞTÜRÜCÜLER (DAC)

## GİRİŞ ÖZELLİKLERİ

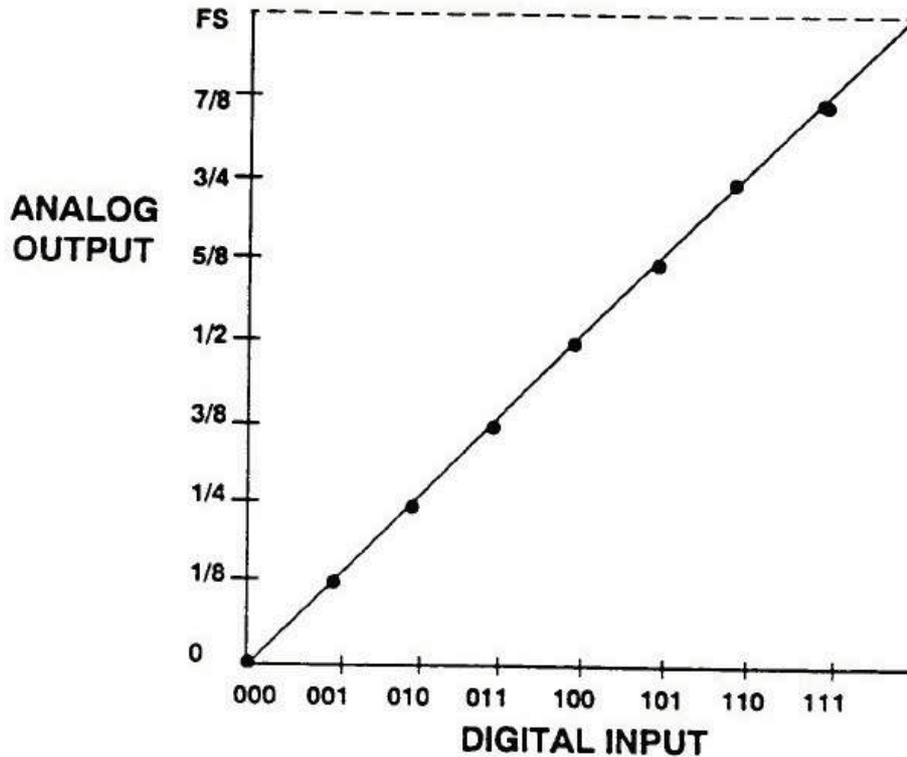
Lojik Tipi	TTL, ECL, CMOS, $\pm 4\text{mA}$ vb.
Veri Biçimi	İkili, Tümleyen ikili, BCD, Gray Kodu vs.
Yapısı	Paralel veya Seri
Ayırıcılık	8,10,12,14,16,24 Bit ikili, $2\frac{1}{2}$ , $3\frac{1}{2}$ , $4\frac{1}{2}$ , $5\frac{1}{2}$ Basamak BCD vb.

## ÇIKIŞ ÖZELLİKLERİ

Çıkış Tipi	Gerilim, Akım veya Direnç (zayıflatma)
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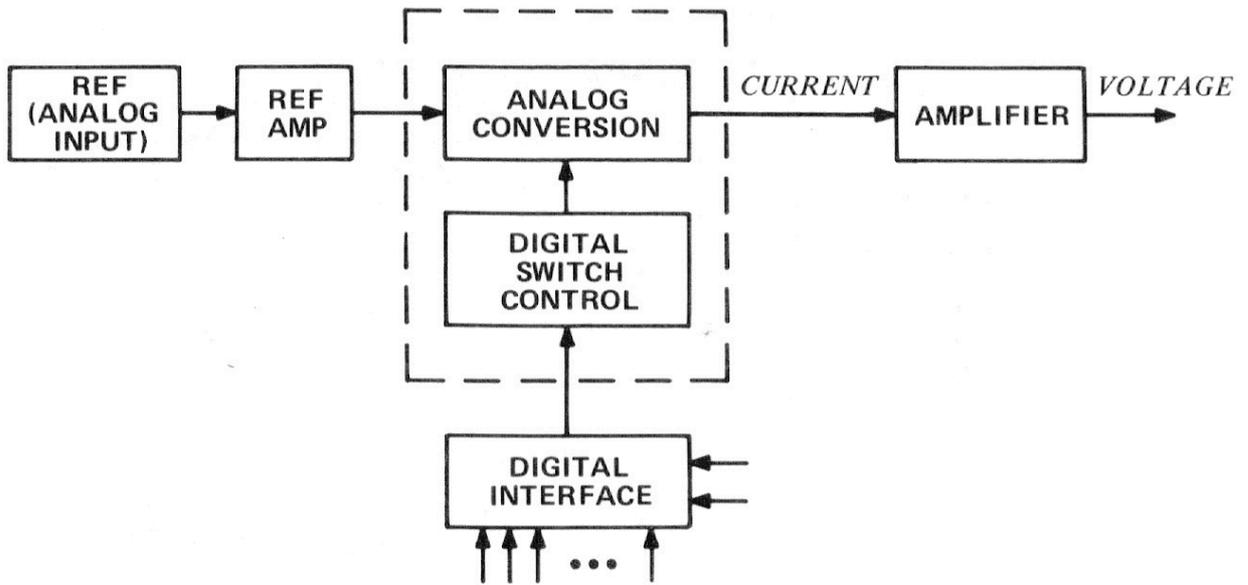
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## DAC DÖNÜŞÜM KARAKTERİSTİĞİ



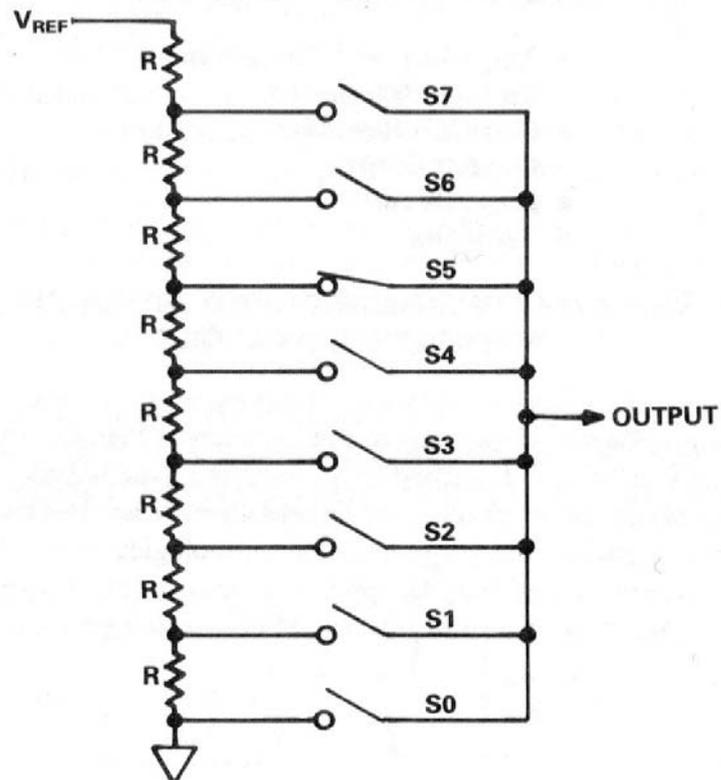
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## DAC GENEL BLOK DİYAGRAMI



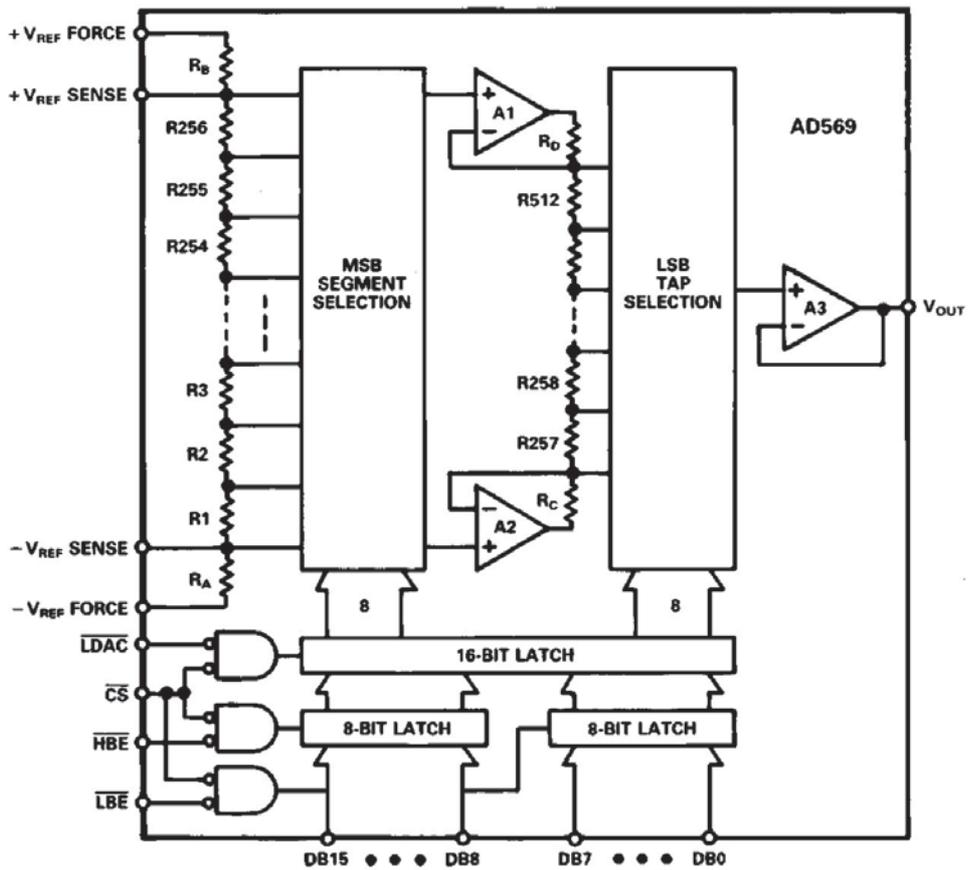
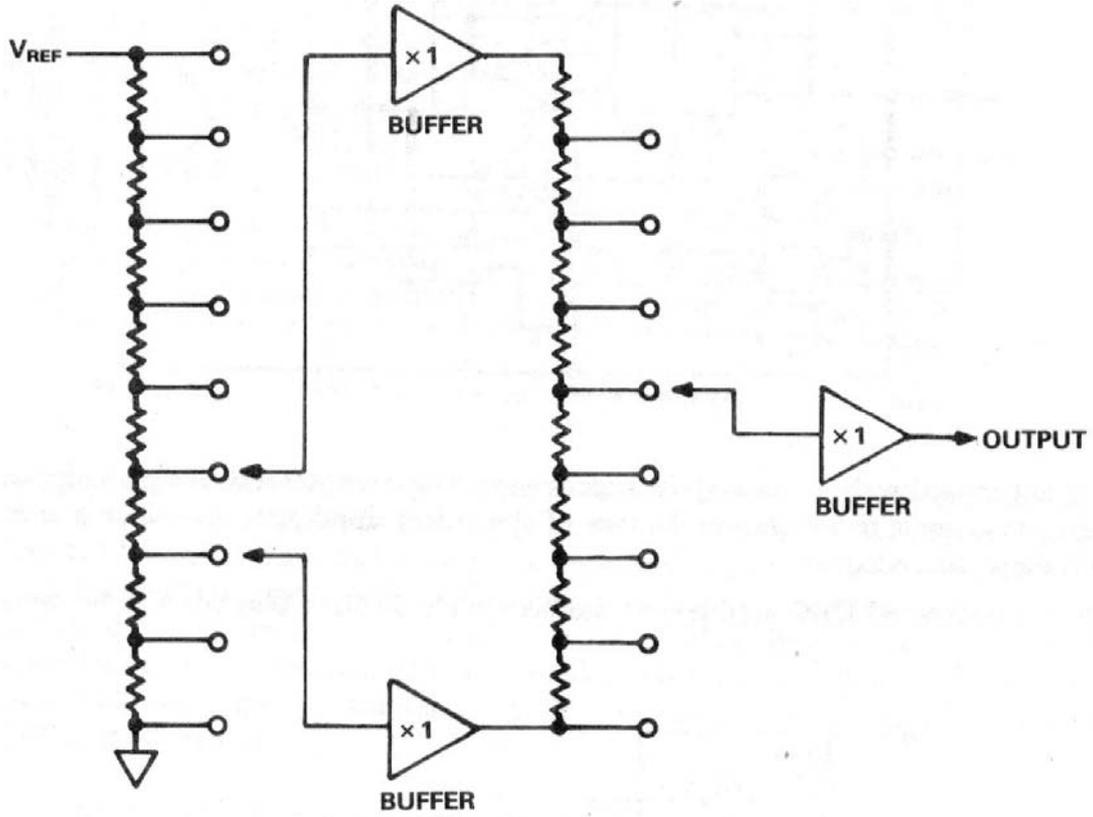
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## DAC DEVRELERİNİN TEMEL YAPISI

