



## TDA7335

### STEREO PREAMP + AMS + DOLBY B\* NOISE REDUCTION PROCESSOR

- DUAL CHANNEL PROCESSOR FOR PLAY-BACK APPLICATIONS.
- STEREO DOLBY B NR SYSTEM
- LOW NOISE HEAD PREAMPLIFIER
- MUTE, AUTOREVERSE, AMS (AUDIO MUSIC SENSOR) FUNCTIONS
- INTERNAL SWITCHES FOR EQUALIZATION
- DOLBY REFERENCE LEVEL -6dBm (388.2mVRMS)
- MINIMUM NUMBER OF EXTERNAL COMPONENTS
- LOW SUPPLY CURRENT (18mA)
- MIXED BIPOLAR/CMOS TECHNOLOGY

#### DESCRIPTION

The TDA7335 is a monolithic BiCMos IC designed for use in stereo cassette player systems.

The device includes two separate audio channels composed by low noise preamplifier, Dolby B noise reduction system and Audio Music Sensor.

The dual preamplifier contains mute, autoreverse, metal/normal facilities for amplification of low level signal in applications requiring very low noise performances.

Each channel consists of two cascaded operational amplifiers.

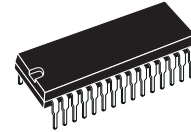
The first one, AMP1, has a fixed gain of 36dB, low noise forward/reverse switchable input, and allows magnetic heads connection directly to ground. The second one, AMP2, is a standard operational amplifier whose equalizing external components fix the frequency response.

The Audio Music Sensor circuit detects the inter-program space and then the starting point of musical programs (the interprogram time and program detection time are externally selectable).

The device contains Dolby B decoder NR chains requiring very few external components and do not require coils.

\* **Dolby B and the Double-D symbol are trademarks of Dolby Laboratories Licensing Corporation, San Francisco, California 94103-4813, USA.**

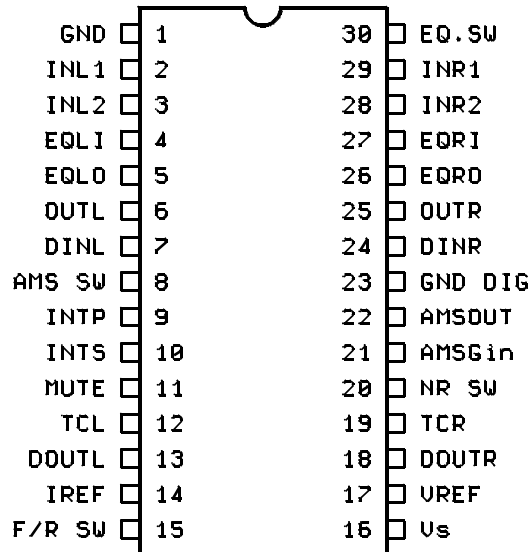
**This device is available only to Licensing and application information may be obtained from Dolby Lab.**



SDIP30

ORDERING NUMBER: TDA7335

#### PIN CONNECTION (Top view)



NS1TDA7335-01D

## TDA7335

### ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V <sub>s</sub>	Supply Voltage	12	V
P <sub>tot</sub>	Total Power Dissipation	1	W
T <sub>op</sub>	Operating Temperature Range	-40 to 85	°C
T <sub>stg</sub>	Storage Temperature Range	-40 to 150	°C

### THERMAL DATA

R <sub>th j-pins</sub>	Thermal resistance junction-pins	85	°C/W
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### PIN FUNCTIONS

N.	Name	V <sub>DC</sub> (V)	Function
1	GND		Ground
2,3	IN L1, IN L2	0	Preamplifier Left Inputs 1,2
4,27	EQLI, EQRI	4.6	Equalizer Inputs
5, 26	EQLO, EQRO	4.6	Equalizer Outputs
6, 25	OUTL, OUTR	4.6	Preamplifier Outputs
7, 24	DINL, DINR	V <sub>ref</sub>	Dolby NR Inputs
8	AMS SW	5.6	Audio Music Sensor Switch (ON/OFF) HIGH = ON
9	INTP		Interprogram Time Constant ("Signal Detection")
10	INTS		Interspace Time Constant ("Blank Detection")
11	MUTE		Mute Switch ON = LOW (2)
12, 19	TLC, TCR	0.4	Dolby Time Constants
13, 18	DOU <sub>L</sub> , DOU <sub>R</sub>	V <sub>ref</sub>	Dolby Outputs
14	I <sub>ref</sub>	1.2	Reference Current Source
15	F/R SW	5.6	Forward/Reverse Switch HIGH = Forward LOW = Reverse
16	V <sub>s</sub>		Positive Power Supply
17	V <sub>ref</sub>	V <sub>s</sub> /2	Reference Voltage
20	NR SW		Noise reduction ON/OFF: HIGH = OFF (2)
21	AMS GIN	1.4	Audio Music Sensor Input Pin
22	AMS OUT		Audio Music Sensor Output Pin (open collector configuration, see Fig. 2)
23	GND DIG.	0	Digital Ground
28, 29	IN R1, IN R2	0	Preamplifier Right Inputs 1,2
30	EQ SW	0	Equalizer Switch (Low = normal position High = metal position)

