

# TDA4503

## Small-Signal Subsystem for Monochrome TV

### Product Specification

#### Linear Products

#### DESCRIPTION

The TDA4503 combines all small-signal functions (except the tuner) which are required for monochrome TV receivers. For a complete monochrome TV receiver only power output stages are required to be added for horizontal and vertical deflection, video and sound. This part is designed to work with the TDA3561, Vertical Output IC.

The TDA4503 can also be used in low cost color television receivers.

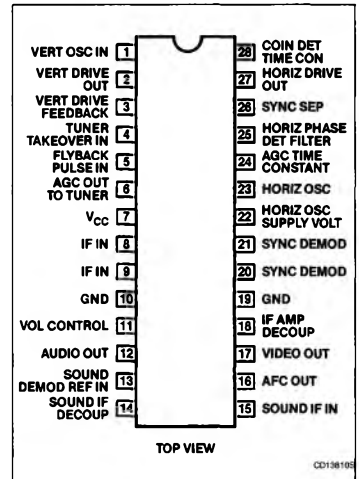
#### FEATURES

- Vertical sync separator and oscillator
- Video preamplifier
- AGC detector
- Sync separator
- Horizontal synchronization
- Vision IF amplifier and synchronous demodulator
- Tuner AGC
- AFC circuit
- Sound IF amplifier and demodulator
- Audio preamplifier with DC volume control
- Gate pulse generator

#### APPLICATIONS

- Television receiver
- CATV converter

#### PIN CONFIGURATION



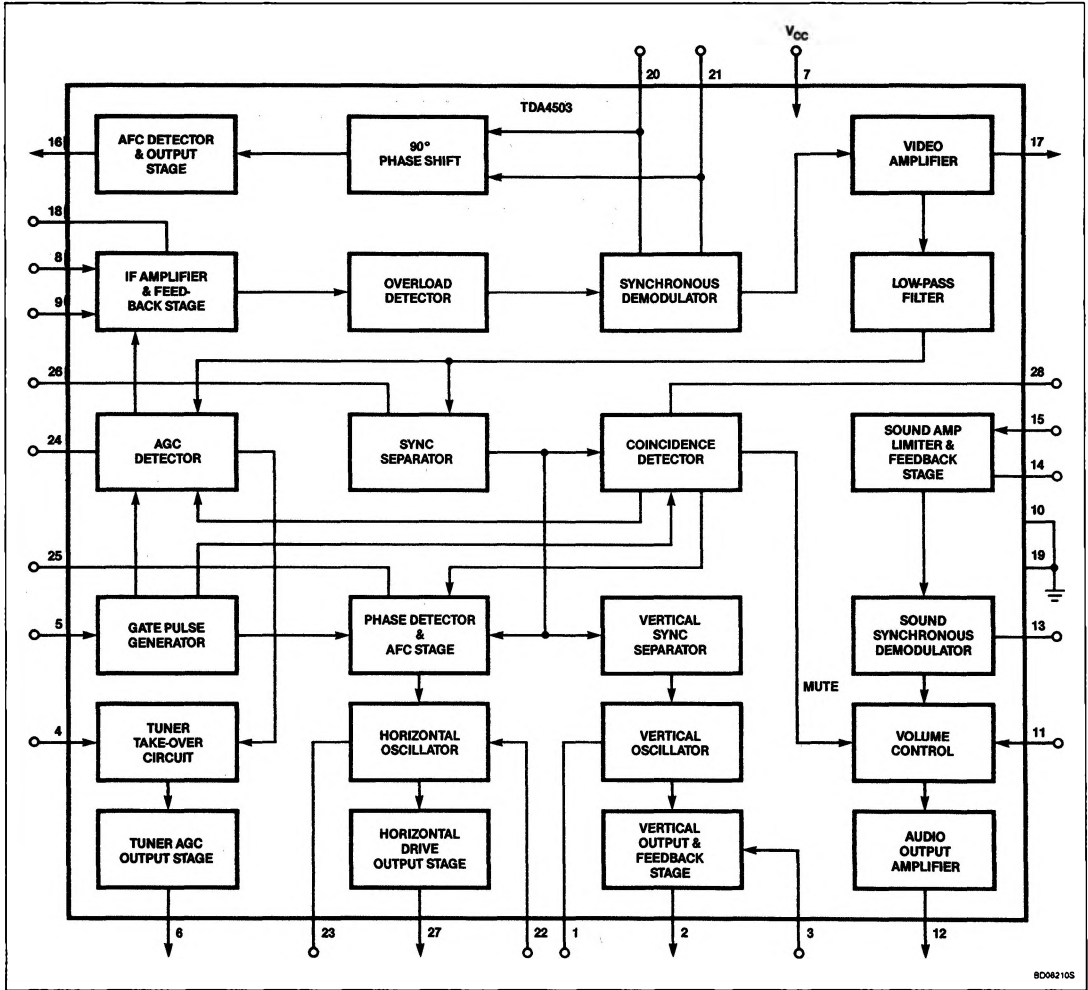
#### ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
28-Pin Plastic DIP (SOT-117)	-25°C to +65°C	TDA4503N