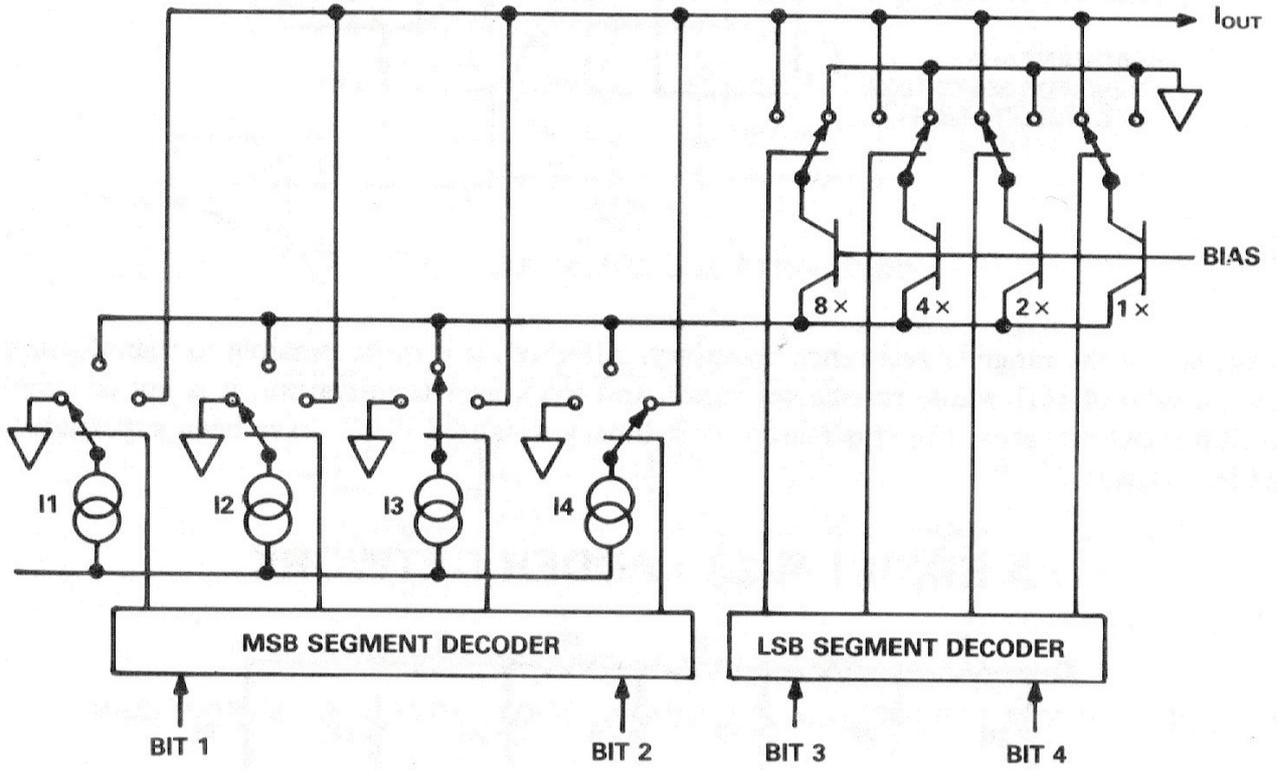


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# GERİLİM BÖLMELİ DAC

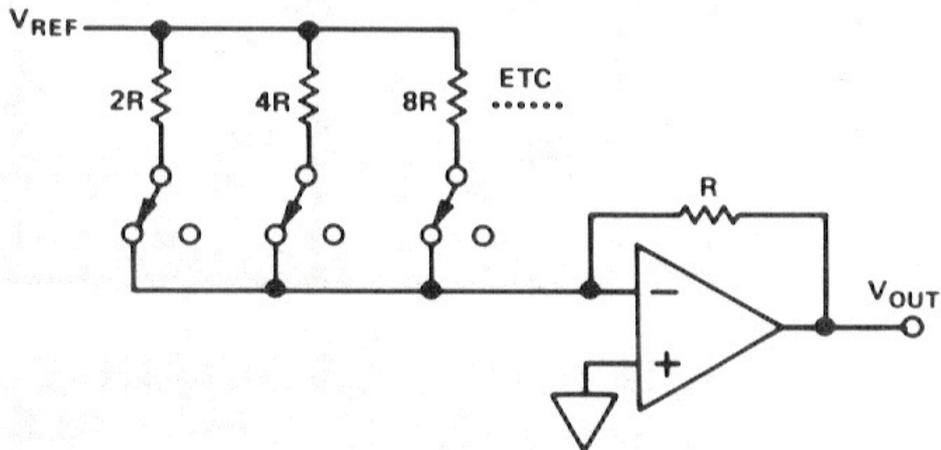


## AKIM BÖLMELİ DAC



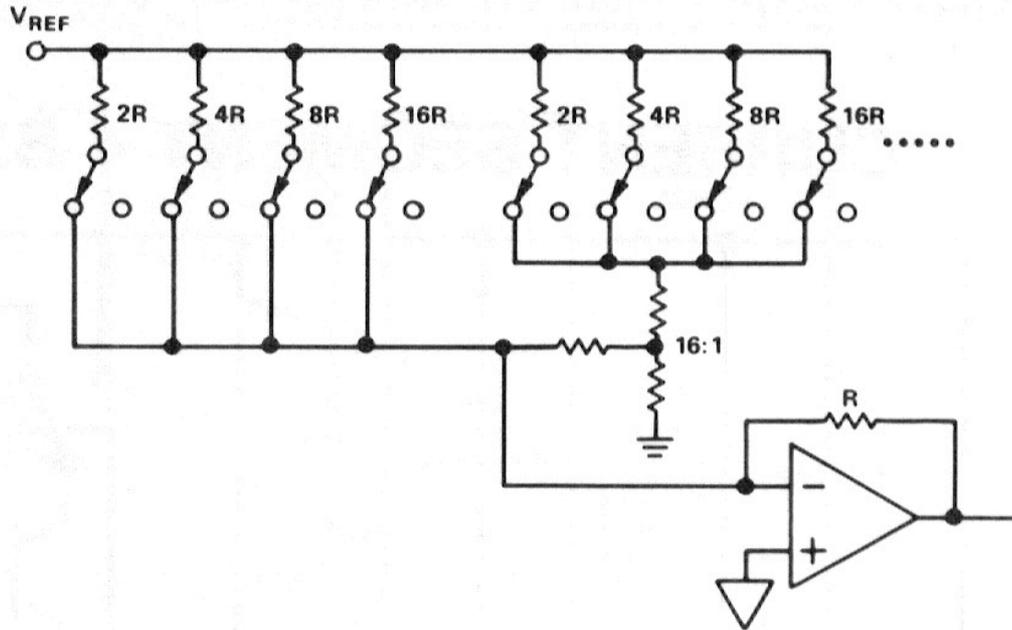
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## İKİLİ-AĞIRLIKLI DİRENÇLİ DAC



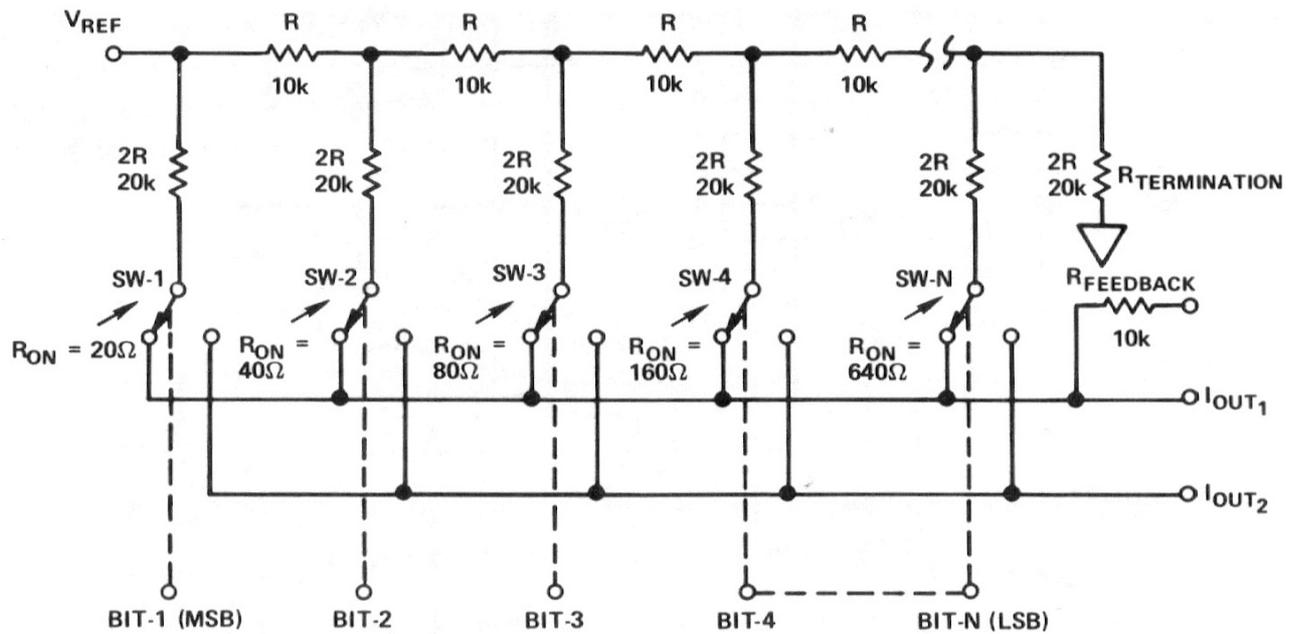
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## ARDIŞIL İKİLİ-AĞIRLIKLI DİRENÇLİ DAC



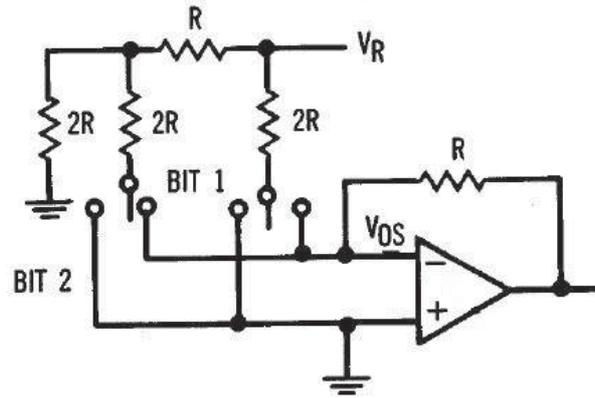
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## N-Bit R-2R MERDİVEN DEVRESİ



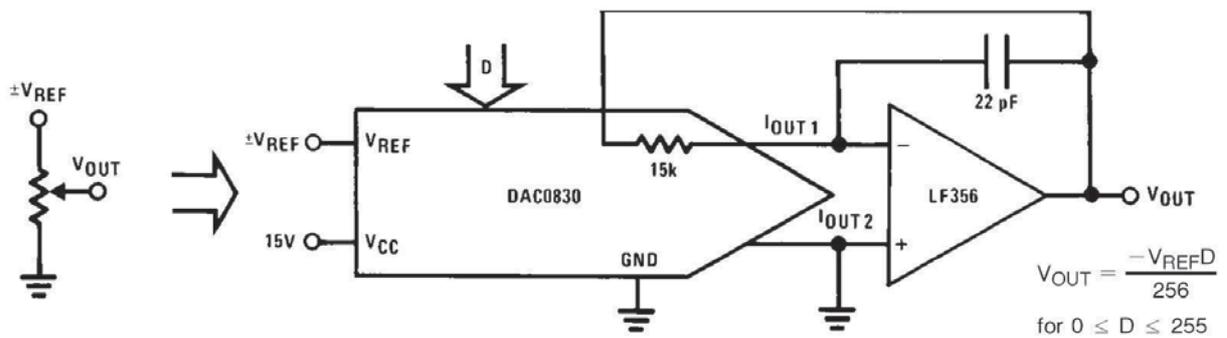
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## R-2R DİRENÇLİ DAC



