Application Notes

Introduction

Application notes for all the device categories in this catalog are given in this section. Devices include:

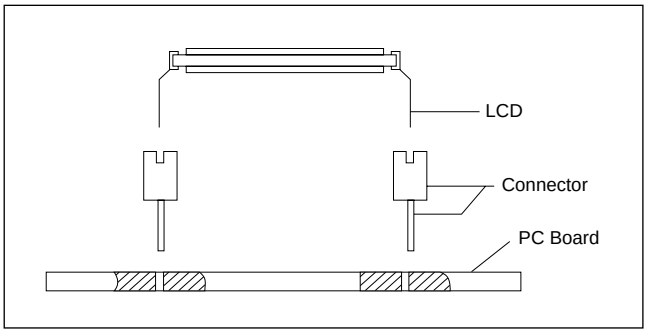
- Field Effect LCD Panels
- Intelligent Alphanumeric Displays
- Intelligent Graphics Displays
- Fiber Optic Backlighting

In addition, the last paragraph of these application notes contains amplifying information about how optical specification terms are defined.

Field Effect (FE) LCD Panels

Connector Pinned LCD's

The LCD connector pins are simply inserted into the plug-in sockets as shown below:



Features

- Self-alignment of LCD
- Highly conductive, corrosion free contacts
- Rigid mechanical support
- Rapid assembly
- Shock and vibration resistance

Liquid crystal displays are rapidly gaining in popularity and are specified in a variety of applications. Versatility, readability, and low power consumption make them extremely attractive for portable applications.

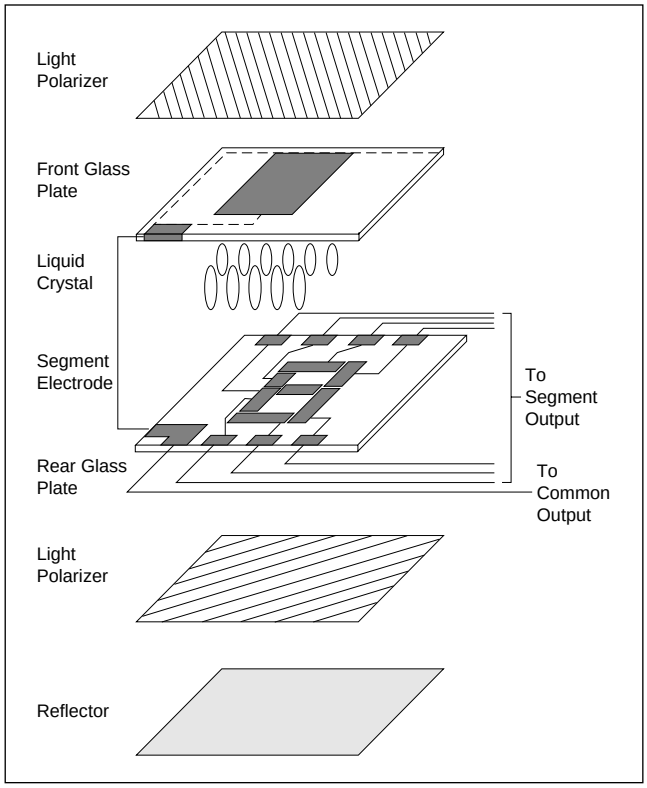
Introduction

This application note is for the design engineer or technician who may not know how liquid crystal displays are made, how they operate, or how they are driven electronically.

As shown in the accompanying FE LCD Construction illustration, Field Effect Liquid Crystal Display Devices (FE-LCDs) have two glass plates, the insides of which are coated with a pattern of transparent and conductive material. These plates are mounted so the conducting layers face each other. The distance between the two plates is adjusted to about 10-30 µm (microns - 25 = .001").

Liquid crystal materials are retained between the plates by a peripheral seal of glass molding, epoxy or the like. Both outer surfaces of the front and rear glass plates require light polarizing films which may or may not be crossed, depending on the function of the cell. The polarizing film on the rear glass is covered with a reflective material (silverbead, silver foil or gold foil) or a transflective material (a material that reflects ambient light and transmits back light). Images are displayed by applying a voltage between the segment and the common electrodes.

FE LCD Construction



The Driving Method of the FE Direct Drive LCD

Numeric, symbolic and other patterns can be displayed by applying a voltage between the segment and the common electrodes.

- Although a typical driving voltage is 5 Vrms, 3 Vrms to 10 Vrms can drive AND LCDs.
- The allowable AC frequency range of the driving voltage is from 30 to 100 Hz.