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### BLOCK DIAGRAM



8D04210S

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## ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
$V_{CC} = V_{7-10}$	Supply voltage (Pin 7)	13.2	V
$P_{TOT}$	Total power dissipation	1.7	W
$T_A$	Operating ambient temperature range	-25 to +65	°C
$T_{STG}$	Storage temperature range	-65 to +150	°C

DC AND AC ELECTRICAL CHARACTERISTICS  $V_{7-10} = 10.5V$ ;  $V_{22-10} = 10.5V$ ;  $T_A = 25^\circ C$ , unless otherwise specified.

SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
<b>Supplies</b>					
$V_{7-10}$	Supply voltage (Pin 7)	9.5	10.5	13.2	V
$I_7$	Supply current (Pin 7)		82	100	mA
$V_{22-10}$	Supply voltage (Pin 22)	9.5	10.5	13.2	V
$I_{22}$	Supply current (Pin 22) <sup>1</sup>		5	6.5	mA
$P_{TOT}$	Total power dissipation		920	1150	mW
<b>Vision IF amplifier (Pins 8 and 9)</b>					
$V_{8-9}$	Input sensitivity at 38.9 MHz <sup>2</sup>	40	80	120	$\mu V$
$V_{8-9}$	Input sensitivity at 45.75 MHz <sup>2</sup>		90		$\mu V$
$R_{8-9}$	Differential input resistance (Pin 8 to 9)		1.3		k $\Omega$
$C_{8-9}$	Differential input capacitance (Pin 8 to 9)		5		pF
	AGC range		59		dB
$V_{8-9}$	Maximum input signal	50	70		mV
$\Delta V_{17-10}$	Expansion of output signal (Pin 17) for 50dB variation of input signal (Pins 8 and 9) <sup>3</sup>		0.5	1.0	dB
<b>Video amplifier<sup>4</sup></b>					
$V_{17-10}$	Output level for zero signal input (zero point of switched demodulator)	4.2	4.5	4.8	V
$V_{17-10}$	Output signal top sync level <sup>5</sup>	1.25	1.45	1.65	V
$V_{17-10}(P-P)$	Amplitude of video output signal (peak-to-peak value)	2.4	2.7	3.0	V
$I_{17}(INT)$	Internal bias current of output transistor (NPN emitter-follower)	1.4	2.0		mA
BW	Bandwidth of demodulated output signal		5		MHz
$G_{17}$	Differential gain <sup>6</sup> (Figure 5)		6		%
	Differential phase <sup>6</sup> (Figure 5)		4		%
	Video non-linearity over total video amplitude (peak white to black)			10	%
	Intermodulation (Figures 6 and 7) at gain control = 45dB				dB
	f = 1.1MHz; blue	55	60		dB
	f = 1.1MHz; yellow	50	54		dB
	f = 3.3MHz; blue	60	66		dB
	f = 3.3MHz; yellow	55	59		dB
S/N	Signal-to-noise ratio <sup>7</sup>				dB
S/N	at $V_i = 10mV$	50	54		dB
S/N	at end of AGC range	50	56		dB
S/N	as a function of input signal	see Figure 8			
	Residual AM of intercarrier output signal <sup>8</sup>		5	10	%
	Residual carrier signal		7	30	mV
	Residual 2nd harmonic of carrier signal		3	30	mV