(2) Internal pull-up resistor (digital high level if pin left open)

Figure 1: Application Circuit

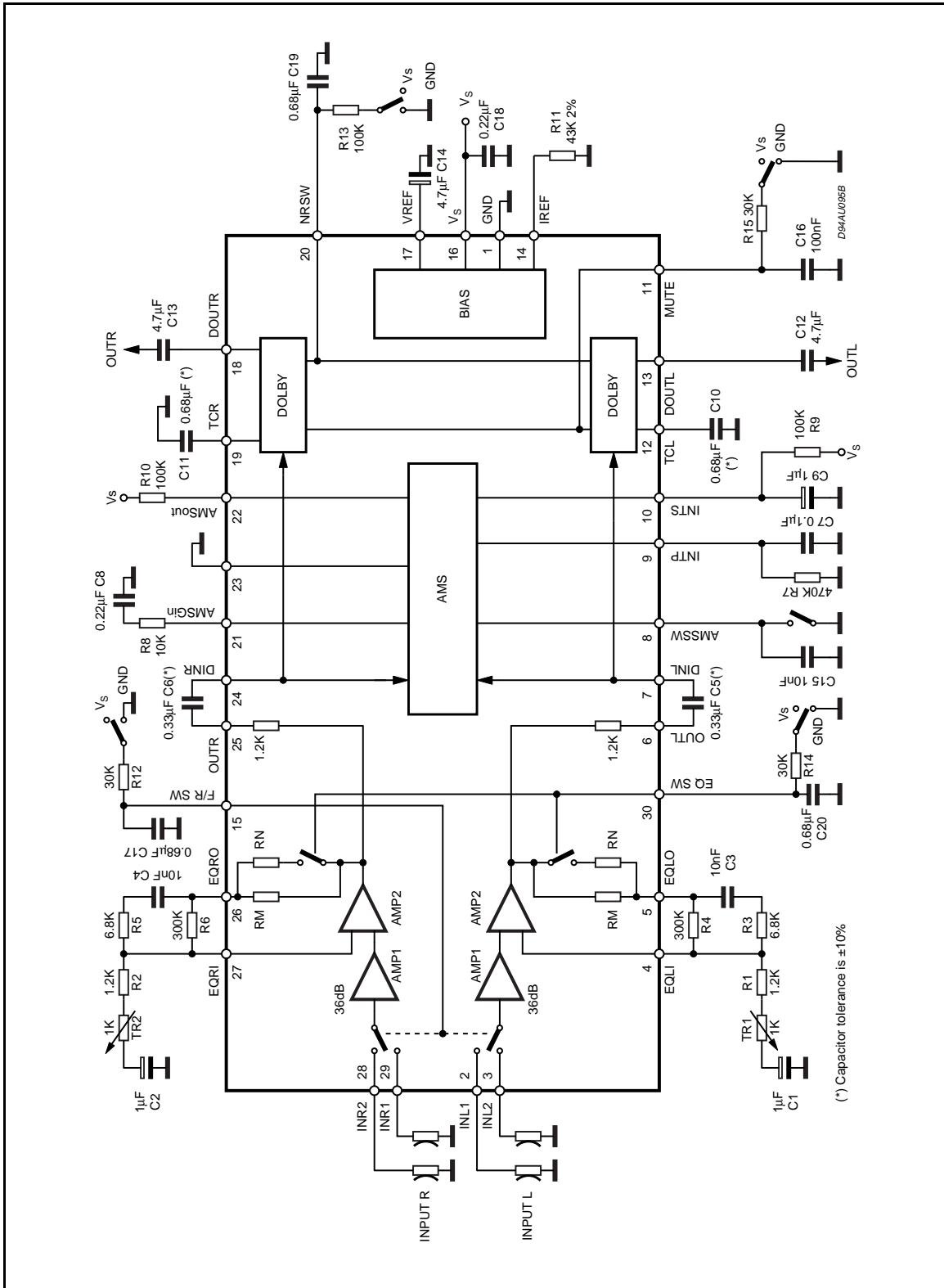


Figure 1a: Components & Top Copper Layer of the Fig. 1 (1:1 scale).