Flicker may occur if the drive frequency is below 30 Hz. Because power consumption increases in direct proportion to the driving frequency, we recommend driving LCDs using a frequency below 100 Hz.

Driving Waveform

Because they are different from LEDs, LCDs should be driven with AC voltages to prevent plating of the conductive

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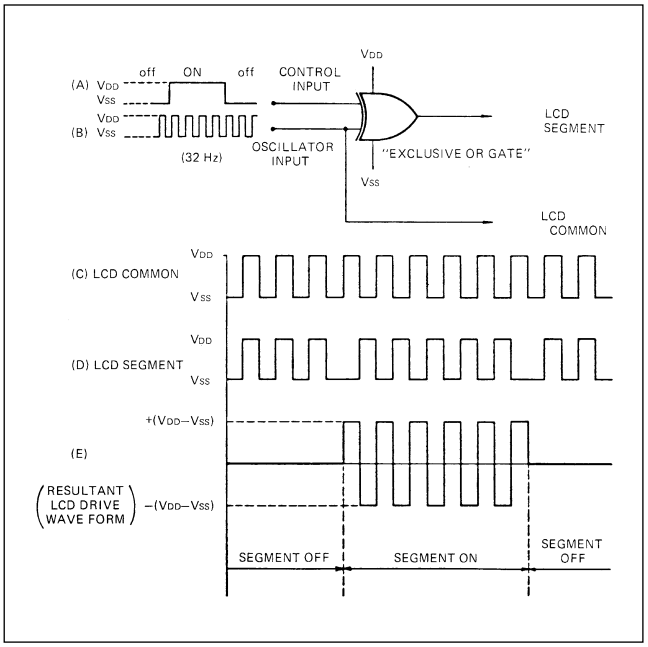
electrodes due to electrolysis. Usually, LCDs are connected to logic circuits so an AC symmetrical square-wave is a common driving voltage. This AC symmetrical square-wave features less DC offset and can be obtained in all LCD drivers by using “exclusive OR” (Ex. OR) gates. The following illustration shows the actual input and output waveforms of an “exclusive OR” drive.

Exclusive Or Drive



Plot (A) is the control input waveform that selects the mode of the display. Plot (B) is the 32 Hz 50% duty-cycle square-wave input to the “exclusive OR” gate, and is also input to the common electrode of LCD Plot (C). Plot (D) is the output of the “exclusive OR” gate, which has shifted the oscillator input 180° when the control input is high. Plot (E) is the resultant waveform of Plot (C) and (D) is seen by the LCD. Presently, many LCD drivers include exclusive OR gates; for instance, you can obtain 10 volts between the segment and the common electrodes using a 5 volt power supply.

Devices CD4055A, CD4056A, and MC14543 are most suitable for the seven segment numeric displays and device CD4054A is most suitable for symbolic displays such as decimal point, colon, unit and so on. Several LCD IC vendors and models are listed in the chart below. Please refer to the vendors technical data sheets; AND is not responsible for any technical changes, or changes to specifications for the products represented in the table below.

Integrated Circuit Drivers for FE LCDs

Input/Output	Description	Vendor	Part No.
BCD to 4 segments	4 segments (“.”, “:”, “+”, “-”, etc.)	RCA/SGS	CD4054

Integrated Circuit Drivers for FE LCDs (Continued)

Input/Output	Description	Vendor	Part No.
BCD to 7 segments	Single digit	RCA/Mitel	CD4055/56
BCD to 7 segments	Single digit	Motorola	MC14543
BCD to 7 segments	4 digits	Hughes	HLCD0437
BCD to 7 segments	4 digits	Harris/MAXIM	ICM7211
BCD to 7 segments	4 digits	Siliconics	DF412
Serial to 32 segments	Up to 4 1/2 digits	Hughes	HLMP0438
Serial to 32 segments	Up to 4 1/2 digits	National	MM5452/ 53/80

Specialized ICs with LCD Driving Capabilities

Type of ICs	Vendor	Part No.	AND’s LCD
3 digit LCD A/D Converter	Harris	CA3162	FE0201, FE0203
3 1/2 digit LCD A/D Converter	Harris	H17131	FE0201, FE0203
3 1/2 digit LCD A/D Converter	Harris/ MAXIM	ICL7106	FE0201, FE0203
3 1/2 digit LCD A/D Converter	Harris/ MAXIM	ICL7116	FE0201, FE0203
3 1/2 digit LCD A/D Converter	Harris/ MAXIM	ICL7136	FE0201, FE0203
3 1/2 digit LCD A/D Converter	MAXIM	MAX139	FE0201, FE0203
4 1/2 digit LCD A/D Converter	Harris	ICL7129	FE0206
4 1/2 digit LCD Converter	Harris	ICM7224	FE0206

Special Attention for Circuit Design

Purdy Electronics recommends you connect the unused segment terminals to the common terminal; otherwise an undesired character or a faint display appears (NC pins that are not connected to the segment must not be connected to the common terminal). If there are some segments that must be displayed constantly, you can do this by applying the inverse signal (inverted from the common signal) to the segment terminals.