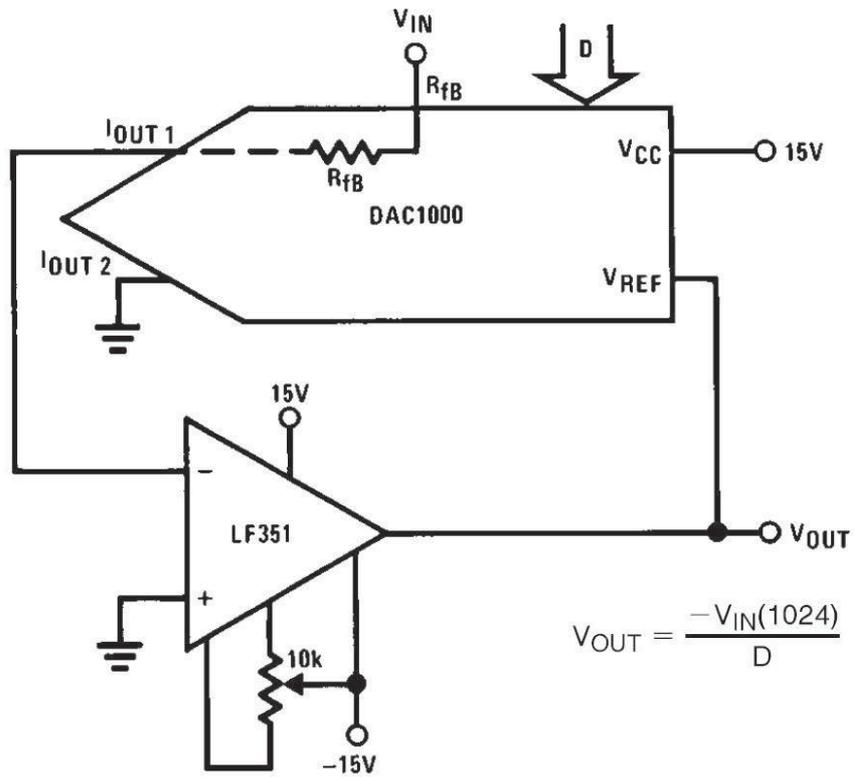
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## DAC UYGULAMALARI

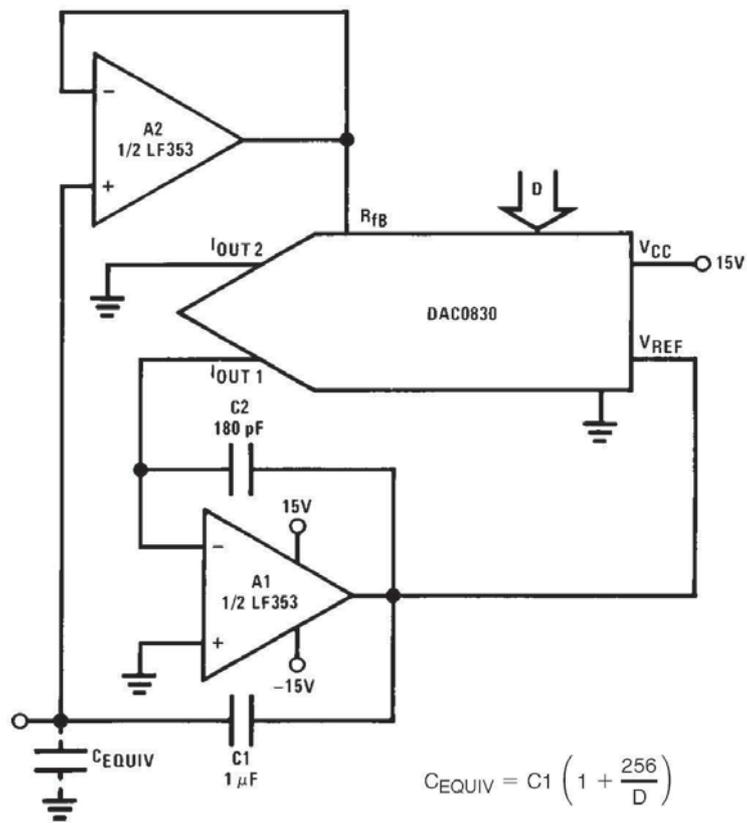


The Digital Pot

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**DAC Controlled Amplifer**



**Capacitance Multiplier**

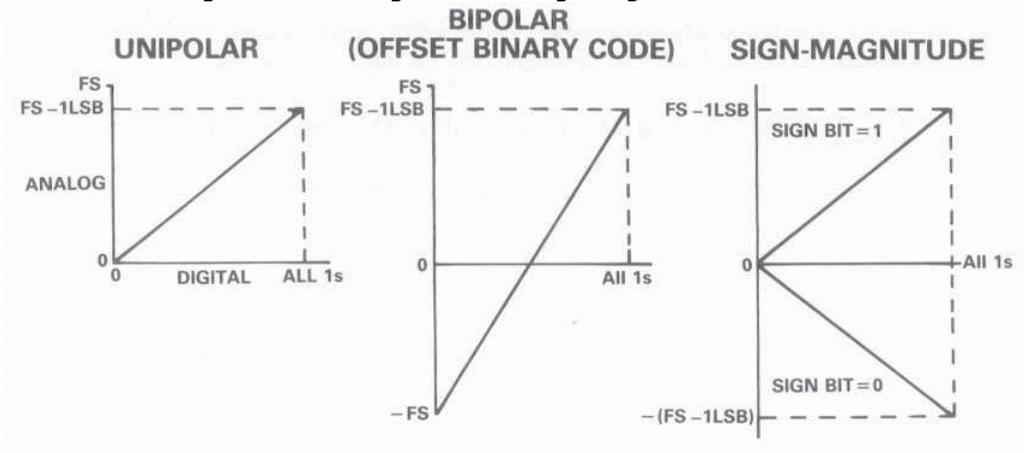
## ÖRNEKSEL SAYISAL DÖNÜŞTÜRÜCÜLER (ADC)

<b>Flash and Half-Flash</b>	<ul style="list-style-type: none"><li>● Fast</li><li>● Power-Hungry</li><li>● Lower Resolution</li></ul>
<b>Integrating</b>	<ul style="list-style-type: none"><li>● High Resolution</li><li>● Inexpensive</li><li>● Slow</li><li>● Noise Immune</li></ul>
<b>Voltage-Frequency Converters (VFCs)</b>	<ul style="list-style-type: none"><li>● Fast Response But Slow Conversion</li><li>● Serial</li><li>● High Resolution</li><li>● Noise Immune</li></ul>
<b>Tracking (Counter/Comparator)</b>	<ul style="list-style-type: none"><li>● Fast in Track</li><li>● Slow in Multi-Channel Applications</li><li>● Susceptible to Noise</li></ul>
<b>Successive Approximation</b>	<ul style="list-style-type: none"><li>● Quite Fast</li><li>● Flexible and Versatile</li><li>● Accurate</li></ul>
<b>Floating-Point</b>	<ul style="list-style-type: none"><li>● Uses Any Type of ADC</li><li>● Wide Dynamic Range</li><li>● Complex</li></ul>

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### GİRİŞ ÖZELLİKLERİ

**Giriş Tipi** Tek yönlü, İki yönlü veya işaretli

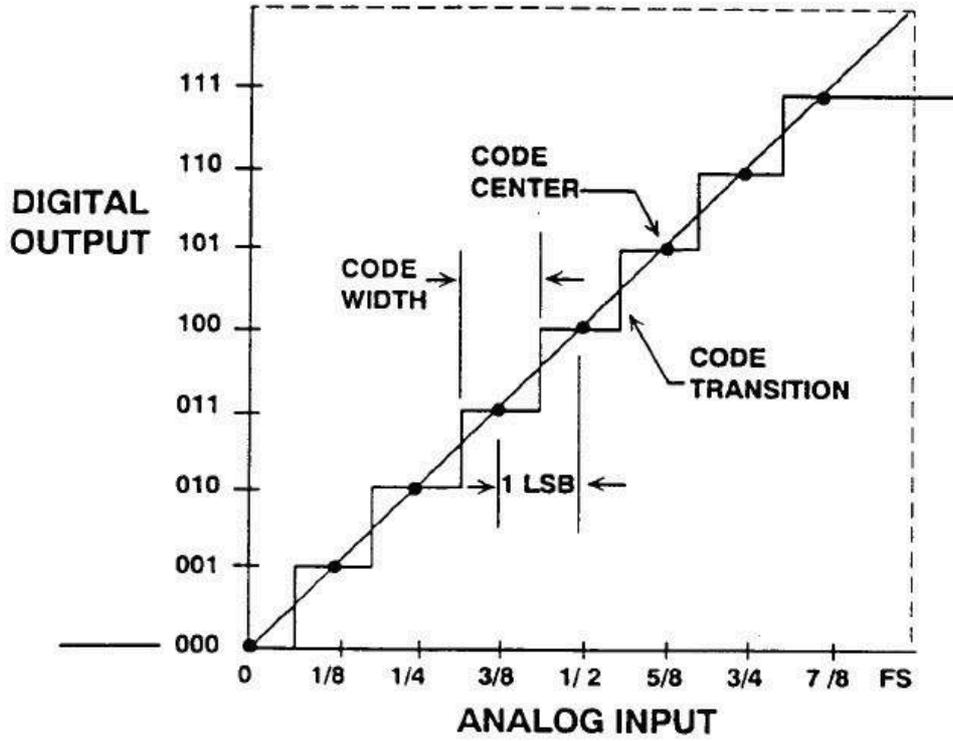


### ÇIKIŞ ÖZELLİKLERİ

**Lojik Tipi** TTL, ECL, CMOS,  $\pm 4\text{mA}$  vb.  
**Veri Biçimi** İkili, Tümleyen ikili, Kayan noktalı ikili, BCD, Gray Kodu, Gösterge vs.  
**Yapısı** Paralel veya Seri  
**Ayırıcılık** 8,10,12,14,16,24-Bit ikili,  $2\frac{1}{2}$ ,  $3\frac{1}{2}$ ,  $4\frac{1}{2}$ ,  $5\frac{1}{2}$ -Basamak BCD vb.

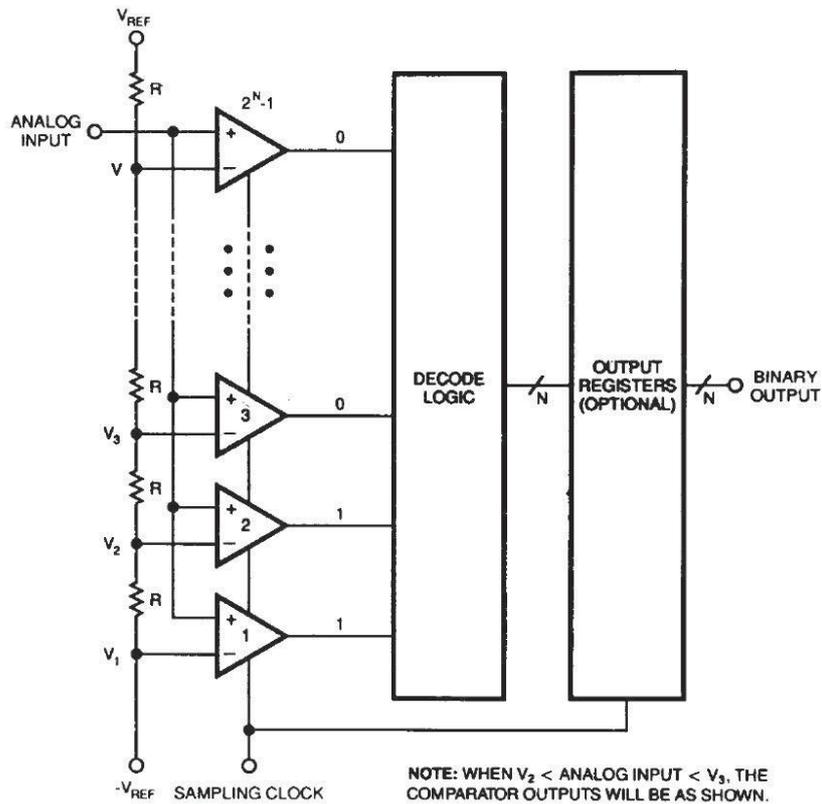
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## ADC DÖNÜŞÜM KARAKTERİSTİĞİ



