Signetics

NE5150/5151/5152
Triple 4-Bit RGB D/A Converter With and Without Memory

Product Specification

Linear Products

DESCRIPTION

The NE5150/5151/5152 are triple 4-bit DACs intended for use in graphic display systems. They are a high performance — yet cost effective — means of interfacing digital memory and a CRT. The NE5150/5152 are single integrated circuit chips containing special input buffers, an ECL static RAM, high-speed latches, and three 4-bit DACs. The input buffers are user-selectable as either ECL or TTL compatible for the NE5150. The NE5152 is similar to the NE5150, but is TTL compatible only, and operates off of a single +5V supply. The RAM is organized as 16 × 12, so that 16 "color words" can be down-loaded from the pixel memory into the chip memory. Each 12-bit word represents 4 bits of red, 4 bits of green and 4 bits of blue information. This system gives 4096 possible colors. The RAM is fast enough to completely reload during the horizontal retrace time. The latches resynchronize the digital data to the DACs to prevent glitches. The DACs include all the composite video functions to make the output waveforms meet RS-170 and RS-343 standards, and produce $1V_{P-P}$ into 75Ω. The composite functions (reference white, bright, blank, and sync) are latched to prevent screen-edge distortions generally found on "video DACs." External components are kept to an absolute minimum (bypass capacitors only as needed) by including all reference generation circuitry and termination resistors on-chip, by building in high-frequency PSRR (eliminating separate V_{EE}s and costly power supplies and filtering), and by using a single-ended clock. The guaranteed maximum operating frequency for the NE5150/5152 is 110MHz over the commercial termperature range. The devices are housed in a standard 24-pin package and consume less than 1W of power.

The NE5151 is a simplified version of the NE5150, including all functions except the memory. Maximum operating frequency is 150MHz.

FEATURES

- **Single-chip**
- **On-board ECL static RAM**
- **4096 colors**
- **ECL and TTL compatible**
- **110MHz update rate (NE5150, 5152)**
- **150MHz update rate (NE5151)**
- **Low power and cost**
- **Drives 75Ω cable directly**
- **Internal reference**
- **40dB PSRR**
- **No external components necessary**

APPLICATIONS

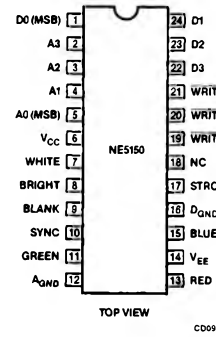
- **Bit-mapped graphics**
- **Super high-speed DAC**
- **Home computers**
- **Raster-scan displays**

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
24-Pin Ceramic DIP	0°C to +70°C	NE5150F
24-Pin Ceramic DIP	0°C to +70°C	NE5151F
24-Pin Ceramic DIP	0°C to +70°C	NE5152F
24-Pin Plastic SOL	0°C to +70°C	NE5152D

PIN CONFIGURATIONS

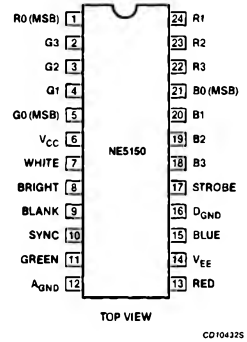
NE5150 F Package



TOP VIEW

CD09550S

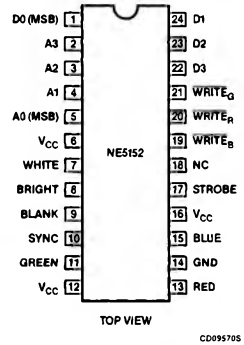
NE5151 F Package



TOP VIEW

CD10432S

NE5152 D[1] and F Packages



TOP VIEW

CD09570S

NOTE:
1. Available in large SO pakage only.