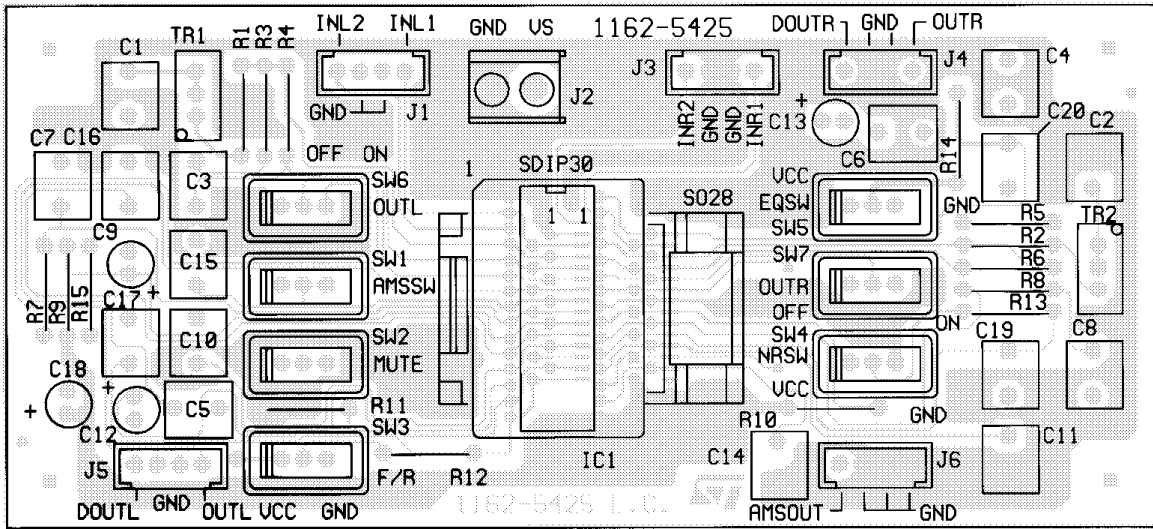
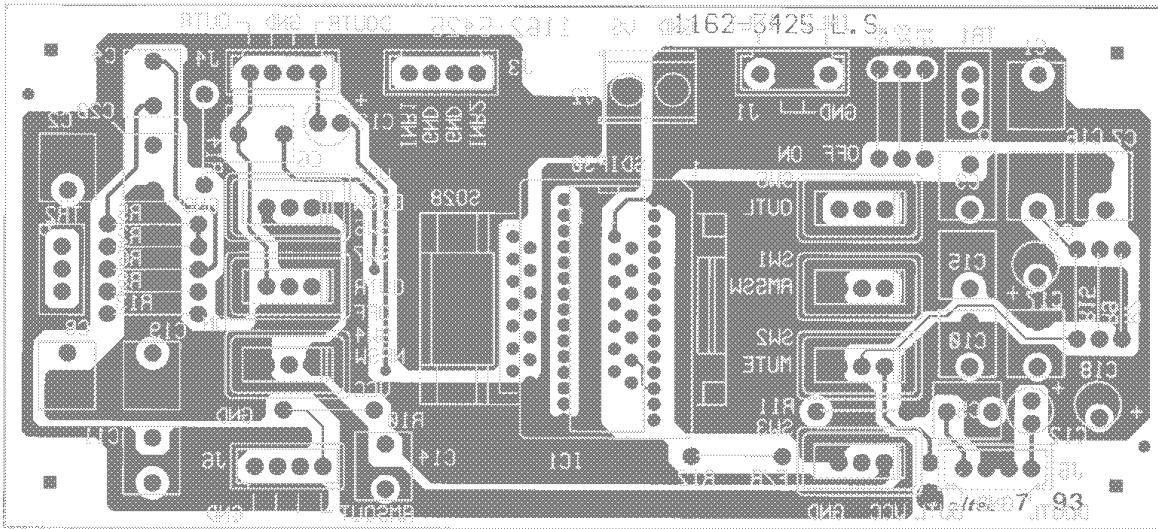
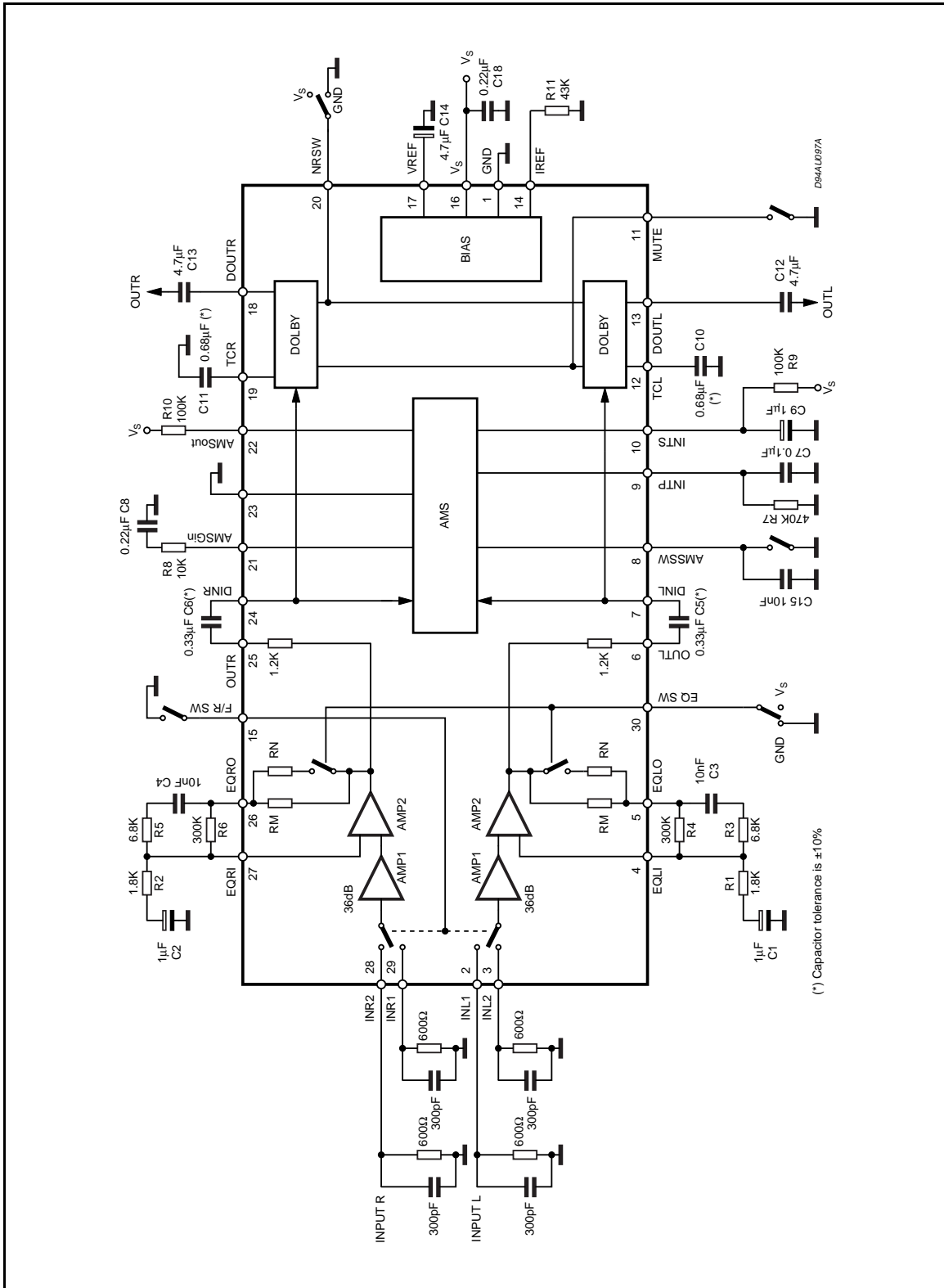