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SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
<b>Tuner AGC<sup>9</sup></b>					
$V_{4-10}$	Takeover voltage (Pin 4) for positive-going tuner AGC (NPN tuner)		3.5		V
$V_{8-9(RMS)}$	Starting point takeover at $V_{4-10} = 5V$ (RMS value)		0.4	2.0	mV
$V_{8-9(RMS)}$	Starting point takeover at $V_{4-10} = 1.2V$ (RMS value)	50	70		mV
$V_{4-10}$	Takeover voltage (Pin 1) for negative-going tuner AGC (PNP tuner)		8		V
$V_{8-9(RMS)}$	Starting point takeover at $V_{4-10} = 9.5V$ (RMS value)		0.3	2.0	mV
$V_{8-9(RMS)}$	Starting point takeover at $V_{4-10} = 5.6V$ (RMS value)	50	70		mV
$I_{6MAX}$	Maximum tuner AGC output swing	2	3		mA
$V_{6-10(SAT)}$	Output saturation voltage at $I_6 = 2mA$			300	mV
$I_6$	Leakage current at Pin 6			1	$\mu A$
$\Delta V_{8-9}$	Input signal variation required for complete tuner control	0.5	2	4	dB
<b>AFC circuit (Pin 16)<sup>10</sup></b>					
$V_{16-10(P-P)}$	AFC output voltage swing (peak-to-peak value)	9		10	V
$\pm I_{16}$	Available output current		1		mA
	Control steepness at 100% picture carrier 10% picture carrier	20	40 15	80	mV/kHz mV/kHz
$V_{16-10}$	Output voltage at nominal tuning of the reference-tuned circuit		5.25		V
$V_{16-10}$	Output voltage without input signal	2.7	6.0	8.5	V
<b>Sound circuit</b>					
$V_{15LIM}$	Input limiting voltage <sup>11</sup> (RMS value) at $V_O = V_{O\ MAX} - 3dB$		2		mV
$R_{15-10}$	Input resistance at $V_{I(RMS)} = 1mV$		2.6		k $\Omega$
$C_{15-10}$	Input capacitance at $V_{I(RMS)} = 1mV$		6		pF
AMR AMR	AM rejection (Figures 7 and 8) at $V_i = 10mV$ $V_i = 50mV$		35 43		dB dB
$V_{12-6(RMS)}$	AF output signal <sup>12</sup> (RMS value)	220	320		mV
$Z_{12-10}$	AF output impedance		150		$\Omega$
THD	Total harmonic distortion <sup>12</sup>		1		%
RR RR	Ripple rejection at $f_K = 100Hz$ , volume control 20dB when muted		22 26		dB dB
$V_{12-10}$	Output voltage in mute condition		2.6		V
S/N	Signal-to-noise-ratio; weighted noise (CCIR 468)		47		dB
<b>Volume control</b>					
$V_{11-10}$	Voltage (Pin 11 disconnected)		6.9		V
$I_{11}$	Current (Pin 11 connected to ground)		1		mA
$R_{11-10}$	External control resistor <sup>13</sup>		5		k $\Omega$
	Suppression of output signal during mute condition		66		dB