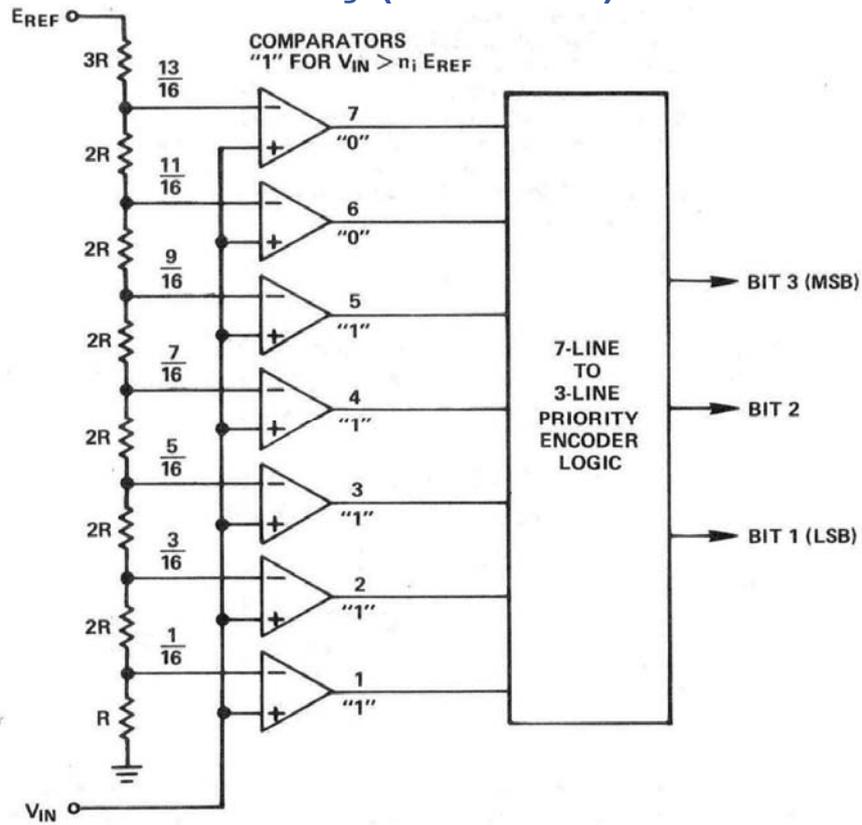
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## FLAŞ (PARALEL) ADC GENEL YAPISI

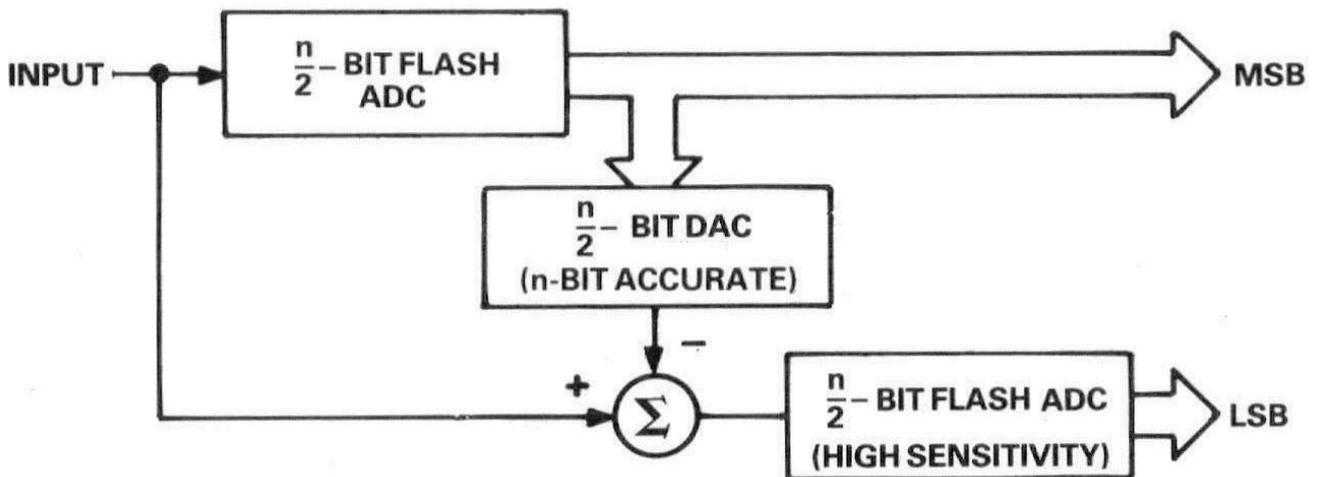


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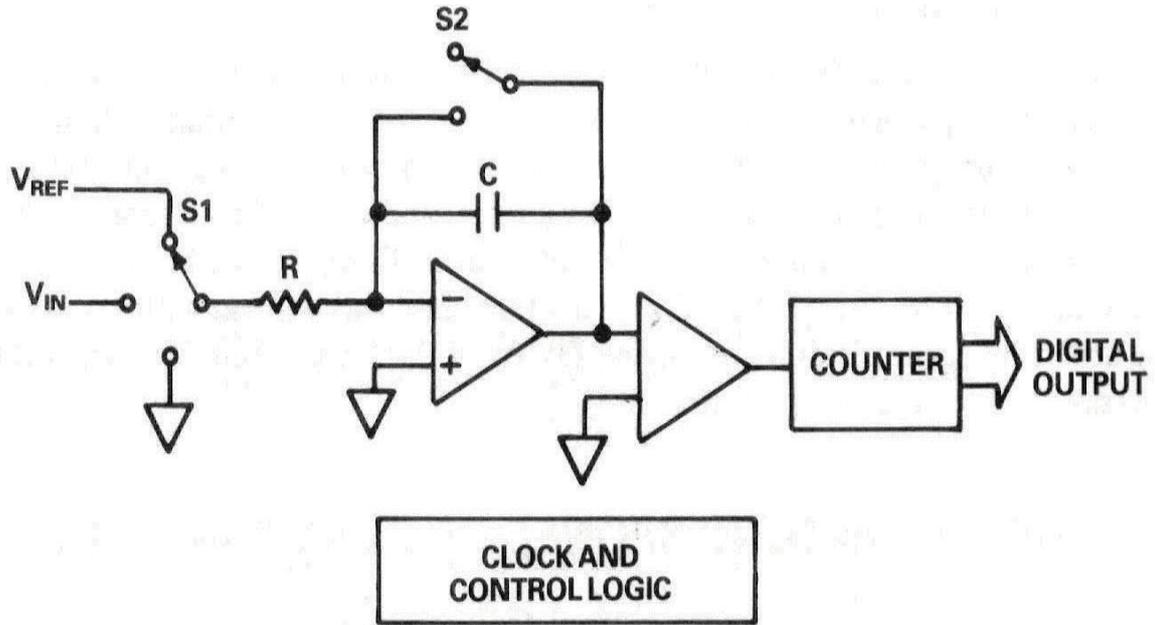
### 3-Bit FLAŞ (PARALEL) ADC



### YARIM FLAŞ (PARALEL) ADC

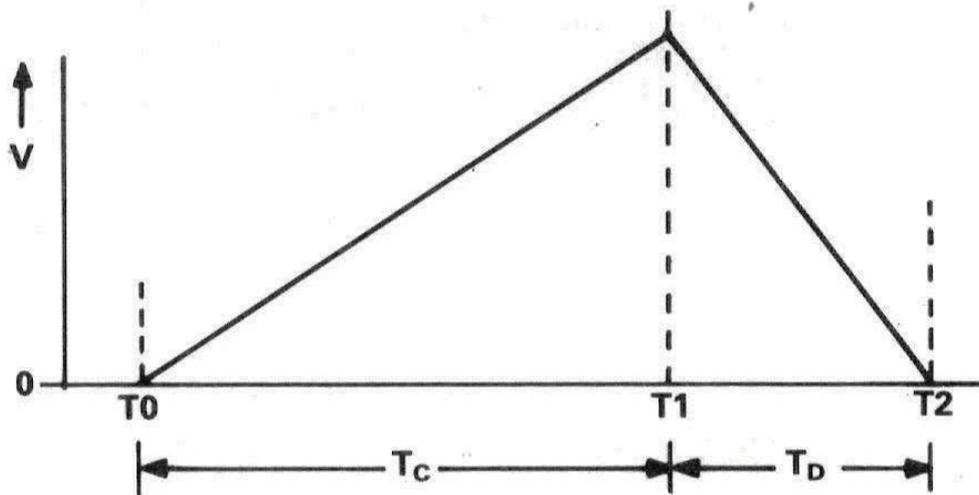


## ENTEGRALLİ ADC



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## ENTEGRALLİ ADC nin ÇALIŞMA ŞEKLİ

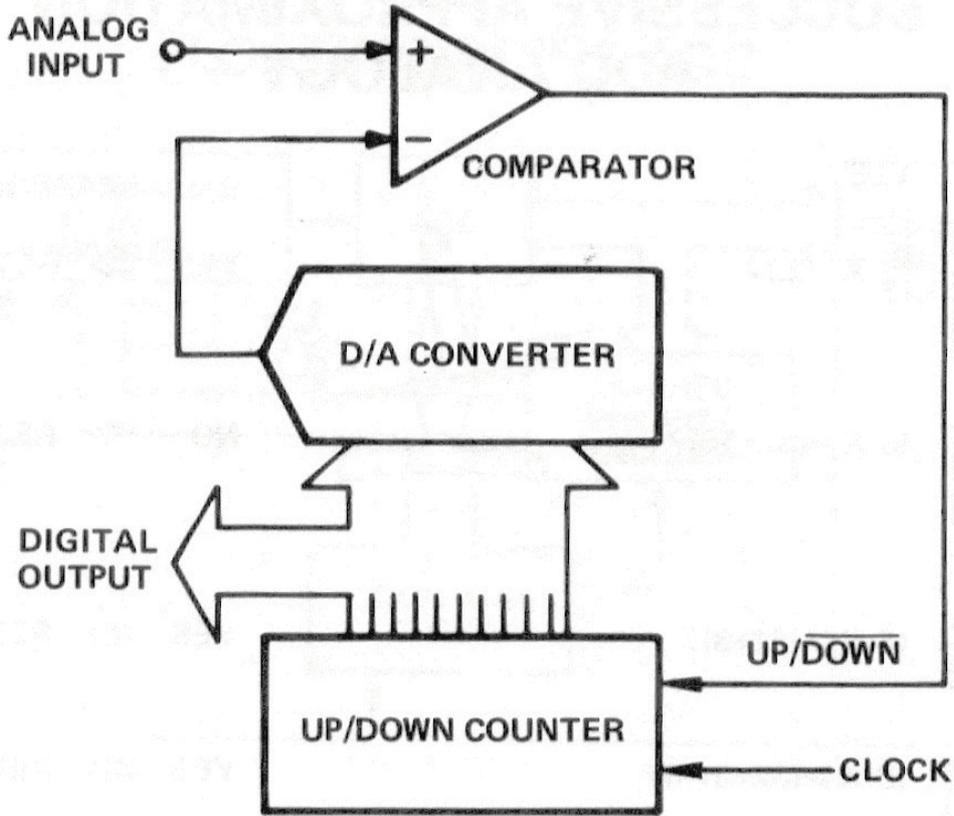


THE INTEGRATOR CHARGES FOR FIXED TIME  $T_C$  WITH  $V_{IN}$ . THE DISCHARGE TIME WITH A FIXED REFERENCE ( $= V_{REF}$ ) INPUT IS THEN MEASURED ( $T_D$ ).

$$V_{IN} = V_{REF} \frac{T_D}{T_C}$$

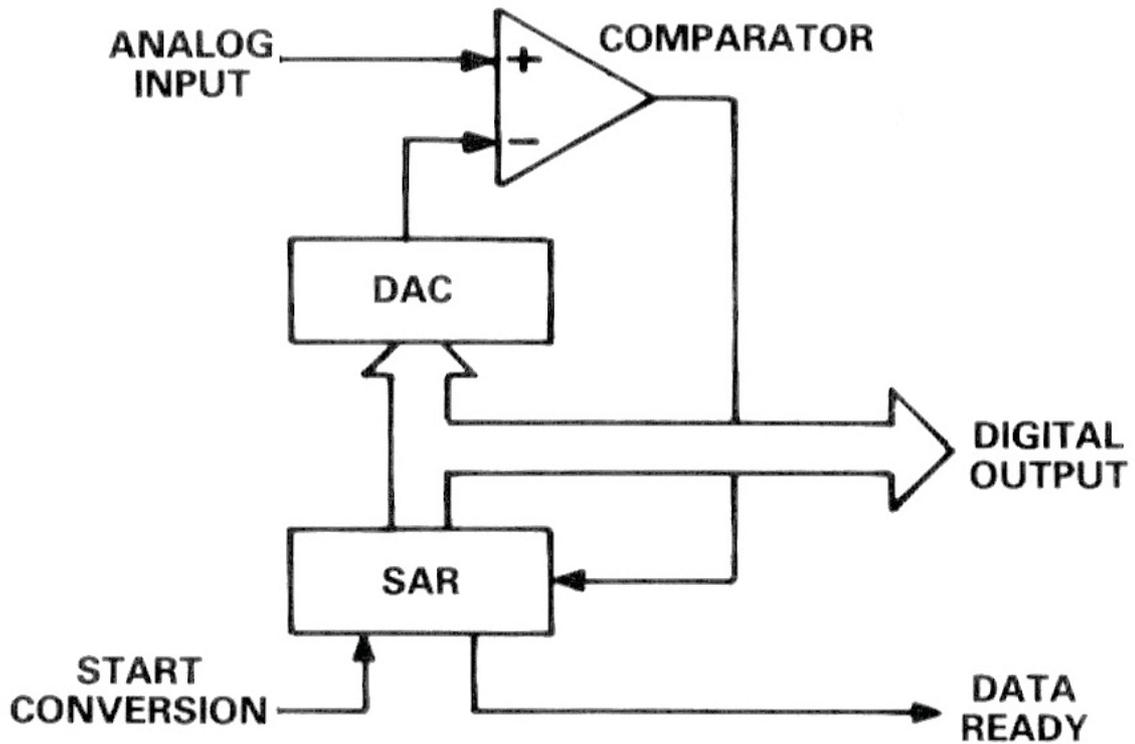
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## SAYICI-KARŞILAŞTIRICI (İZLEMELİ/TRACKING) ADC