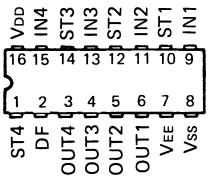
A CDC driving voltage or an AC driving voltage that has a large DC offset greatly shortens the life of the LCD; therefore, pay strict attention to this factor and do not exceed the specified DC offset (25 mV).

Symbol Indicator Circuit

The CD4054A is a 4-segment display driver for an FE LCD. When a square-wave is present at the DF input, the selected segments will have a square-wave output that is 180° out of phase with the DF input. Those segments which are not selected will have a square-wave output that is in-

phase with the input. When the input signal is high, the LCD is directly driven by applying a DF pulse to the common terminal of the LCD. The CD4054A is most suitable to display symbols such as a decimal point, a plus, and a minus. This device may also be used for logic level down-conversion at $V_{EE} < V_{SS}$.

Pinout of Device CD4054



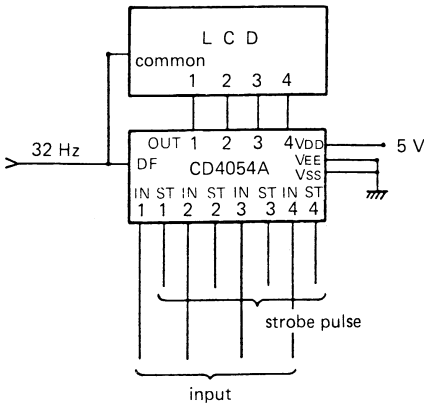
Truth Table

DF	IN_n	STROBE n	OUT_n
L	L	H	L
H	L	H	H
L	H	H	H
H	H	H	L
*	*	L	**

* Don't care

** Depends upon the INPUT mode previously applied when ST = "H"

Segment Display Driver



Maximum Ratings

Item	Symbol	Rating	Unit
Supply Voltage	$V_{DD} - V_{SS}$	-0.5 – 20	V
	$V_{DD} - V_{EE}$	-0.5 – 20	V
Input Voltage	V_{IN}	V_{SS} – 0.5 - V_{DD} + 0.5	V

Maximum Ratings (Continued)

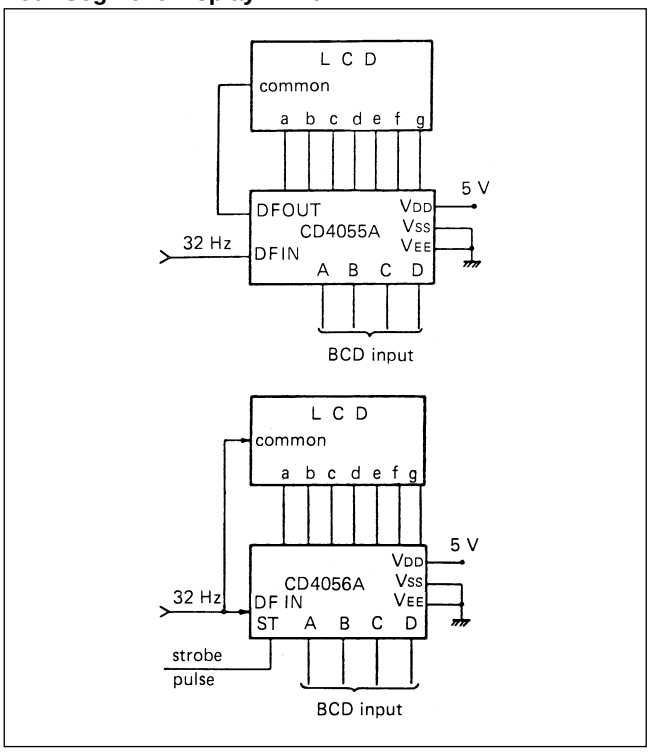
Item	Symbol	Rating	Unit
Output Voltage	V_{OUT}	V_{EE} – 0.5 - V_{DD} + 0.5	V
Input Current	I_{IN}	±10	mA
Power Consumption	P_D	300	mW
Storage Temperature	T_{stg}	-65 – 150	°C
Solder Temperature & Time	T_{sol}	260°C .10 sec	

Note: For further technical information, please refer to manufacturer's specifications.