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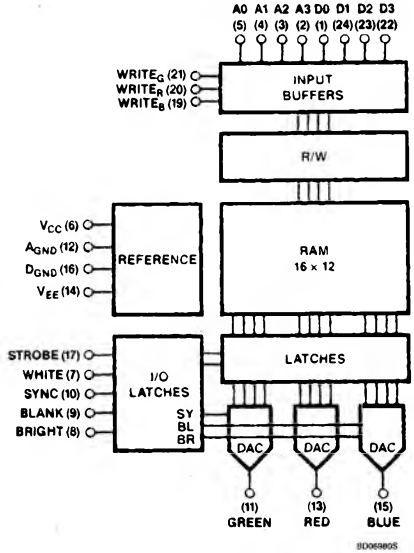
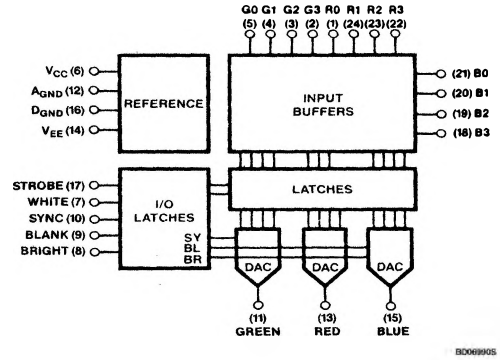
BLOCK DIAGRAMS

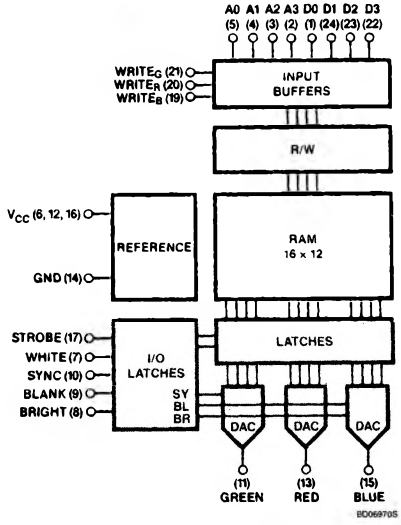
NE5150



NE5151



NE5152



Triple 4-Bit RGB D/A Converter With and Without Memory

NE5150/5151/5152

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
	Temperature range		
T_A	Operating	0 to +70	°C
T_{STG}	Storage	−65 to +150	°C
V_{CC}	Power supply	7.0	V
V_{EE}		−7.0	V
	Logic levels		
	TTL-high	5.5	V
	TTL-low	−0.5	V
	ECL-high	0.0	V
	ECL-low	0 to V_{EE}	V

DC ELECTRICAL CHARACTERISTICS

V_{CC} = +5V (TTL), 0V (ECL), V_{EE} = −5V, 0°C < T_A < +70°C, for NE5150/5151; V_{CC} = +5V (TTL), GND = 0V for NE5152, unless otherwise noted.

SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
	Resolution	4			bits
	Monotonicity	4			bits
NL	Non-linearity		± 1/16	± 1/2	LSB
DNL	Differential non-linearity		± 1/8	± 1	LSB
	Offset error (25°C) [1111] (BRT = 1)		−1/5	± 1	LSB
	Gain error (25°C) [0000] (BRT = 1)		± 1/2	± 1	LSB
V_{CC}	Positive power supply (TTL mode) (NE5150)	4.5	5.0	5.5	V
	(TTL mode) (NE5151)	4.75	5.0	5.5	V
	(ECL mode)	−0.1	0.0	0.1	V
V_{EE}	Negative power supply (TTL or ECL mode) (NE5150/5151)	−4.75	−5.0	−5.5	V
I_{CC}	Positive supply current (NE5150/5151)		15	25	mA
	(NE5152)		175	210	mA
I_{EE}	Negative supply current (NE5150)		175	210	mA
	(NE5151)		145	175	mA
	Analog voltage range (ZS to FS)		603		mV
	Gain tracking (any two channels)			± 1/4	LSB
LSB	Least significant bit		40.2		mV
EWH	Enhanced white level (25°C)[2]		0		mV
BS	Bright shift (25°C)(0 to 1)		71.4		mV
EBL	Enhanced blanking level (25°C)[2]		−674		mV
ESY	Enhanced sync level (25°C)[2]		−960		mV
R_O	Output resistance (25°C)	67.5	75.0	82.5	Ω
V_{IH}	TTL logic input high	2.0			V
V_{IL}	TTL logic input low			0.8	V
I_{IH}	TTL logic high input current (V_{IN} = 2.4V)			20	μA
I_{IL}	TTL logic low input current (V_{IN} = 0.4V)			−1.6	mA
V_{IH}	ECL logic input high	−1.045			V
V_{IL}	ECL logic input low			−1.48	V
I_{IH}	ECL logic high input current (V_{IN} = −0.8V)			−1.0	mA
I_{IL}	ECL logic low input current (V_{IN} = −1.8V)			−1.0	mA