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SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
<b>Horizontal synchronization</b>					
	Slicing level sync separator <sup>14</sup>		30		%
	Phase-locked loop holding range	$\pm 800$	$\pm 1100$	$\pm 1500$	Hz
	Phase-locked loop catching range	$\pm 600$	1000		Hz
	Control sensitivity video to flyback <sup>15</sup>		2.3		kHz/ $\mu s$
	Delay between leading edge of sync pulse and zero cross-over of sawtooth (Pin 5)		3		$\mu s$
<b>Horizontal oscillator (Pin 23)</b>					
$f_{FR}$	Free-running frequency; $R = 35k\Omega$ ; $C = 2.7nF$		15,626		Hz
	Spread with fixed external components			4	%
$\Delta f_{FR}$	Frequency variation due to change of supply voltage from 8 to 12V		0	0.5	%
TC	Temperature coefficient			$1 \times 10^{-4}$	$^\circ C^{-1}$
$\Delta f_{FR}$	Maximum frequency shift			10	%
$\Delta f_{FR}$	Maximum frequency deviation ( $V_{7-10} = 8V$ )			10	%
<b>Horizontal output (Pin 27)</b>					
$I_{27}$	Output current	5			mA
$R_{27}$	Output impedance		200		$\Omega$
$V_{27-10}$	Output voltage at $I_{27} = 5mA$		1.4		V
$V_{27-22}$			2.5		V
$\alpha$	Duty factor of horizontal output signal <sup>16</sup>	0.35	0.40	0.45	%
$t_R, t_F$	Rise and fall times of output pulse		400		ns
<b>Flyback input (Pin 5)</b>					
$V_5$	Amplitude of input pulse	2	4	6	V
$V_5$	Voltage at which gate pulse generator changes state <sup>17</sup>		0		V
<b>Coincidence detector mute output (Pin 28)<sup>18</sup></b>					
$V_{28-10}$	Voltage for in-sync condition		9.5		V
$V_{28-10}$	Voltage for no-sync condition (no input signal)		1.0	1.5	V
$V_{28-10}$	Voltage level for phase detector to switch from slow to fast	3.7	4.1	4.5	V
	Fast-to-slow hysteresis		1		V
$V_{28-10}$	Voltage level to activate mute function (transmitter identification)	2.25	2.5	2.75	V
$I_{22(P-P)}$	Output current for in-sync condition (peak-to-peak value)	0.7	1.0		mA

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SYMBOL	PARAMETER	LIMITS			UNIT
		Min	Typ	Max	
<b>Vertical oscillator (Pin 1)</b>					
$f_{FR}$	Free-running frequency at $C = 220nF$ ; $R = 560k\Omega$		47.5		Hz
	Spread with fixed external components			4	%
	Holding range at nominal frequency	52.5			Hz
TC	Temperature coefficient			$2 \times 10^{-4}$	$^\circ C^{-1}$
$\Delta f_{FR}$	Frequency variation due to change of supply voltage from 9.5 to 12V		3	5	%
$I_1$	Leakage current at Pin 1			1.6	$\mu A$
<b>Vertical output (Pin 2)</b>					
$I_2$	Output current	1	1.3		mA
$R_2$	Output resistance		2		$k\Omega$
<b>Feedback input (Pin 3)</b>					
$V_{3-10}$ $V_{3-10(P-P)}$	Input voltage DC component AC component (peak-to-peak value)	4.0	5.0 1.2	5.5	V V
$I_3$	Input current			12	$\mu A$
$\Delta I_3$	Non-linearity of deflector current at $V_{7-10} = 10.5V$			2.5	%
	Delay between leading edge of vertical sync and start of vertical oscillator flyback	6		10	$\mu s$