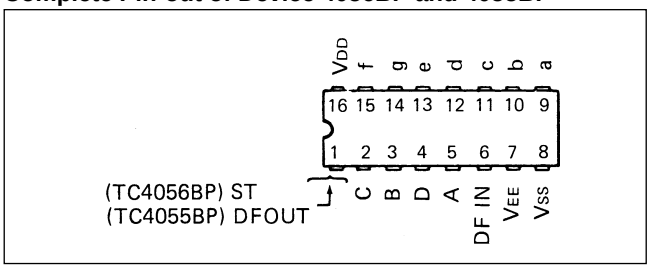
Segments Numerical Display Circuit

The CD4055A and CD4056A devices are single-digit BCD to 7-segment decoder and driver circuits for an FE LCD. When the DF input is high, the output segment is high when selected by the BCD input. When the DF input is high, the output segment is low when selected by the BCD inputs. The seven segment LCD is directly driven by applying the pulse that is in phase with the DF input to the common terminal of the LCD. Device CD4055A has the display frequency (DF) output and device CD4056A has the strobed-latch function. They may also be used for logic-level down conversion at $V_{EE} < V_{SS.}$

Four Segment Display Driver



Complete Pin-out of Device 4056BP and 4055BP



Maximum Ratings

Item	Symbol	Rating	Unit
Supply Voltage	$V_{DD} - V_{SS}$	-0.5 – 20	V
	$V_{DD} - V_{EE}$	-0.5 – 20	V
Input Voltage	V_{IN}	V_{SS} – 0.5 - V_{DD} + 0.5	V
Output Voltage	V_{OUT}	V_{EE} – 0.5 - V_{DD} + 0.5	V
Input Current	I_{IN}	±10	mA
Power Consumption	P_D	300	mW
Storage Temperature	T_{stg}	-65 – 150	°C
Solder Temperature & Time	T_{sol}	260°C .10 sec	

Truth Table

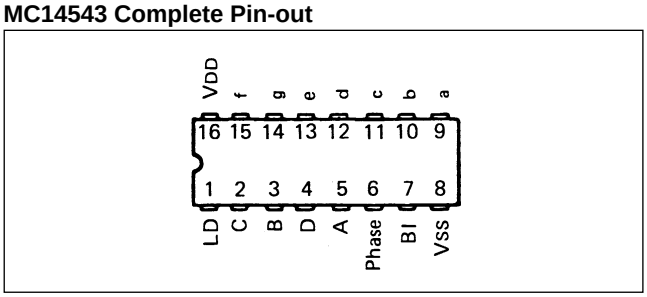
BCD Inputs				Segment Outputs							Display Character
D	C	B	A	a	b	c	d	e	f	g	
L	L	L	L	H	H	H	H	H	H	L	0
L	L	L	H	L	H	H	L	L	L	L	1
L	L	H	L	H	H	L	H	H	L	H	2
L	L	H	H	H	H	H	H	L	L	H	3
L	H	L	L	L	H	H	L	L	H	H	4
L	H	L	H	H	L	H	H	L	H	H	5
L	H	H	L	H	L	H	H	H	H	H	6
L	H	H	H	H	H	H	L	L	L	L	7
H	L	L	L	H	H	H	H	H	H	H	8
H	L	L	H	H	H	H	H	L	H	H	9
H	L	H	L	L	L	L	H	H	H	L	L
H	L	H	H	L	H	H	L	H	H	H	H
H	H	L	L	H	H	L	L	H	H	H	P
H	H	L	H	H	H	H	L	H	H	H	R
H	H	H	L	L	L	L	L	L	L	H	–
H	H	H	H	L	L	L	L	L	L	L	Blank

ST = “H”, DF = “L”

Seven Segments Numerical Display Circuit

Device MC14543 is a single digit BCD to 7-segment latch and decoder-driver with Blanking Input (BI) and Latch Disable (LD) Input for an FE LCD. A degraded BCD input or a high “BI” will blank the display. For an LC display, a square-wave is applied to the Phase input of the circuit and to the common terminal of the LCD.