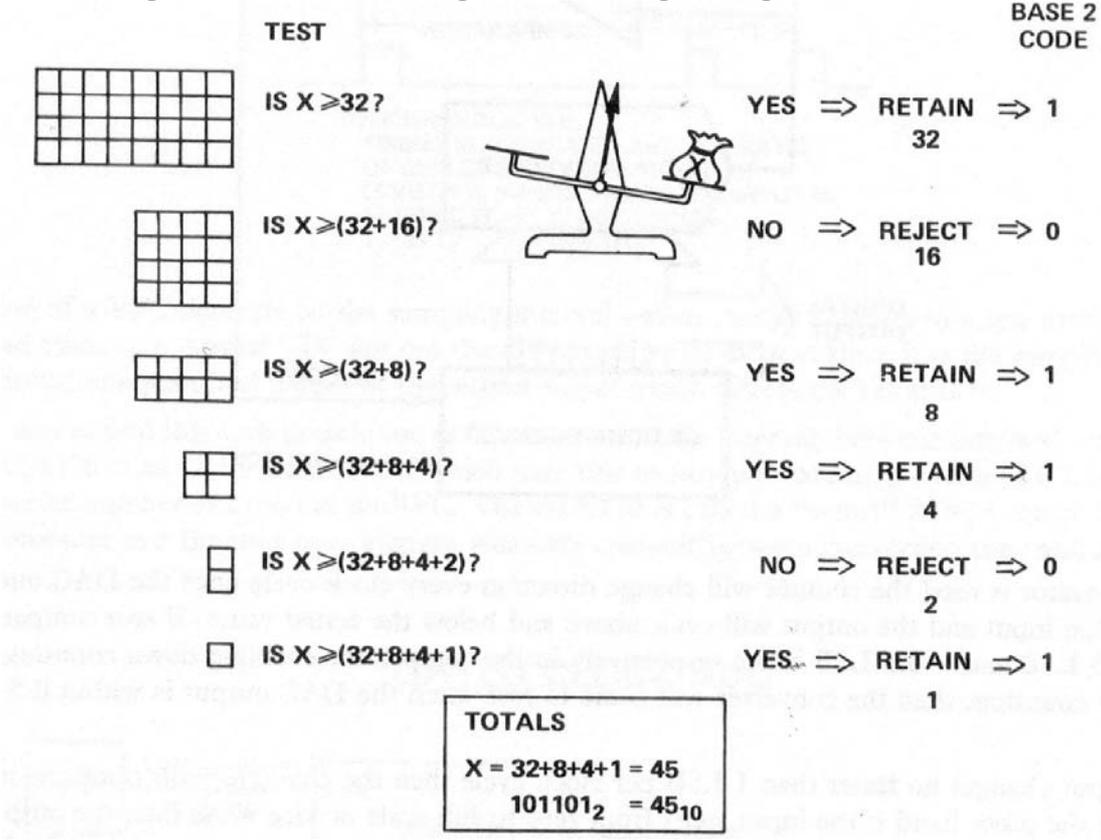
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## BAŞARILI YAKLAŞIM ADC

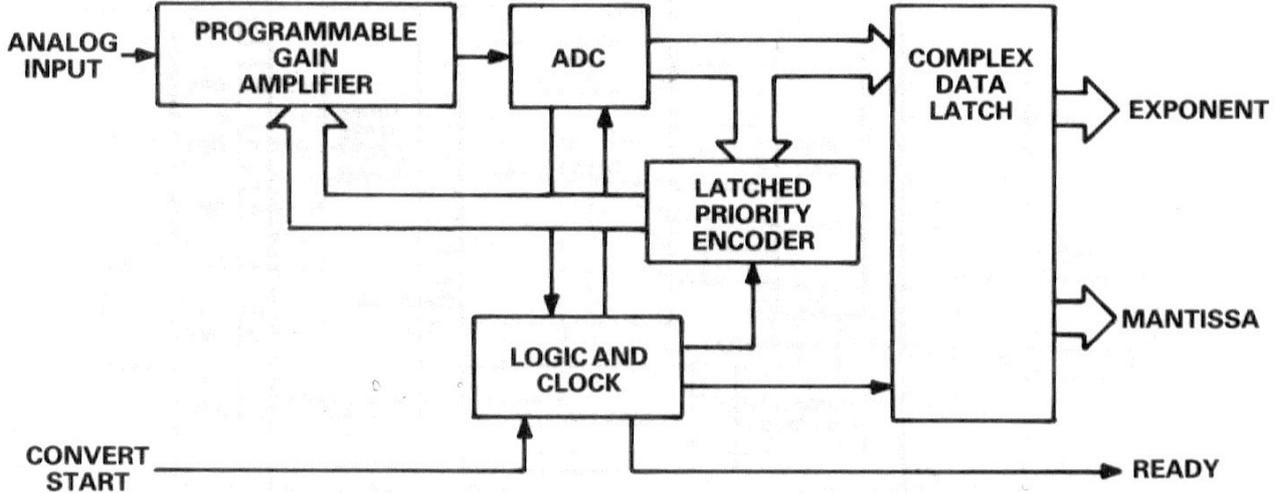


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# BAŞARILI YAKLAŞIM ADC ÇALIŞMA MANTIĞI



## KAYAN NOKTALI ADC

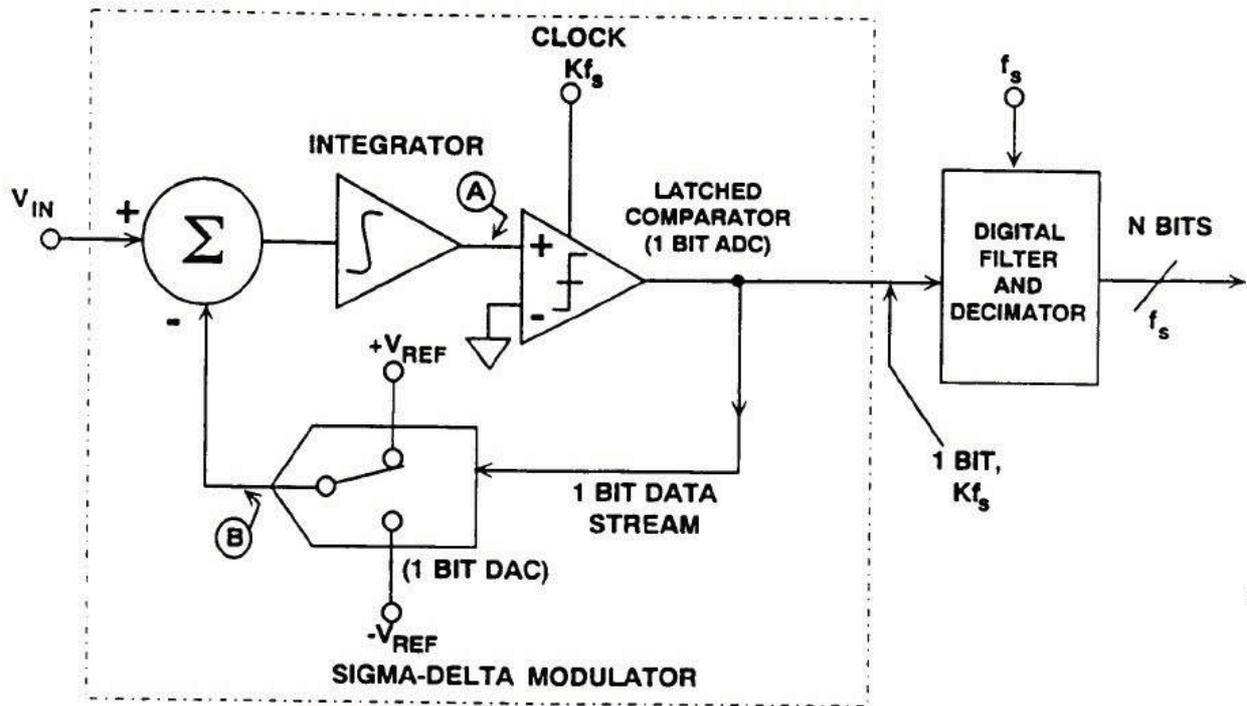


$$A = (-1)^S \cdot f \cdot 2^e$$

S: işaret biti, e: üst kısmı, f: kesir kısmı  
(exponent) (mantissa) .

b31	b30	...b23	b22	.....	b0
<b>S</b>	<b>e</b>		<b>f</b>		

## SİGMA-DELTA ADC (BİRİNCİ DERECE)



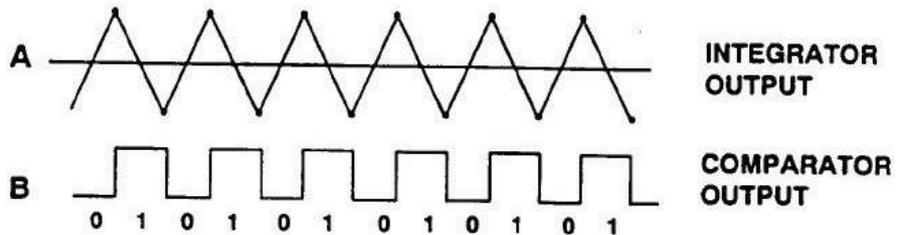
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## SİGMA-DELTA ADC ÇALIŞMA DALGA ŞEKİLLERİ