TEMPERATURE CHARACTERISTICS V_{CC} = +5V (TTL), 0V (ECL), V_{EE} = −5V, 0°C < T_A < +70°C, for NE5150/5151; V_{CC} = +5V (TTL), GND = 0V for NE5152, unless otherwise noted.

SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
	Offset TC[1]		± 50	± 100	ppm/°C
	Gain TC[1]		± 70	± 200	ppm/°C
	Gain Tracking TC (any two channels)		± 20	± 50	ppm/°C
	Enhanced white level TC[1]		± 50	± 100	ppm/°C
	Bright shift TC		± 70	± 200	ppm/°C
	Enhanced blanking level TC		± 100	± 300	ppm/°C
	Enhanced sync level TC		± 100	± 300	ppm/°C
	Output resistance TC		+ 1000	+ 2000	ppm/°C

NOTES:
1. Normalized to full-scale (603mV).
2. With respect to [1111] (BRT = 1).

AC ELECTRICAL CHARACTERISTICS V_{CC} = +5V (TTL), 0V (ECL), V_{EE} = −5V, 0°C < T_A < +70°C, for NE5150/5151; V_{CC} = +5V (TTL), GND = 0V for NE5152, unless otherwise noted.

SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
f_{MAX}	Maximum operating frequency (NE5150/5152)	110			MHz
t_{WAS}	Write address setup (NE5150/5152)	0			ns
t_{WAH}	Write address hold (NE5150/5152)	0			ns
t_{WDS}	Write data setup (NE5150/5152)	4			ns
t_{WDH}	Write data hold (NE5150/5152)	2			ns
t_{WEW}	Write enable pulse width (NE5150/5152)	3			ns
t_{RCS}	Read composite[1] setup (NE5150/5152)	3			ns
t_{RCH}	Read composite[1] hold (NE5150/5152)	2			ns
t_{RAS}	Read address setup (NE5150/5152)	3			ns
t_{RAH}	Read address hold (NE5150/5152)	2			ns
t_{RSW}	Read strobe pulse width (NE5150/5152)	3			ns
t_{RDD}	Read DAC delay (NE5150/5152)		8		ns
f_{MAX}	Maximum operating frequency (NE5151)	150			MHz
t_{CS}	Composite[1] setup (NE5151)	3			ns
t_{CH}	Composite[1] hold (NE5151)	2			ns
t_{DS}	Data-bits setup (NE5151)	1			ns
t_{DH}	Data-bits hold (NE5151)	5			ns
t_{SW}	Strobe pulse width (NE5151)	3			ns
t_{DD}	DAC delay (NE5151)		8		ns
t_R	DAC rise time (10 - 90%)		3		ns
t_S	DAC full-scale settling time[2]		10		ns
C_{OUT}	Output capacitance (each DAC)		10		pF
SR	Slew rate		200		V/μs

SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
GE	Glitch energy			30	pV-s
PSRR[3]	Power supply rejection ratio (to red, green or blue outputs)				
	V_{EE} at 1kHz		43		dB
	V_{EE} at 10MHz		28		dB
	V_{EE} at 50MHz		14		dB
	V_{CC} at 1kHz		80		dB
	V_{CC} at 10MHz		50		dB
	V_{CC} at 50MHz		36		dB

NOTES:
1. Composite implies any of the WHITE, BRIGHT, BLANK or SYNC signals.
2. Setting to ± ½ LSB, measured from STROBE 50% point (rising edge). This time includes the delay throught the strobe input buffer and latch.
3. Listed PSRR is for the NE5150/51. The NE5152 PSRR specs are identical to the V_{EE} numbers in the table.