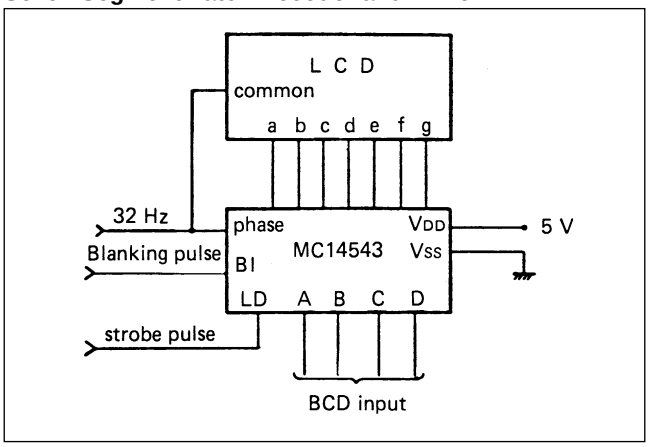
MC14543 Complete Pin-out



Maximum Ratings

Item	Symbol	Rating	Unit
Supply Voltage	$V_{DD} - V_{SS}$	-0.5 – 20	V
	$V_{DD} - V_{EE}$	-0.5 – 20	V
Input Voltage	V_{IN}	V_{SS} – 0.5 - V_{DD} + 0.5	V
Output Voltage	V_{OUT}	V_{EE} – 0.5 - V_{DD} + 0.5	V
Input Current	I_{IN}	±10	mA
Power Consumption	P_D	300	mW
Storage Temperature	T_{stg}	-65 – 150	°C
Solder Temp. & Time	T_{sol}	260°C .10 sec	

Seven Segment Latch Decoder and Driver



Truth Table

Inputs							Outputs							Display
LD	BI	PHASE	A	B	C	D	a	b	c	d	e	f	g	
*	H	H	*	*	*	*	H	H	H	H	H	H	L	Blank
*	H	L	*	*	*	*	L	H	H	L	L	L	L	Blank
L	L	H	*	*	*	*	Latch							
L	L	L	*	*	*	*	Latch							
H	L	H	L	L	L	L	L	L	L	L	L	L	H	0
H	L	H	H	L	L	L	H	L	L	H	H	H	H	1
H	L	H	L	H	L	L	L	L	H	L	L	H	L	2
H	L	H	H	H	L	L	L	L	L	L	H	H	L	3
H	L	H	L	L	H	L	H	L	L	H	H	L	L	4
H	L	H	H	L	H	L	L	H	L	L	H	L	L	5
H	L	H	L	H	H	L	L	H	L	L	L	L	L	6
H	L	H	H	H	H	L	L	L	L	H	H	H	H	7
H	L	H	L	L	L	H	L	L	L	L	L	L	L	8
H	L	H	H	L	L	H	L	L	L	L	H	L	L	9
H	L	H	L	H	L	H	H	H	H	H	H	H	H	Blank
H	L	H	H	H	L	H	H	H	H	H	H	H	H	Blank
H	L	H	L	L	H	H	H	H	H	H	H	H	H	Blank
H	L	H	H	L	H	H	H	H	H	H	H	H	H	Blank
H	L	H	L	H	H	H	H	H	H	H	H	H	H	Blank
H	L	H	H	H	H	H	H	H	H	H	H	H	H	Blank
H	L	L	L	L	L	L	H	H	H	H	H	H	L	0
H	L	L	H	L	L	L	L	H	H	L	L	L	L	1
H	L	L	L	H	L	L	H	H	L	H	H	L	H	2
H	L	L	H	H	L	L	H	H	H	H	L	L	H	3
H	L	L	L	L	H	L	L	H	H	L	L	H	H	4
H	L	L	H	L	H	L	H	L	H	H	L	H	H	5
H	L	L	L	H	H	L	H	L	H	H	H	H	H	6
H	L	L	H	H	H	H	H	H	H	L	L	L	L	7
H	L	L	L	L	L	H	H	H	H	H	H	H	H	8
H	L	L	H	L	L	H	H	H	H	H	L	H	H	9
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H	L	L	L	L	H	H	L	L	L	L	L	L	L	Blank
H	L	L	H	L	H	H	L	L	L	L	L	L	L	Blank
H	L	L	L	H	H	H	L	L	L	L	L	L	L	Blank
H	L	L	H	H	H	H	L	L	L	L	L	L	L	Blank

*Don't care

For further technical information, please refer to manufacturer's specifications.