$$V_{IN} = 0V$$

$$= \frac{2}{4}$$

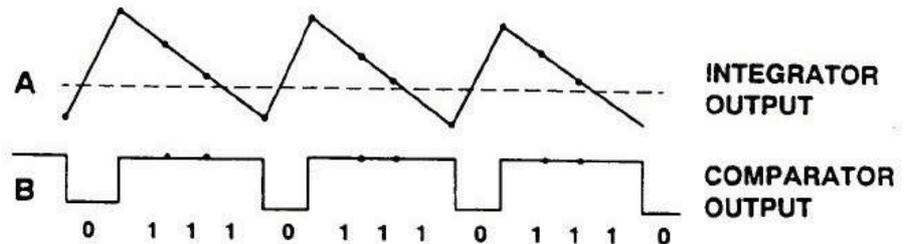
$$= \frac{4}{8}$$



$$V_{IN} = + \frac{V_{ref}}{2}$$

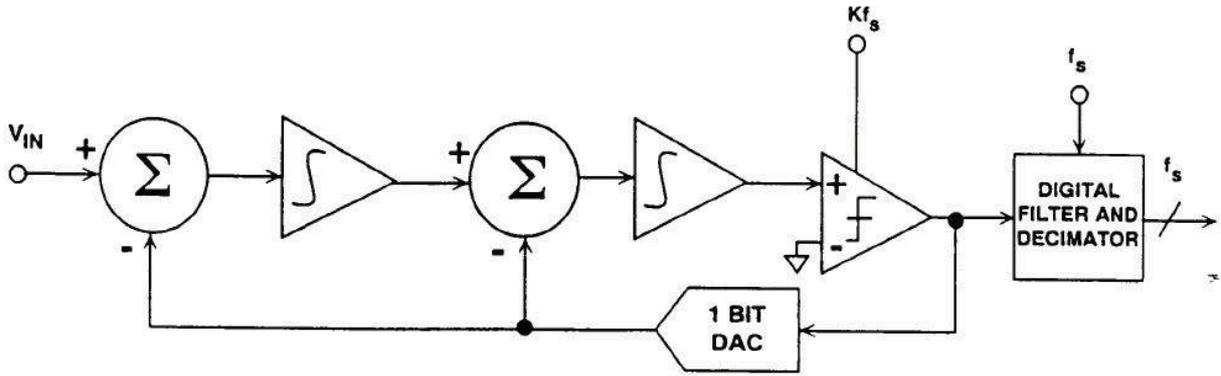
$$= \frac{3}{4}$$

$$= \frac{6}{8}$$



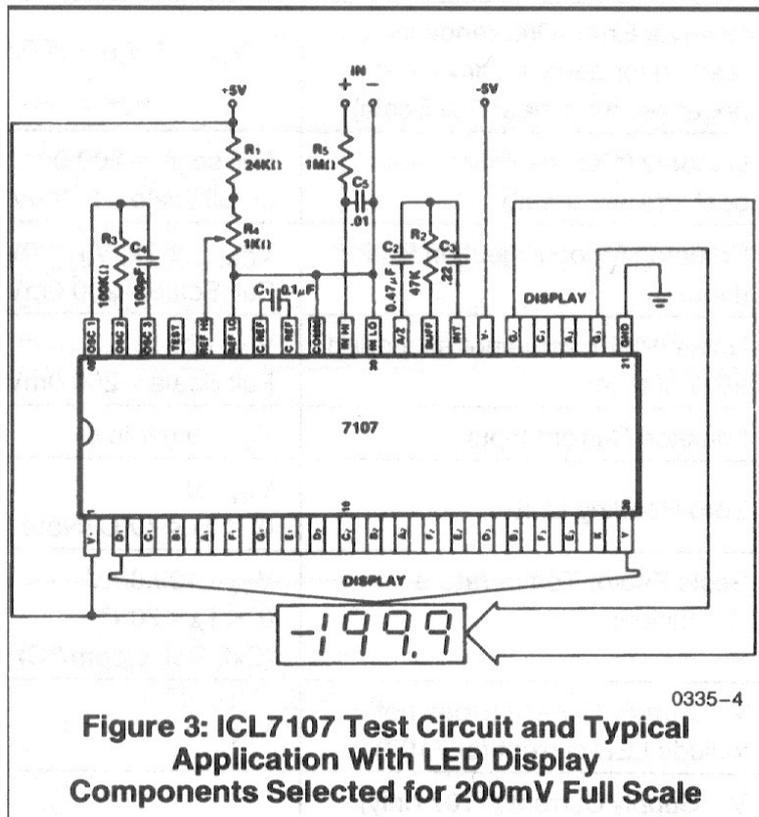
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## SIGMA-DELTA ADC (İKİNCİ DERECE)



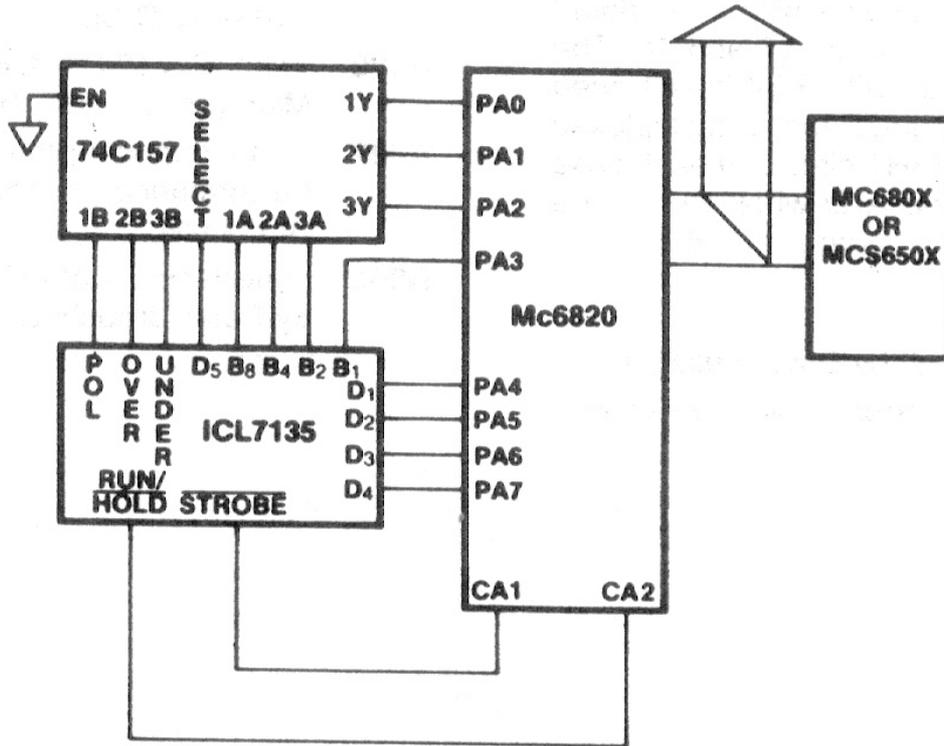
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## ADC UYGULAMALARI

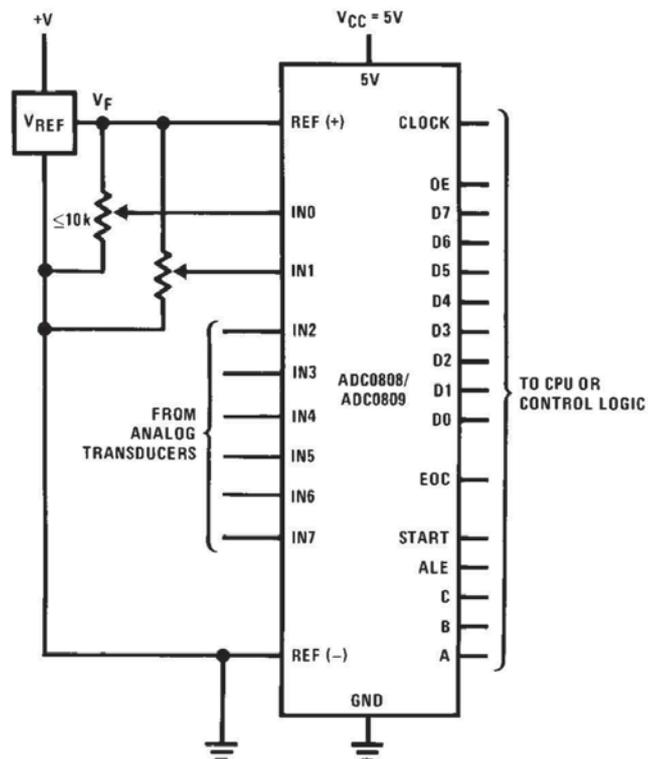


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## BCD ÇIKIŞLI ADC uP BAĞLANTISI

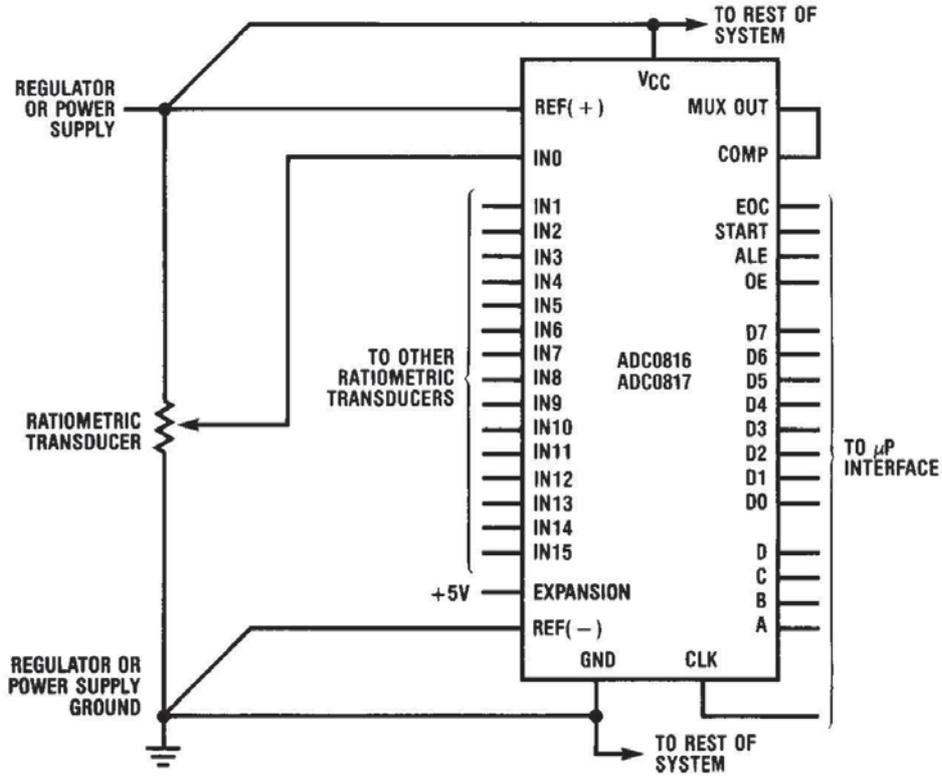


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Ratiometric Converter  
with Separate Reference

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Simple Ratiometric Converter Using Power Supply as Reference