NE5150 PIN DESCRIPTION

Write enable inputs use negative-true logic while all other inputs are positive-true. All inputs operate synchronously with the positive edge-triggered strobe input. When V_{CC} is taken high (5V), all inputs are TTL compatible. When V_{CC} is grounded, all inputs are ECL compatible. All DACs are complementary, so that all ones is the highest absolute voltage and all zeroes is the lowest. All ones is called zero-scale (ZS) and all zeroes is called full-scale (FS). The analog output voltage is approximately 0V (ZS) to −1V (SYNC).

Pins 1, 24, 23, 22: **DATA** bits D0 (MSB) through D3, used to input digital information to the memory during the write phase. During this phase, the data bits are presented to the internal latches (noninverted) and the DACs will output the analog equivalent of the stored word, unless overridden by WHITE, BLANK or SYNC.

Pins 5, 4, 3, 2: **ADDRESS** lines A0 (MSB) through A3, used for selecting a memory address to write to or read from.

Pin 7: **WHITE** command. Presets the latches to all ones [1111] and outputs 0V absolute on all DACs. Can be modified to −71mV absolute when BRIGHT is taken low. Will be overridden by either a BLANK or SYNC command.

Pin 8: **BRIGHT** command. A low input here turns on an additional −71mV (10 IRE unit) switch, shifting all other levels downward. Not overridden by any other input.

Pin 9: **BLANK** command. Presets the latches to all zeroes [0000] and turns on an additional −71mV (10 IRE unit) switch. Absolute output is −671mV. Can be modified another −71mV to −742mV absolute when BRIGHT is taken low. Will override WHITE, and will be overridden by SYNC.

Pin 10: **SYNC** command. Presets the latches to all zeroes [0000] and turns on the BLANK switch. Additionally turns on a −286mV (40 IRE unit) switch in the green channel only. Absolute output is −671mV for the red and blue channels, and −957mV for the green channel. All levels can be shifted −71mV by taking BRIGHT low. Overrides WHITE and BLANK.

Pins 11, 13, 15: **GREEN, RED, BLUE.** Analog outputs with 75Ω internal termination resistors. Can directly drive 75Ω cable and should be terminated at the display end of the line with 75Ω. Output voltage range is approximately 0V to −1V, independent of whether the digital inputs are ECL or TTL compatible. All outputs are simultaneously affected by the WHITE, BLANK or BRIGHT commands. Only the GREEN channel carries SYNC information.

NOTE:
There are 100 IRE units from WHITE to BLANK. One IRE unit is approximately 7.1mV. Full-scale is 90 IRE units and 10 IRE units is ⅑ of full-scale (e.g., BRIGHT function).

Pins 19, 20, 21: $\overline{\text{WRITE}}_B$, $\overline{\text{WRITE}}_R$, $\overline{\text{WRITE}}_G$. Write enable commands for each of the three 16 × 4 memories. When all write commands are high, then the READ operation is selected. This is the normal display mode. To write data into memory, the write enable pin is taken low. Data D0 − D3 will be written into address A0 − A3 of each memory when its corresponding write enable pin goes low.

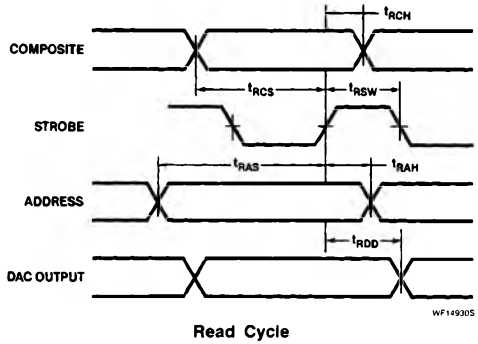
Pin 17: **STROBE.** The strobe signal is the main system clock and is used for resynchronizing digital signals to the DACs. Preventing data skew eliminates glitches which would otherwise become visible color distortions on a CRT display. The strobe command has no special drive requirements and is TTL or ECL compatible.