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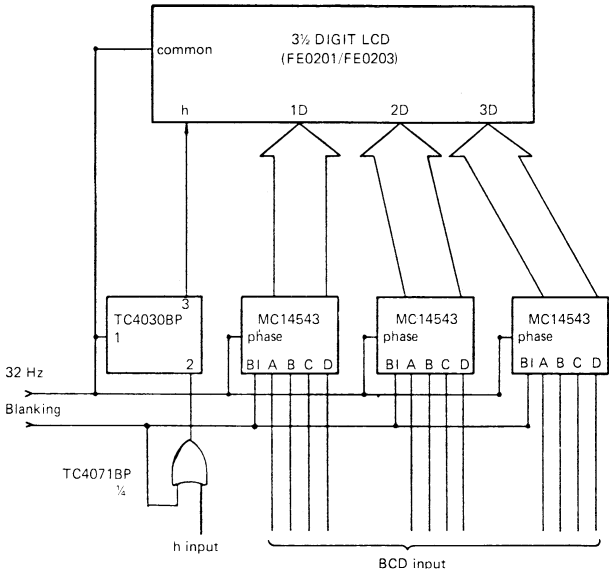
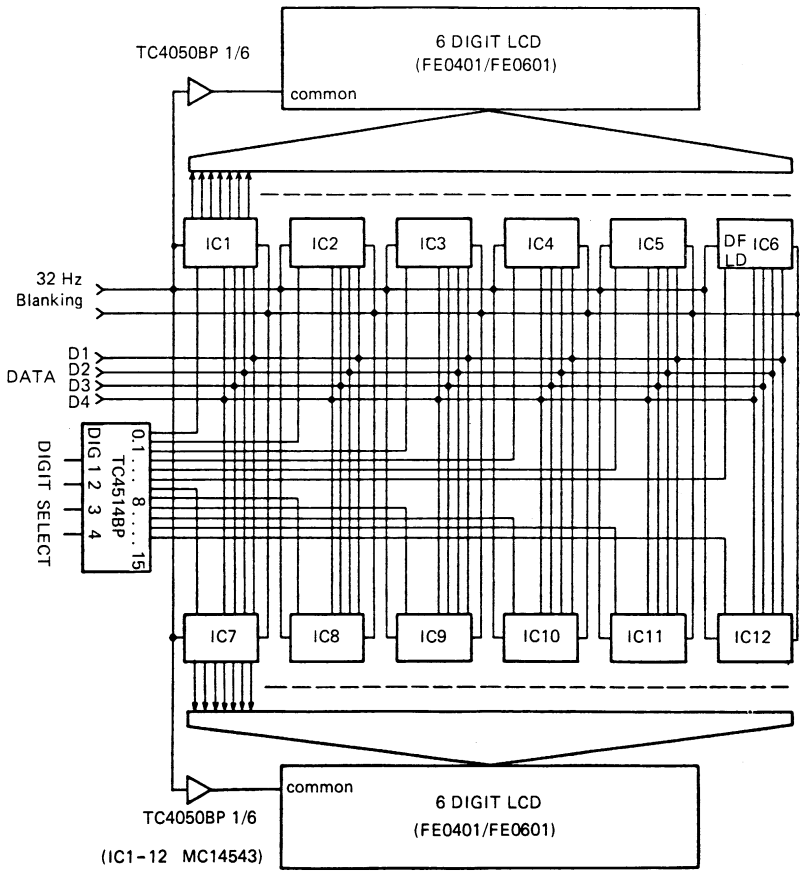
Application Circuits