## NOTES:

- The horizontal oscillator can be started by supplying a current of 6mA to Pin 22. Taking this current from the mains rectifier allows the positive supply voltage to Pin 7 to be derived from the horizontal output stage (the load current of Pin 27 is additional to the 6mA quoted).
- At start of AGC.
- Measured with  $\Delta B = 200\mu V$ .
- Measured at 10mV (RMS) top sync output signal.
- Signal with negative-going sync; top white = 10% of the top sync amplitude.
- Measured with test line as shown in Figure 3. The differential gain is expressed as a percentage of the difference in peak amplitudes between the largest and smallest values relative to the subcarrier amplitude at blanking level. The differential phase is defined as the difference in degrees between the largest and smallest phase angles.
- Measured with a source impedance of  $75\Omega$ .

$$\text{Signal-to-noise ratio} = 20 \log \frac{V_O \text{ black-to-white}}{V_{I(RMS)} \text{ at } B = 5\text{MHz}}$$

- Measured with a sawtooth-modulated input signal:  $m = 90\%$ ;  $V_{I(RMS)} = 10\text{mV}$ ;

$$\text{Amplitude modulation} = \frac{V_O \text{ SC at top sync} - V_O \text{ SC at white}}{V_O \text{ SC at top sync} + V_O \text{ SC at white}} \times 100\%$$

(SC = sound carrier)

- Starting point of tuner take-over for an NPN tuner is when  $I_6 = 1.8\text{mA}$ , and for a PNP tuner is when  $I_6 = 0.2\text{mA}$ .
- Measured at  $V_{O-9(RMS)} = 10\text{mV}$  and Pin 16 loaded with  $2 \times 100k\Omega$  between  $V_7$  and ground. Reference tuned circuit Q-factor = 36.
- Reference tuned circuit Q-factor = 18; audio frequency = 1kHz; carrier frequency = 5.5 MHz.
- The demodulator tuned circuit must be tuned for minimum distortion; output signal is measured at  $\Delta f = 7.5\text{kHz}$ ; other measurements are at  $\Delta f = 27.5\text{kHz}$ .
- Volume control can be realized by a variable resistor ( $5k\Omega$ ) connected between Pin 11 and ground, or by a variable voltage direct to Pin 11 (the low value of input impedance to Pin 11 must be taken into account).
- The sync separator is noise-gated; the slicing level is referred to the top sync level and is independent of the video signal. The value stated is a percentage of the sync pulse amplitude, the level being dependent on external resistors connected to Pin 26.
- The phase detector current is increased by a factor of seven during catching and when the phase detector is switched to 'fast' via Pin 28, thus ensuring a wide catching range and a high dynamic loop gain.
- The negative going edge initiates switching-off of the line output transistor (simultaneous driver).
- The circuit requires an integrated flyback pulse. Gate pulses for AGC and coincidence detectors are obtained from the sawtooth waveform.
- The functions of in-sync, out-of-sync, and transmitter identification are combined on Pin 28. For the reception of VCR signals,  $V_{28}$  must be fixed between 3V and 4.5V so that the time constant is fast and sound information is preserved.

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### FUNCTIONAL DESCRIPTION

#### IF Amplifier, Demodulator, and AFC

The IF amplifier operates with symmetrical inputs at Pins 8 and 9 and has an input impedance suitable for SAW filter application. The amplifier sensitivity gives a peak-to-peak output voltage of 3V for an RMS input of  $70\mu\text{V}$ . The demodulator and the AFC circuit share an external reference tuned circuit (Pins 20 and 21) and an internal RC network provides the phase-shifting necessary for AFC operation. The AFC circuit provides a control voltage output with a (typical) swing of 9V from Pin 16 ( $V_{CC} = 10.5\text{V}$ ).

#### AGC Circuit

Gating of the AGC detector is performed to reduce sensitivity of the IF amplifier to external electrical noise. The AGC time constant is provided by an RC network connected to Pin 24. The typical gain control range of the IF amplifier is 60dB. Tuner AGC voltage is supplied from Pin 6 and is suitable for tuners with PNP or NPN RF stages. The sense of the AGC (to increase in a positive or negative direction) and the point of tuner takeover are preset by the voltage level at Pin 4 ( $V_4 = 3.5\text{V}$  (typ.) for positive AGC;  $V_4 = 8\text{V}$  (typ.) for negative AGC).