## GERİLİM FREKANS DÖNÜŞTÜRÜCÜLER (V/F)

### GİRİŞ ÖZELLİKLERİ

**Giriş Tipi** Tek yönlü, İki yönlü veya Farksal  
**Giriş Biçimi** Gerilim veya Akım

### ÇIKIŞ ÖZELLİKLERİ

**Lojik Tipi** TTL, CMOS vb.  
**Çıkış Tipi** Seri Darbeler

## FREKANS GERİLİM DÖNÜŞTÜRÜCÜLER (F/V)

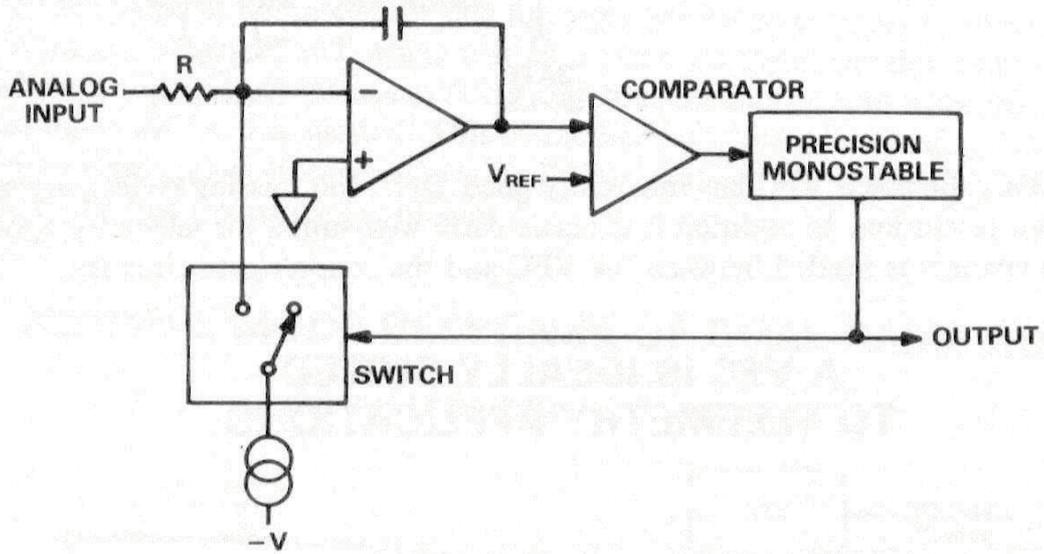
### GİRİŞ ÖZELLİKLERİ

**Lojik Tipi** TTL, CMOS vb.  
**Yapısı** Seri Darbeler

### ÇIKIŞ ÖZELLİKLERİ

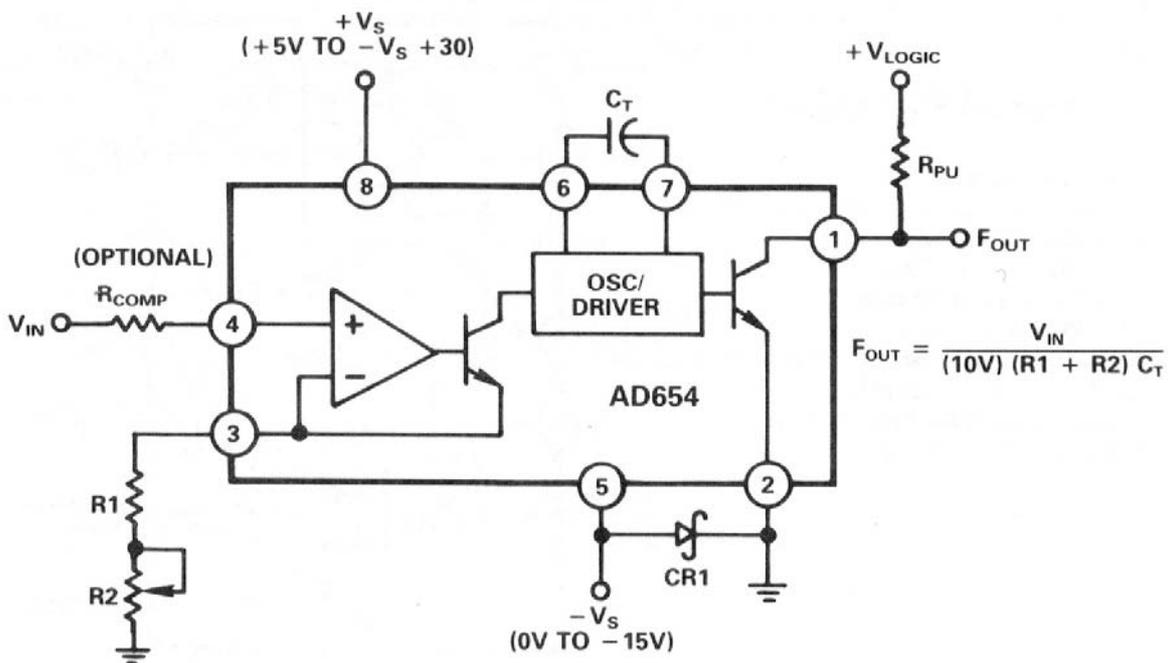
**Çıkış Tipi** Gerilim veya Akım

## VFC USING AN INTEGRATOR



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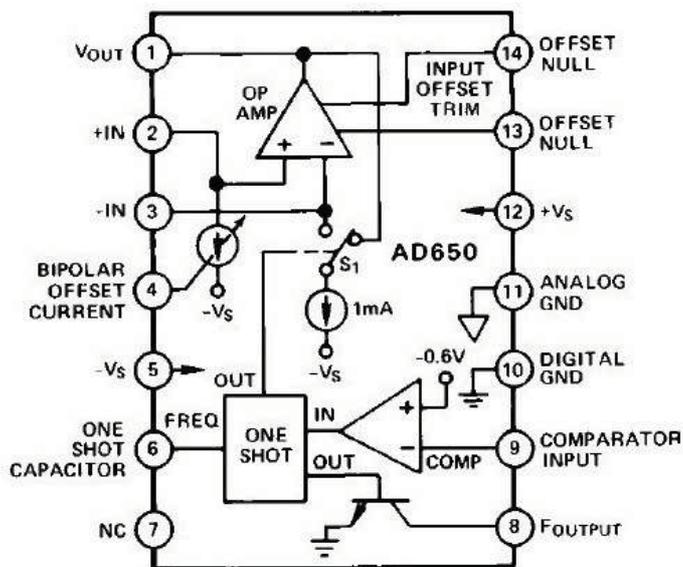
## STANDARD V-F CONNECTION FOR POSITIVE INPUT VOLTAGES



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## V/F F/V ÖZELLİKLERİ

**V/F Conversion to 1 MHz**  
**Reliable Monolithic Construction**  
**Very Low Nonlinearity**  
 0.002% typ at 10 kHz  
 0.005% typ at 100 kHz  
 0.07% typ at 1 MHz  
**Input Offset Trimmable to Zero**  
**CMOS or TTL Compatible**  
**Unipolar, Bipolar, or Differential V/F**  
**V/F or F/V Conversion**



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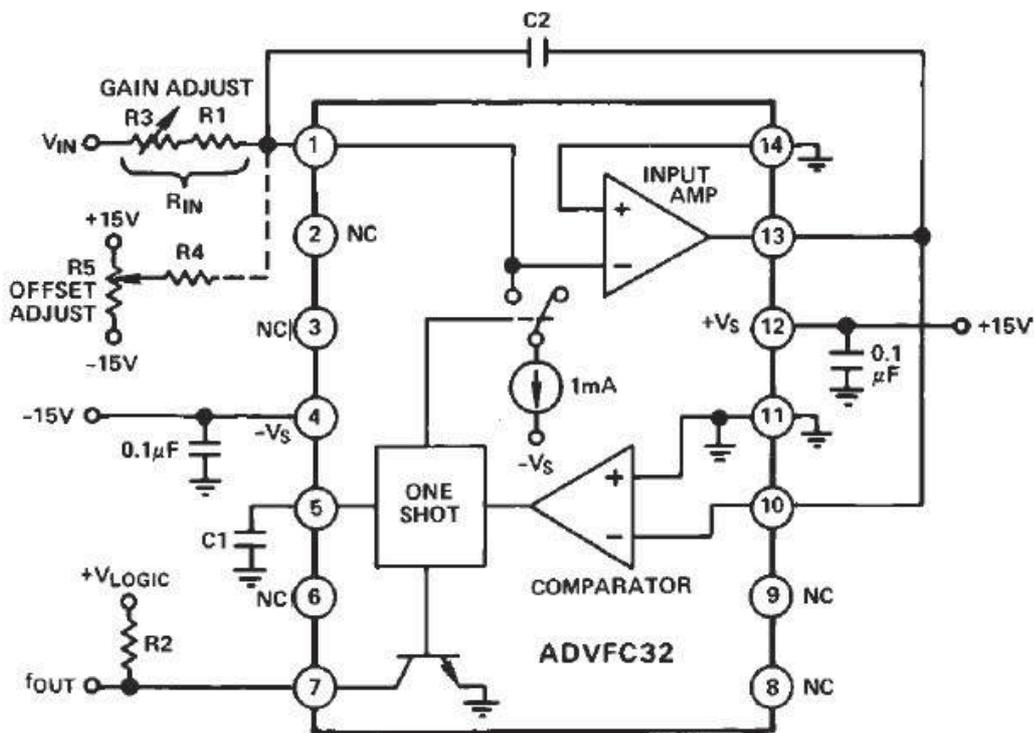


Figure 1. Connection Diagram for V/F Conversion, Positive Input Voltage

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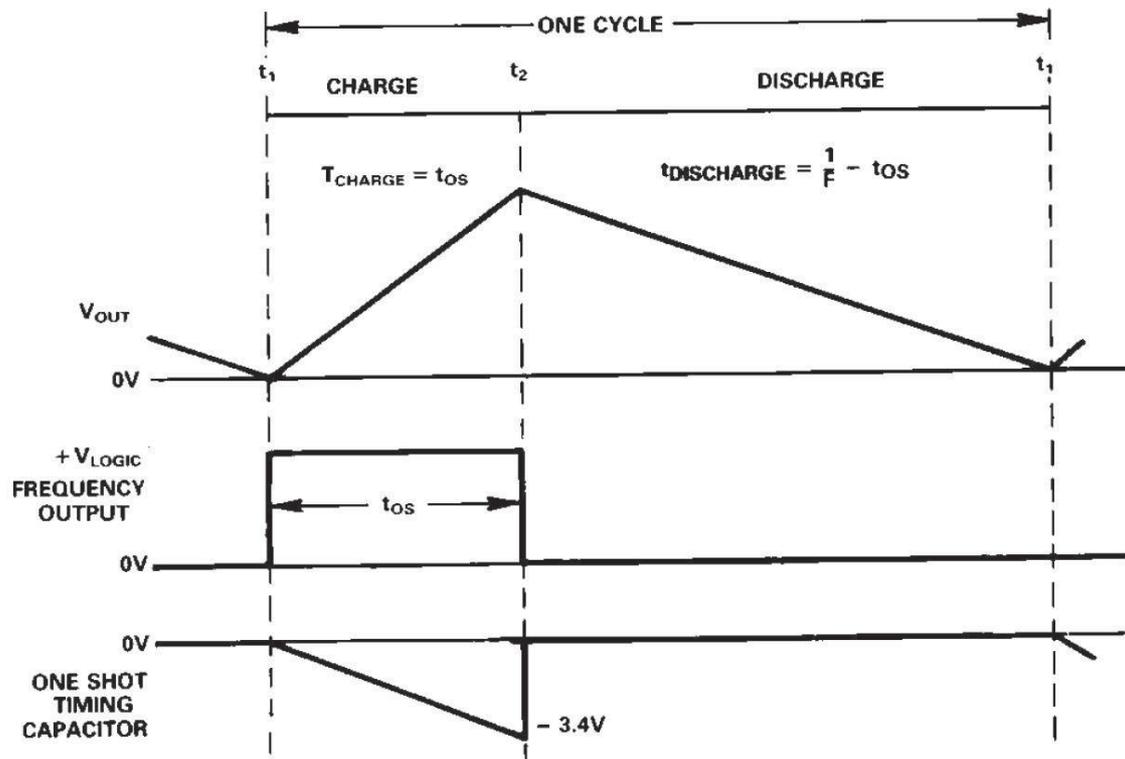