Figure 1b: Bottom Copper Layer of the Fig. 1 (1:1 scale).



TEST CIRCUIT



## TDA7335

**ELECTRICAL CHARACTERISTICS** ( $V_s = 8.5V$ ;  $f = 1KHz$ ;  $R_g = 600\Omega$ ;  $T_{amb} = 25^\circ C$ ;  $R_{11} = 43k\Omega$ ; all level referenced to  $-6dBm/400Hz$ , at  $D_{out}$  with NR SW OFF; unless otherwise specified see application circuit of Fig. 1) NAB METAL position.

### SUPPLY

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	
$V_s$	Supply Voltage		8	8.5	10.5	V	
$I_s$	Supply Current		11	18	26	mA	
$V_{ref}$	Reference Voltage (pin 17)		4	4.3	4.6	V	
$V_{dc}$	DC Voltage pin 14 ( $R_{11} = 43K$ )		1.15	1.25	1.35	V	
SVR	Ripple Rejection (Input referred)	$V_{ripple} = 0.3V_{rms}$ $f_{ripple} = 1KHz$	Dolby OFF	80	90		dB
			Dolby ON	85	95		dB
$MUTE_{th}$	Mute Threshold Pin11	ON OFF	0 2.0		0.8 $V_s$	V V	
$I_{MUTE}$	Mute Current			10	20	$\mu A$	
$MUTE_A$	Mute Attenuation		55	65		dB	

### PREAMPLIFIER

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit	
$R_i$	Input Resistance	(pin 2, 3, 28, 29)	30	50	70	$K\Omega$	
$I_i$	Input Bias Current				10	$\mu A$	
$G_v$	Closed Loop Gain	pin 4, 5 and 26, 27 shorted	32.5	35.5	38.5	dB	
$\Delta G_v$	Closed Loop Gain Match		-1		1	dB	
$R_M$	Resistance Metal Position		4.35	5.8	7.25	$K\Omega$	
$\Delta R_M$	Metal Resistance Matching		-2	0	2	dB	
$R_N$	Resistance Normal Position		50	160	300	$\Omega$	
$e_N$	Total Input Noise	Unw. B = 20Hz to 20KHz; $R_g = 0\Omega$ $R_g = 600\Omega$ A weighted; $R_g = 600\Omega$		0.45			$\mu V$
				0.8			$\mu V$
				0.5			$\mu V$
$R_o$	Output Impedance (pin 6, 25)		0.9	1.2	1.7	$K\Omega$	
$F/R_i$	Reverse Low Level (pin 15)	$IN_2 = ON$ ; $IN_1 = OFF$	0		0.8	V	
$F/R_h$	Forward High Level (pin 15)	$IN_2 = OFF$ ; $IN_1 = ON$	2		$V_s$	V	
$EQ_i$	Normal Low Level (pin 30)		0		1.5	V	
$EQ_h$	Metal High Level (pin 30)		3.5		$V_s$	V	