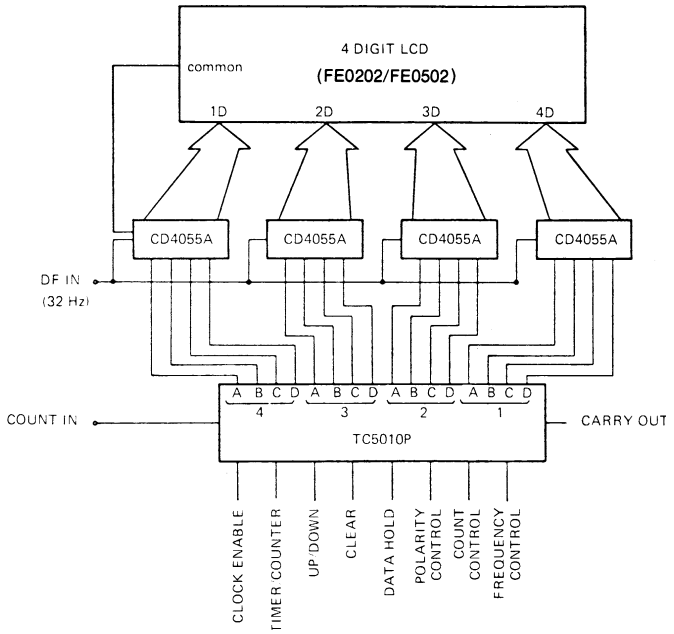
3 1/2 Digit Numerical Display



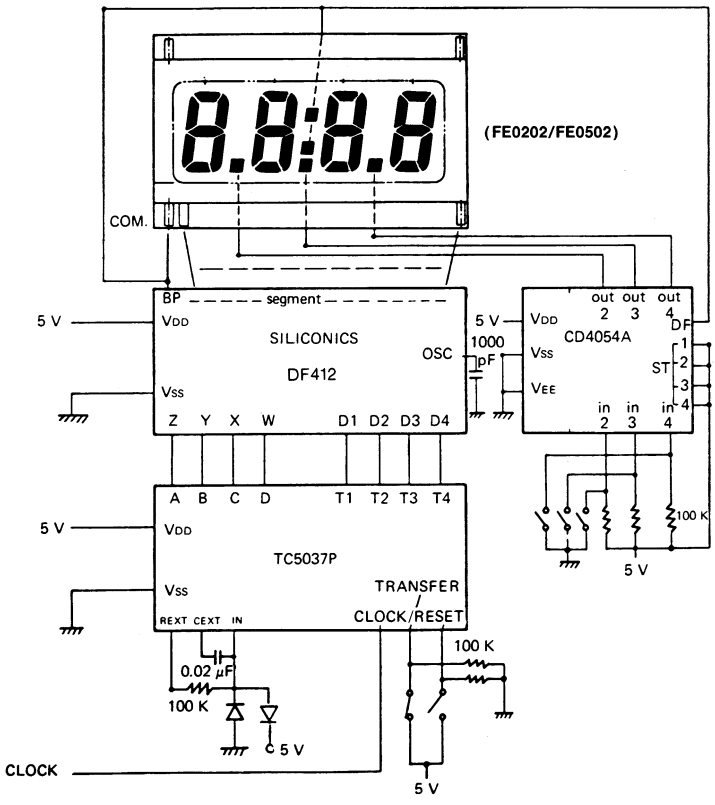
12 Digit Numerical Display



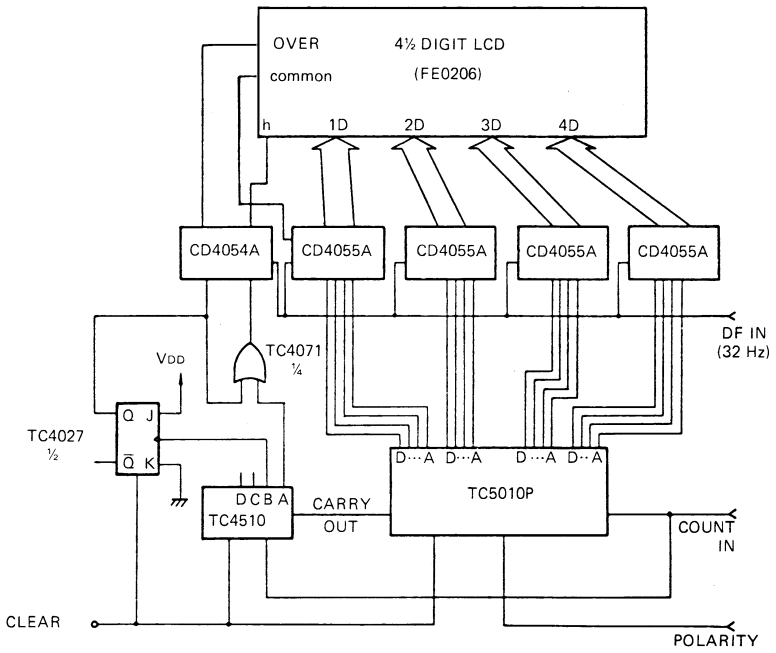
7 Digit Up-Down Counter



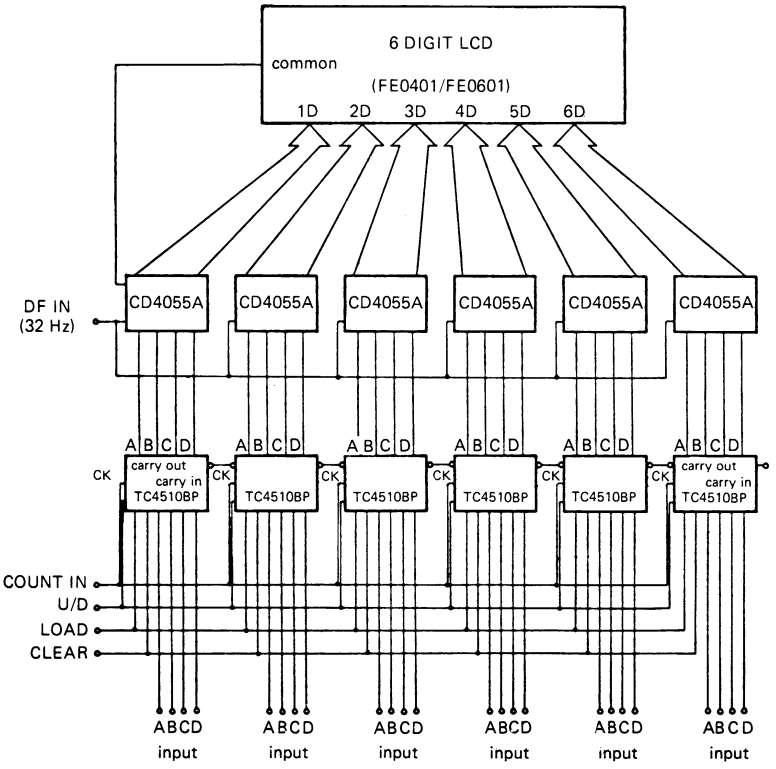
4 Digit Counter