#### Video Amplifier

The video signal output from Pin 17 has a peak-to-peak value of 3V (top sync level = 1.5V) and carries negative-going sync. In order to retain sound information at Pin 17, the video signal is not blanked during flyback periods.

#### Sound Circuit

The sound IF signal present at the video output (Pin 17) is coupled to the sound circuit by a bandpass filter to Pin 15. The sound circuit has an amplifier-limiter stage, a synchronous demodulator with reference tuned circuit at Pin 13, a volume control stage, and an output amplifier. The volume control has a range of approximately 80dB and the audio output signal at maximum volume and with  $\Delta f = 7.5\text{kHz}$  is 320mV (RMS value). The sound output signal is suppressed when no input signal is detected.

#### Synchronization Circuits

The sync separator slicing level is determined by an external resistor network at Pin 26. The slicing level is referred to the top sync level and the recommended value for slicing is 30%. Internal protection from electrical noise is included.

A gated phase detector compares the phase of the separated sync pulses with a sawtooth waveform obtained from the flyback pulse at

Pin 5. In sync and out-of-sync conditions are detected by the coincidence detector at Pin 28 (this circuit also gives transmitter identification). During the out-of-sync condition, gating of the phase detector is switched off and the output current from the phase detector increases to give the detector a short time-constant and thus a fast response. This condition can be imposed by clamping the voltage at Pin 28 to 3.5V for the reception of VCR signals.

The horizontal oscillator frequency is controlled by the output voltage of the phase detector circuit. The horizontal drive output from Pin 27 has a duty factor of 40%.