### AUDIO MUSIC SENSOR

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$I_{AMS_{out}}$	AMS Output Current				5	mA
$V_{AMS_{out}}$	AMS Output Low Level	$I_{AMS_{out}} = 2mA$		200	800	mV
$R_{p21}$	Input Impedance		0.8	1.1	1.4	$K\Omega$
$AMS_{swl}$	AMS OFF Low Level		0		0.8	V
$AMS_{swh}$	AMS ON High Level		2		$V_s$	V
$V_{TH1}$	Interprogram Threshold Voltage	(pin 9)	1.2	1.45	1.7	V
$V_{TH2}$	Interspace Threshold Voltage	(pin 10)	4	4.3	4.6	V
$AMS_{th}$	AMS Threshold Level	see note (3)	0.6	1	1.4	V
$I_{AMS_{sw}}$	AMS Switch pin Current		5	10	15	$\mu A$

### DOLBY SECTION

Symbol	Parameter	Test Condition	DOLBY	Min.	Typ.	Max.	Unit
$G_v$	Voltage Gain	$f = 1KHz$ ;	OFF	-1	0	1	dB
$\Delta G_v$	Gain Matching		OFF	-0.5		0.5	dB
$RD_i$	Dolby Input Res.	(pin 7, 24)		46	63		$K\Omega$

**ELECTRICAL CHARACTERISTICS (continued)**  
**DOLBY SECTION**

Symbol	Parameter	Test Condition	DOLBY	Min.	Typ.	Max.	Unit
RDo	Dolby Output Impedance	(pin 13, 18)		100	200	300	$\Omega$
S/H	Signal Handling	$V_s = 8V$ ; THD = 1%	OFF	12	13		dB
B DEC 1	Decode Out	$f = 10KHz$ ; $V_i = 0.4dB$	ON	-1.5	0	1.5	dB
B DEC 2	Decode Out	$f = 500Hz$ ; $V_i = -22.1dB$	ON	-26.5	-25	-23.5	dB
B DEC 3	Decode Out	$f = 2KHz$ ; $V_i = -18dB$	ON	-26.5	-25	-23.5	dB
B DEC 4	Decode Out	$f = 5KHz$ ; $V_i = -29.7dB$	ON	-41.5	-40	-38.5	dB
B DEC 5	Decode Out	$f = 10KHz$ ; $V_i = -29.6dB$	ON	-41.5	-40	-38.5	dB
NR <sub>l</sub>	Dolby ON Low Level Pin 20			0		0.8	V
NR <sub>h</sub>	Dolby OFF High Level Pin 20			2		$V_s$	V

**GENERAL (PREAMPLIFIER + DOLBY)**

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
THD	Total Harmonic Dist.	$V_o = 0dB$ ; $f = 1KHz$ Dolby OFF		0.02	0.1	%
		$V_o = 0dB$ ; $f = 1KHz$ Dolby ON		0.05	0.1	%
		$V_o = 0dB$ ; $f = 10KHz$ Dolby OFF		0.03		%
		$V_o = 0dB$ ; $f = 10KHz$ Dolby ON		0.08		%
S/N	Signal to Noise Ratio	$R_g = 600\Omega$ ; $V_o = 0dB$ ; Unweighted; Dolby OFF		63		dB
		$R_g = 600\Omega$ ; $V_o = 0dB$ ; Unweighted; Dolby ON		70		dB
		$R_g = 600\Omega$ ; $V_o = 0dB$ ; CCIR/ARM; Dolby OFF	54	63		dB
		$R_g = 600\Omega$ ; $V_o = 0dB$ ; CCIR/ARM; Dolby ON	56	72		dB
C <sub>S</sub>	Channel Separation	$R_g = 600\Omega$ ; $f = 1KHz$ Dolby OFF	50	64		dB
		$R_g = 600\Omega$ ; $f = 1KHz$ Dolby ON		70		dB
C <sub>T</sub>	Channel Cross Talk	$R_g = 600\Omega$ ; $f = 1KHz$ Dolby OFF	56	70		dB
		$R_g = 600\Omega$ ; $f = 1KHz$ Dolby ON		75		dB

**AUDIO MUSIC SENSOR (See Figure 2)**

Aim of this section is to detect interprogram spaces present on a recorded tape.

Both the blanks (interprogram spaces) and the programs minimum detectable durations can be easily set by means of 2 external and independent time constants.

Also the minimum detectable input signal level can be externally adjusted, by a dedicated gain network.