Figure 2. Voltage-to-Frequency Conversion Waveforms

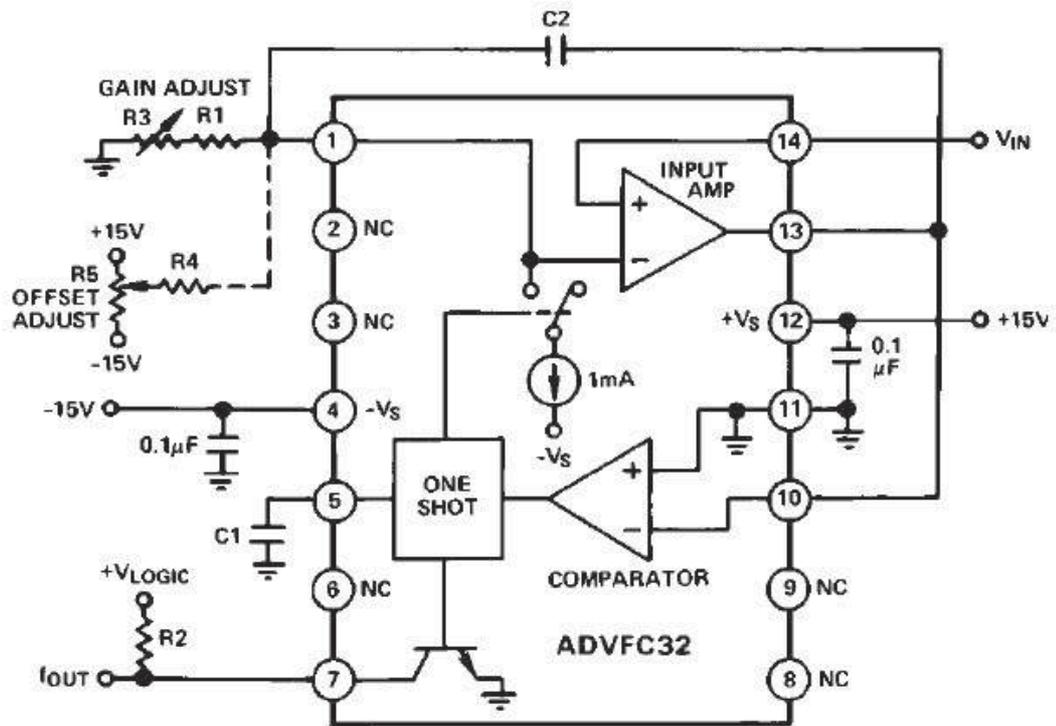


Figure 3. Connection Diagram for V/F Conversion, Negative Input Voltage

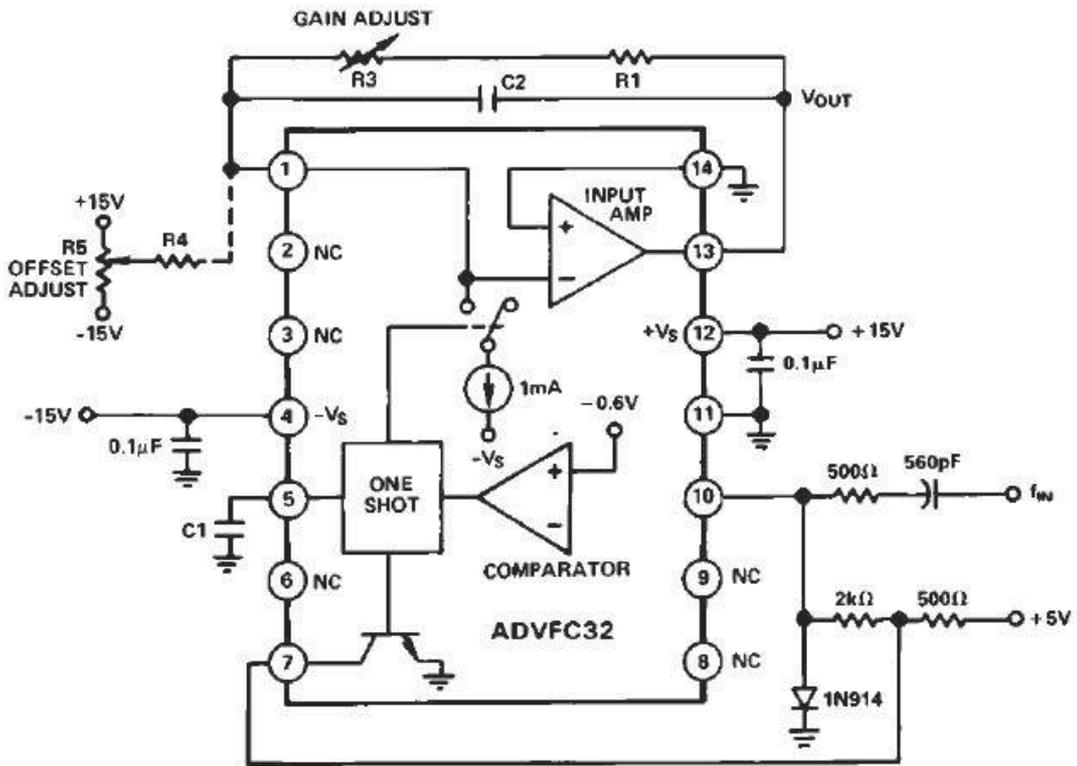
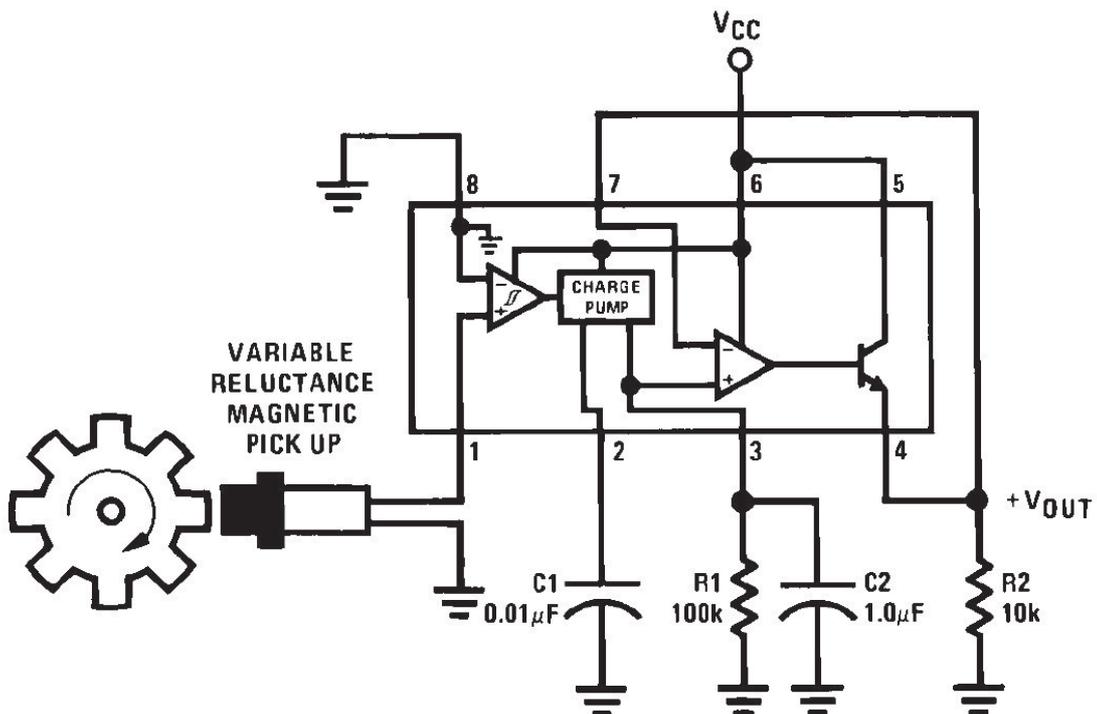
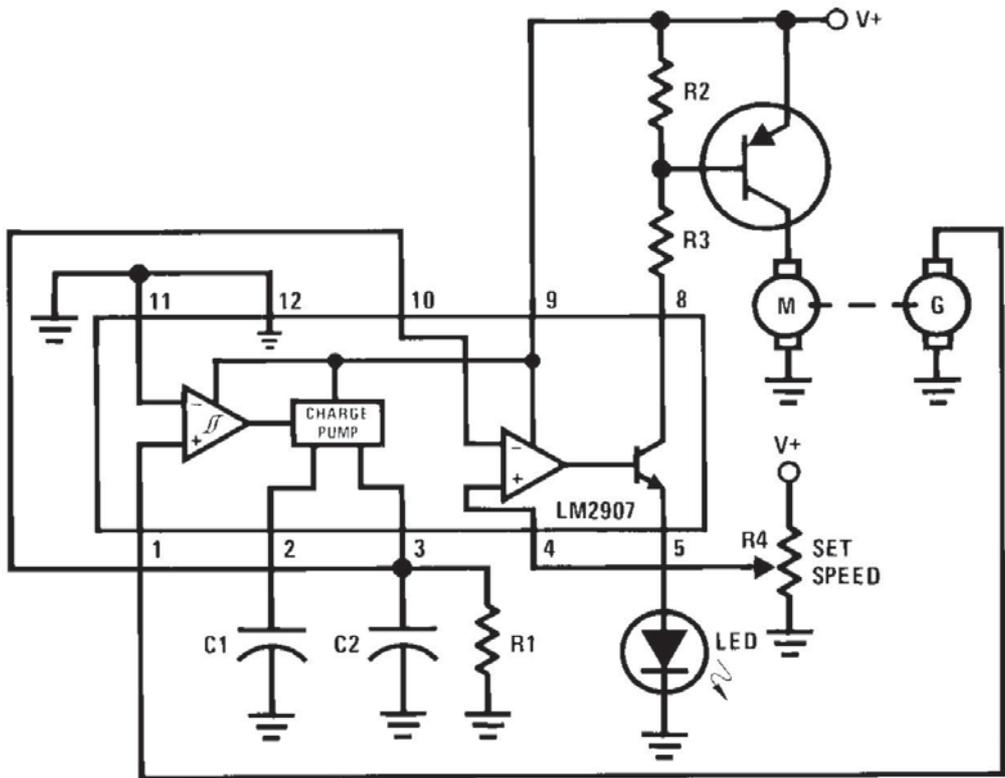


Figure 4. Connection Diagram for F/V Conversion, TTL Input

## V/F F/V UYGULAMALARI

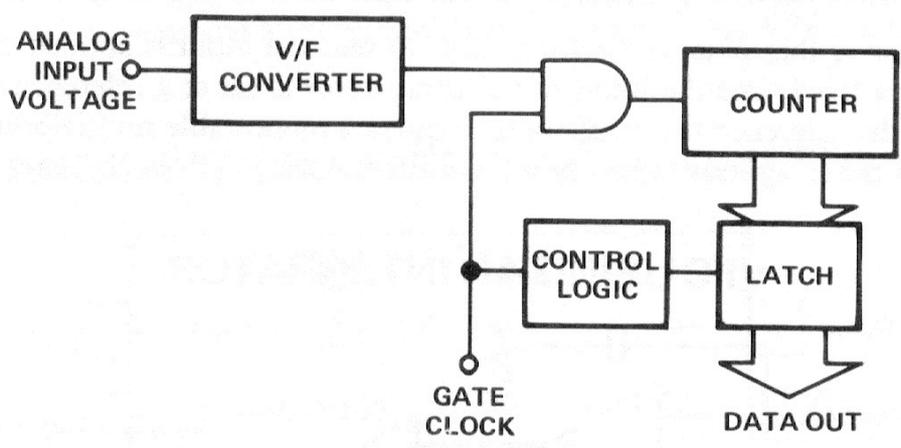


Basic f to V Converter

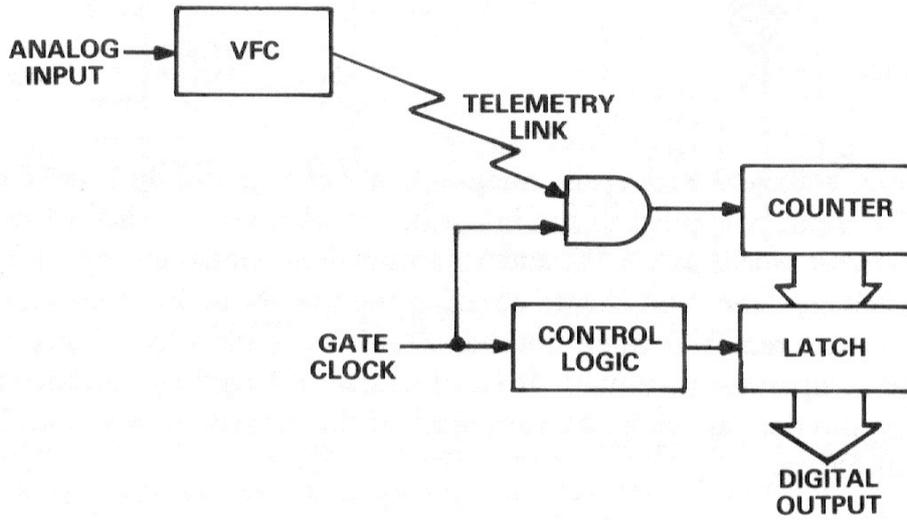


Motor Speed Control

### VFC USED FOR ANALOG-TO-DIGITAL CONVERSION

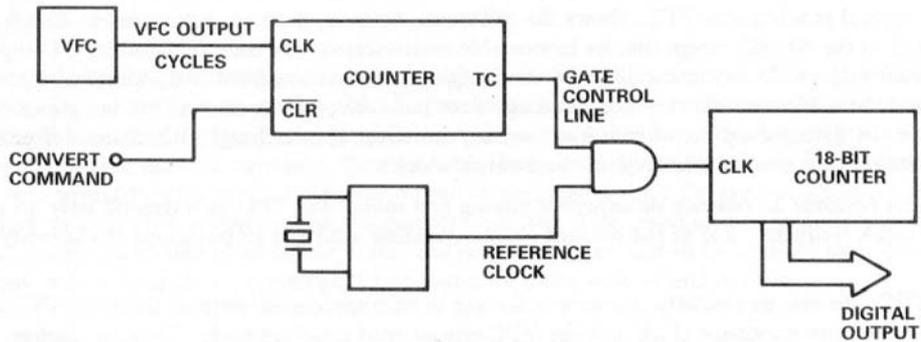


## A VFC IS IDEALLY SUITED TO TELEMETRY APPLICATIONS

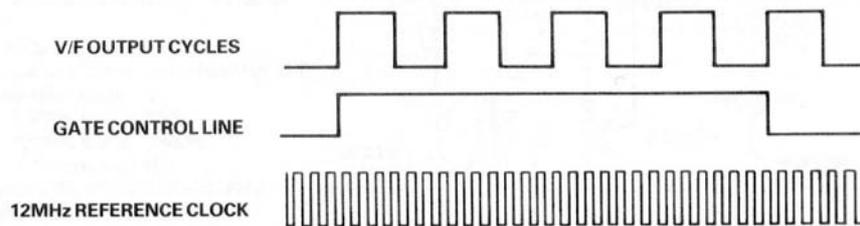


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### GATED CLOCK ADC



### TIMING FOR GATED CLOCK ADC



$C = \text{NUMBER OF V/F CYCLES DURING } T_{(INT)}$

$N = \text{NUMBER OF REFERENCE CLOCKS DURING } T_{(INT)}$

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## KAYNAKLAR

- 1.Linear Design Seminar Handbook, Analog Devices, 1987
- 2.Analog Designer Reference CD-ROM, Analog Devices, 2002
- 3.Technical Literature Database CD-ROM, National Semiconductor Corporation, 1997
- 4.Linear Application Seminar Handbook, National Semiconductor Corporation, 1989
- 5.Linear Application Databook, National Semiconductor Corporation, 1986
- 6.Data Acquisition Handbook, Harris Semiconductor, 1991
- 7.LS/S/TTL Logic Databook, National Semiconductor, 1987