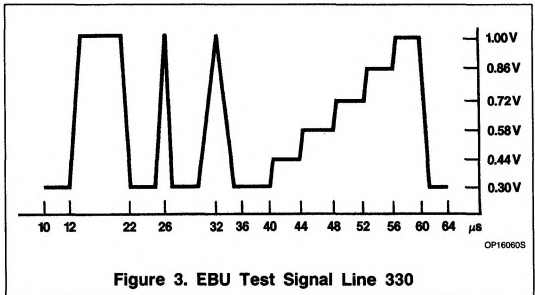
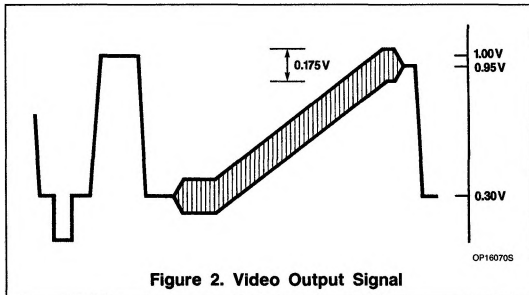
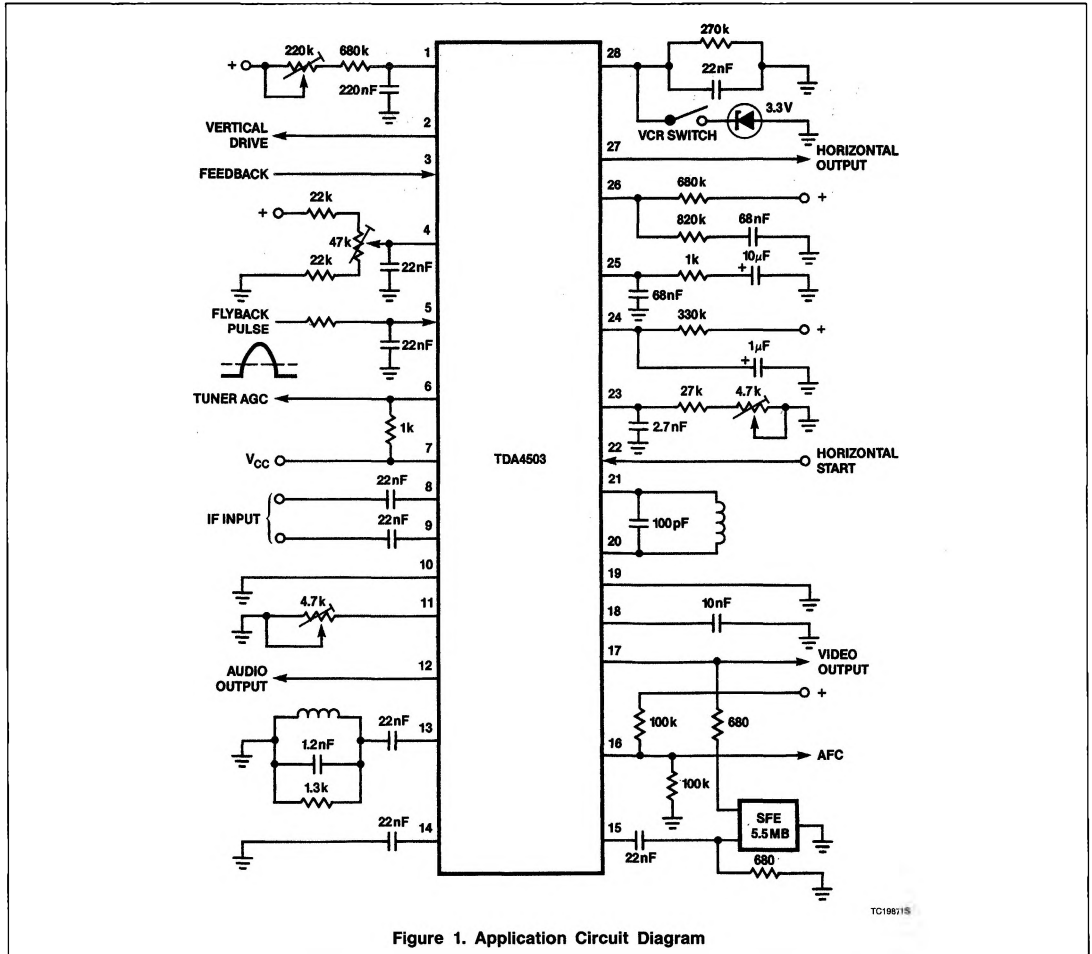
Vertical sync pulses are separated by an internal integrating network and are used to trigger the vertical oscillator. A comparator circuit compares the vertical sawtooth waveform, generated by the vertical oscillator, with feedback from the deflection coils, and supplies the drive voltage for the output stage at Pin 2.

#### Power Supplies

The main supply is to Pin 7 (positive supply) and Pin 10 (ground). The horizontal oscillator is supplied from Pin 22 to facilitate starting of the oscillator from a high-voltage rail. A special ground connection at Pin 19 is used by critical voltage dividers in the feedback loops of the vision and sound IF circuits.

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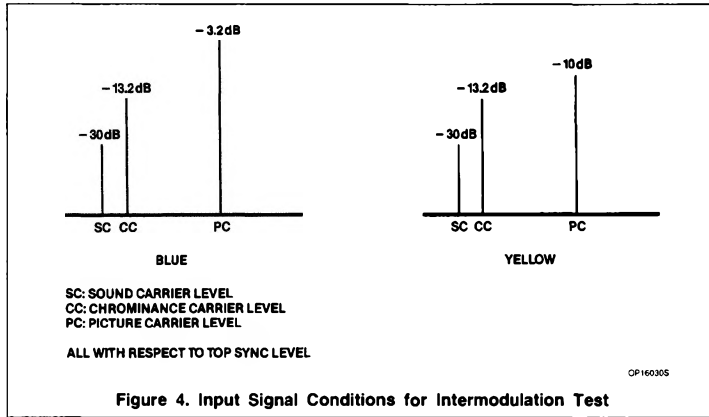