Main blocks are:

- Variable gain limiter amplifier
- Signal detector circuitry
- Logic blocks able to avoid unproper operations.

Operations Description (refer to the simplified schematic of Figure 2).

- a)The two channels left and right mean signal coming from the preamp chain (AC coupled) are added (current) at the AMS input and pre-

sented to the limiter amplifier. The limiter amplifier gain is internally fixed to 40dB, and it could be reduced by the R8 external resistor. The AMSV<sub>th</sub> threshold is fixed at 1V. The following signal detector comparator informs of the presence of music signal (High level out) and avoids the erroneous detection of very low signal (like noise) as real program.

- b)The system moves in blank detection mode everytime the supply is turned on or, with power supplied, the AMS On/Off pin (to be driven by an open collector output) is turned off (T<sub>1</sub> open). Once this condition has happened, the capacitor C<sub>15</sub> charges, defining a minimum reset time, long enough to reset the Flip-Flops FF<sub>1</sub> and FF<sub>2</sub> and to discharge the program detector external C<sub>7</sub> capacitor. The charging current at the AMS SW pin is about 10 $\mu$ A. It follows that the reset time ( $C_{15} \times V_{pin8} / I_{C15}$ ) is given approximately by 0.122  $\times$  C<sub>15</sub> ns where C<sub>15</sub> is in  $\mu$ F.

c) From now on where the sum input signal (left-right) amplified by the limiter exceeds the signal detector threshold (3) the capacitor C<sub>7</sub> is forced to charge. When the voltage across this capacitor reaches the comparator COMP<sub>1</sub> threshold voltage V<sub>th1</sub> (approx. 2 V<sub>be</sub>) FF<sub>1</sub> is set and FF<sub>2</sub> is reset. (4) It follows that Q<sub>1</sub> is turned on discharging the program detection capacitor (C<sub>7</sub>).

d) Always when there is a recorded zone, Q<sub>1</sub> is on; it becomes off only if a blank section is reached. When, with a time constant controlled by the R<sub>9</sub>, C<sub>9</sub> network the voltage at space detection time pin reaches V<sub>th2</sub> threshold (comparator COMP<sub>2</sub>) a true blank section is detected and the FF<sub>2</sub> is set. (The minimum charging time is approximately given by:

$$0.69 \times C_9 \times R_9 \text{ [sec]}$$

In this condition Q<sub>2</sub> is ON, forcing the open collector AMS output to go LOW, informing the user that a true blank section has been detected. The state is then able to start from the above point c). Figures 3-4 show the signal behaviour.

The device is able to prevent false interspace detection and the end of the tape. (see Fig. 4).

**Note:**

(3): minimum RMS input signal is given by:

$$V_{in} = AMSV_{th} = \frac{1K + R_8}{101K + R_8} \cdot 0.6$$

where V<sub>in</sub> is the mean of left and right channels:

$$V_{in} = \frac{V_{right} + V_{left}}{2}$$

(4): the charging current at pin 9 is about 20μA (half input signal) so program detection time constant is given by:

$$\frac{C_7 \times 2V_{be}}{20\mu A} = 70 \times C_7 \text{ [}\mu\text{F]} = \text{[msec]}$$

It is recommended to insert a resistor (R<sub>7</sub>) high enough to prevent fast C<sub>7</sub> capacitor discharging.