Pins 12, 16: A_{GND}, D_{GND}. Both **A**nalog and **D**igital ground carry a maximum of approximately 100mA of DC current. For proper operation, the difference voltage between A_{GND} and D_{GND} should be no greater than 50mV, preferably less.

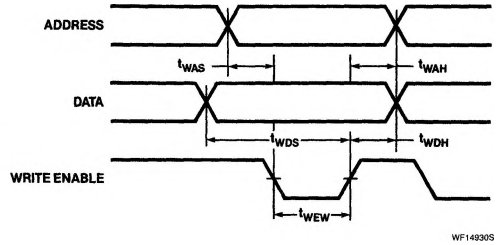
Pin 14: V_{EE}. The negative power supply is the main chip power source. V_{CC} is only used for TTL input buffers. As is usual, good bypassing techniques should be used. The chip itself has a good deal of power supply rejection — well up into the VHF frequency range — so no elaborate power supply filtering is necessary.

Pin 18: **NC.** This unused pin should be tied high or low.

NE5150/5152 TIMING DIAGRAMS



Read Cycle



Write Cycle

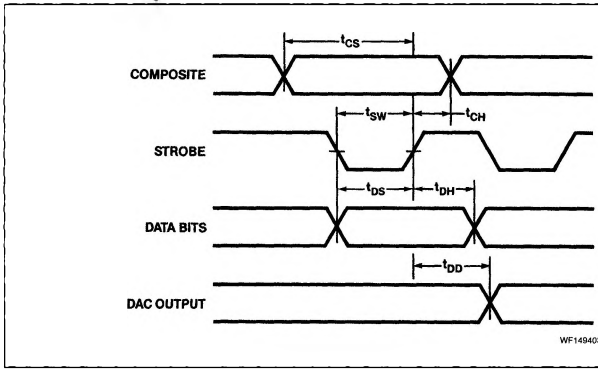
NE5151 PIN DESCRIPTION AND TIMING DIAGRAM

The eleven digital inputs D0 – D3, A0 – A3, $\overline{\text{WRITE}}_{G/R/B}$, and the unused Pin 18 of the NE5150 are replaced in the NE5151 with the three 4-bit DAC digital inputs G0 – G3, R0 – R3, and B0 – B3. All other pin functions (e.g., composite functions, power supplies, strobe, etc.) are identical to the NE5150.

NE5152 PIN DESCRIPTION

The NE5152 is a TTL-compatible-only version of the NE5150, operating off of a single +5V supply. V_{CC} Pins 6, 12 and 16 should be connected to +5V and Pin 14 to 0V. DAC output is referenced to V_{CC}.

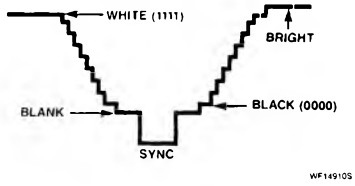
NE5151 TIMING DIAGRAM



NE5150/NE5151/NE5152 LOGIC TABLE

SYNC	BLANK	WHITE	BRIGHT	DATA	ADDRESS	OUTPUT[3]	CONDITION
1	X	X	0	X	X	-1031mV	SYNC[1]
1	X	X	1	X	X	-960mV	Enhanced SYNC[1]
0	1	X	0	X	X	-746mV	BLANK
0	1	X	1	X	X	-674mV	Enhanced BLANK
0	0	1	0	X	X	-71mV	WHITE
0	0	1	1	X	X	0mV	Enhanced WHITE
0	0	0	0	[0000]	Note 2	-674mV	BLACK (FS)
0	0	0	1	[0000]	Note 2	-603mV	Enhanced BLACK (EFS)
0	0	0	0	[1111]	Note 2	-71mV	WHITE (ZS)
0	0	0	1	[1111]	Note 2	0mV	Enhanced WHITE (EZS)

NOTES:

1. Green channel output only. RED and BLUE will output BLANK or Enhanced BLANK under these conditions.
2. For the NE5150/5152 the DATA column represents the memory data accessed by the specific address. For the NE5151, the DATA is the direct digital inputs.
3. Note output voltages in Logic Table are referenced to V_{CC} for the NE5152 only.

COMPOSITE VIDEO WAVEFORM