Figure 4. Input Signal Conditions for Intermodulation Test

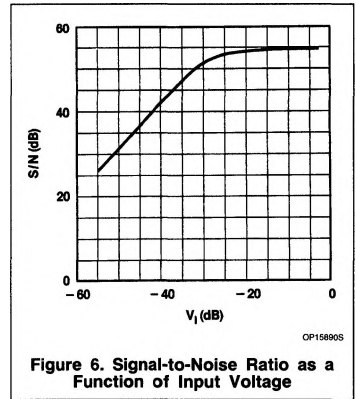


Figure 6. Signal-to-Noise Ratio as a Function of Input Voltage

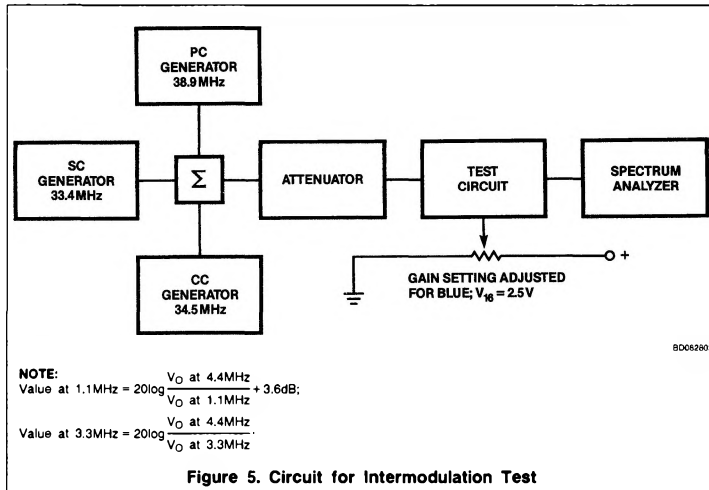


Figure 5. Circuit for Intermodulation Test

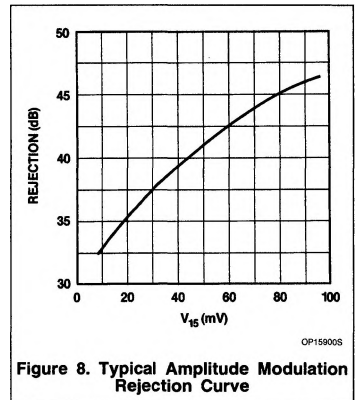


Figure 8. Typical Amplitude Modulation Rejection Curve

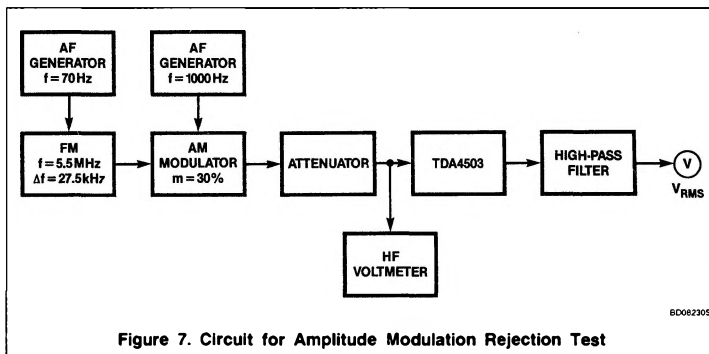


Figure 7. Circuit for Amplitude Modulation Rejection Test

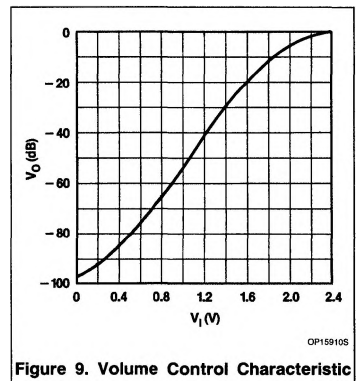


Figure 9. Volume Control Characteristic