Figure 2: Audio Music Sensor

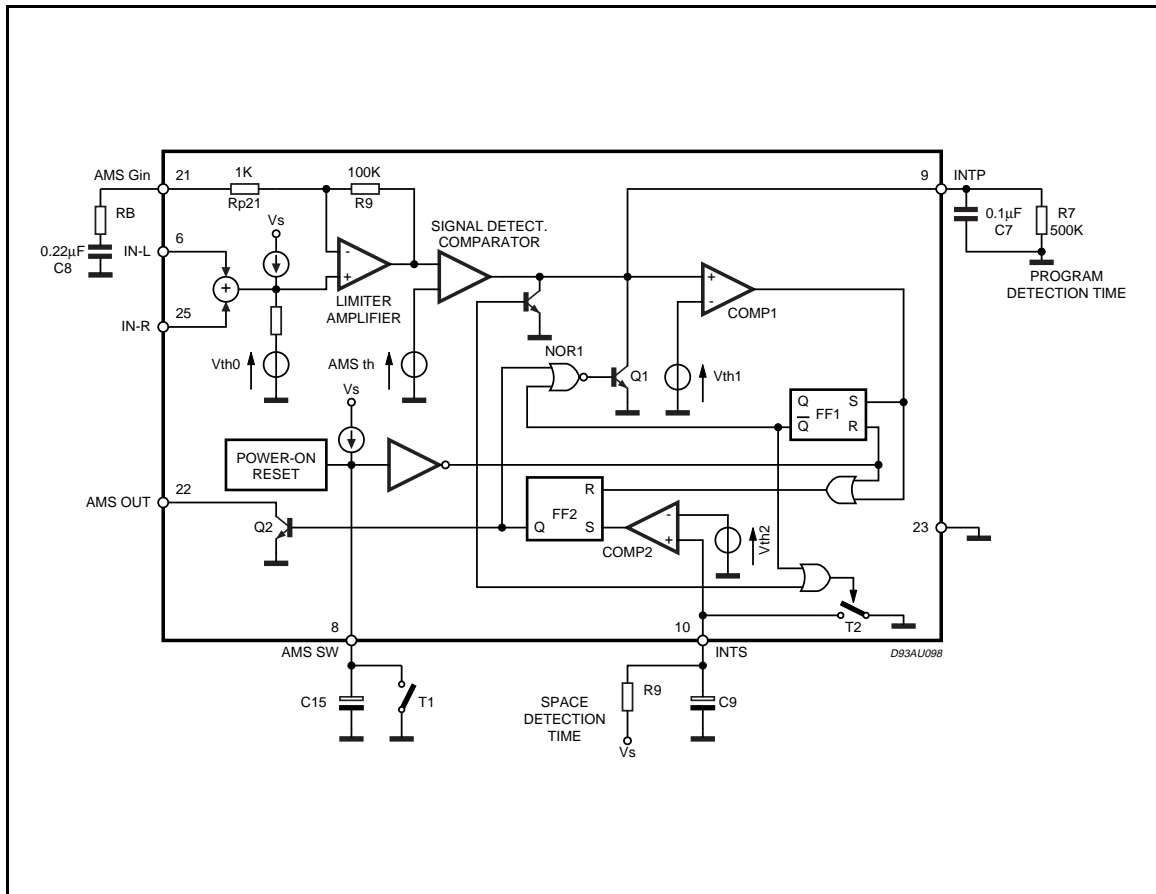




Figure 3: AMS Timing Diagram

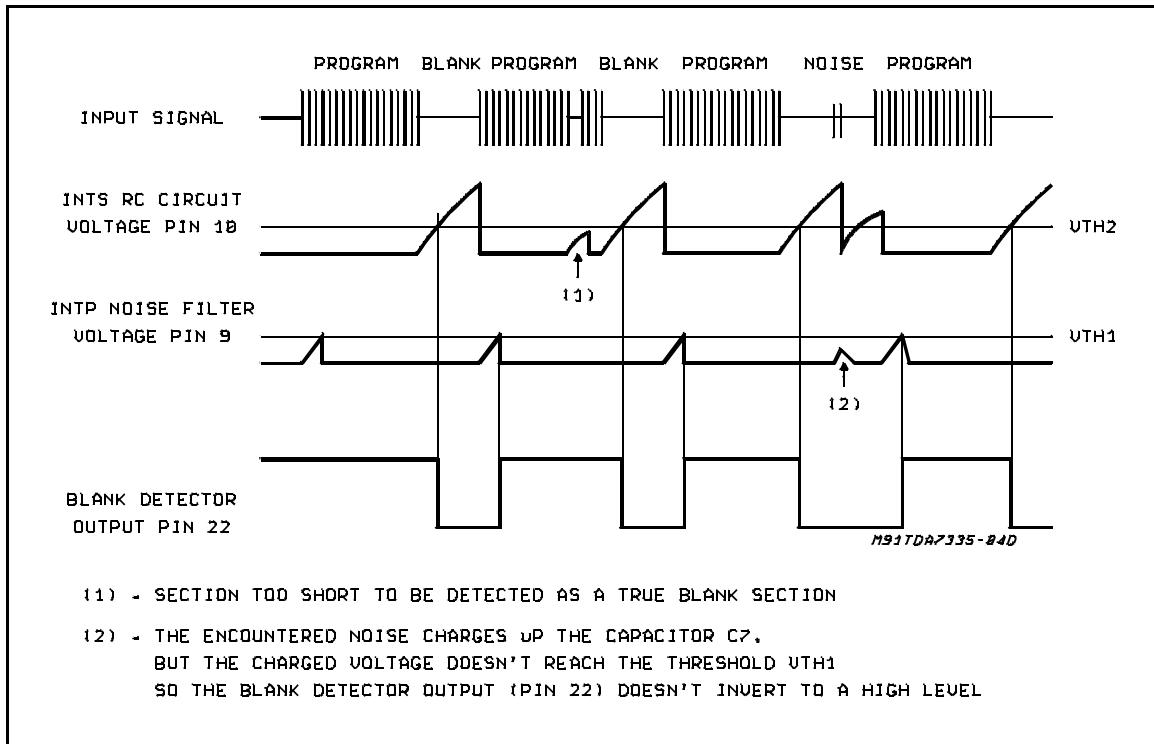
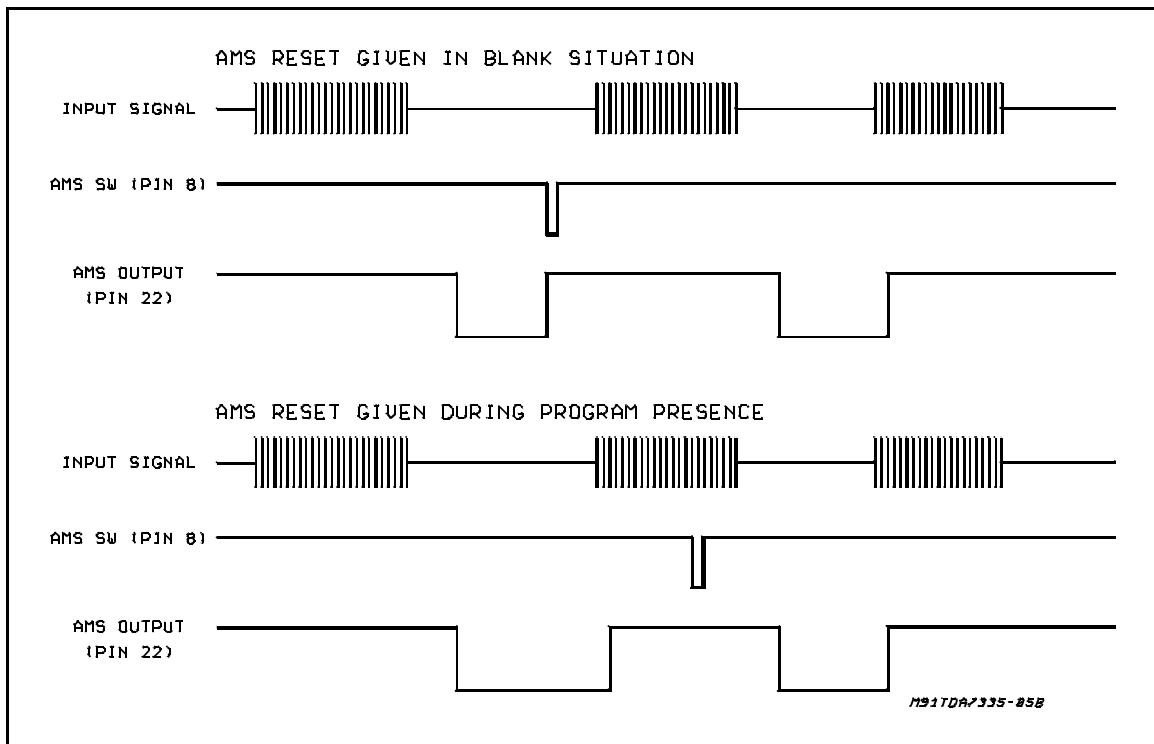