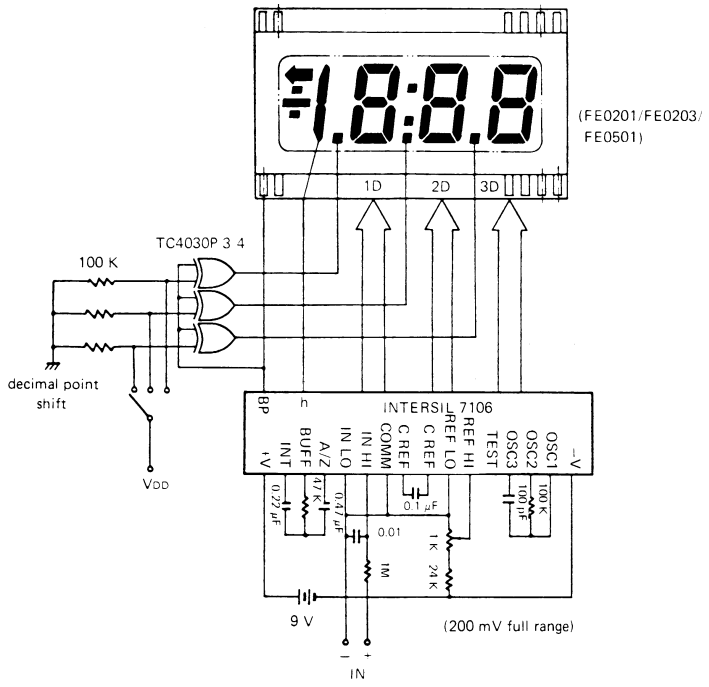
4 1/2 Digit Up-Down Counter



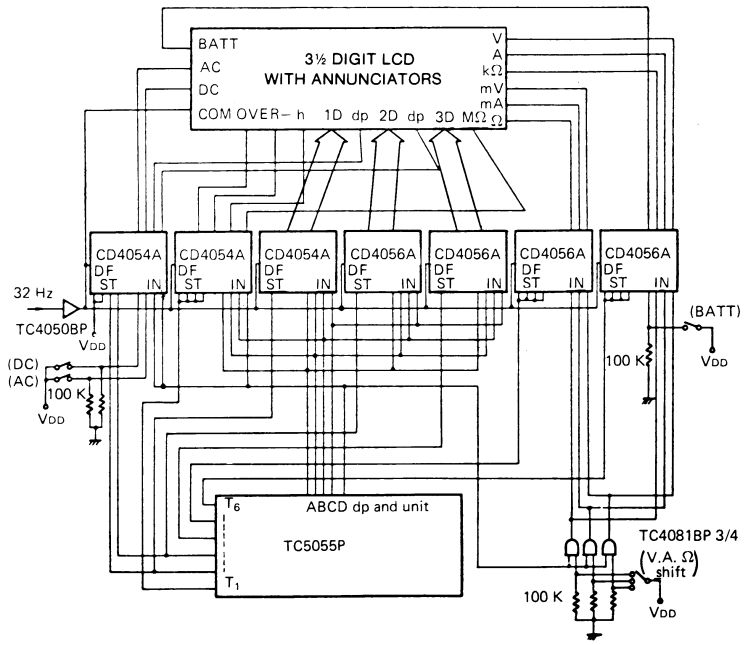
6 Digit Counter



3 1/2 Digit A/D Converter



3 1/2 Digit AD Converter



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8 Digit Drive Scheme