Figure 4



ELECTRICAL COMPONENT DESCRIPTION (see figure 1)

	COMPONENT	RECOMMENDED VALUE	PURPOSE
P R E A M P	TR <sub>1</sub> , TR <sub>2</sub> C <sub>1</sub> , C <sub>2</sub> C <sub>3</sub> , C <sub>4</sub> R <sub>1</sub> , R <sub>2</sub> R <sub>3</sub> , R <sub>5</sub> R <sub>4</sub> , R <sub>6</sub>	1KΩ 1μF 10nF 1.2KΩ 6.8KΩ 300KΩ	Left/Right Channel IN/OUT equalizer filter  TR fixes the gain 150msec NORMAL 70μsec METAL
	C <sub>5</sub> , C <sub>6</sub>	0.33μF ±10%	Preamplifier out to Dolby B input coupling capacitor
A M S	R <sub>8</sub> C <sub>8</sub>	10kΩ 0.22μF	Define the AMS input threshold level  $V_{in} \cdot \frac{101K + R_8}{1K + R_8} \cdot 1.5 > 1V$ where $V_{in} = (V_{right} + V_{left})/2$
	R <sub>7</sub> C <sub>7</sub>	470KΩ 0.1μF	Set the interprogram detection time: INTP = $70 \times 10^{-3} \times C_7[\mu F] = [sec]$
	R <sub>9</sub> C <sub>9</sub>	100KΩ 1μF	Set the interspace detection time: INTS = $0.69 \times C_9 \times R_9_{sec}$
	C <sub>15</sub>	0.1μF	It fixes music search reset time; Tres = $0.122 \times C_{15}[\mu F] = [sec]$ if C <sub>15</sub> expressed in μF
D O L B Y	C <sub>10</sub> , C <sub>11</sub>	0.68μF ±10%	Dolby output coupling capacitors
	C <sub>12</sub> , C <sub>13</sub>	4.7μF ±10%	Dolby time constants
	C <sub>14</sub>	4.7μF	Reference voltage external capacitor
	R <sub>11</sub>	43KΩ	It fixes the I <sub>ref</sub> current
	C <sub>16</sub> R <sub>16</sub>	0.1μF 30KΩ	If fixes the mute time (typ 10msec).

PINS DESCRIPTION: Internal Configuration

Figure 5: PINS: 2 - 3 - 28 - 29

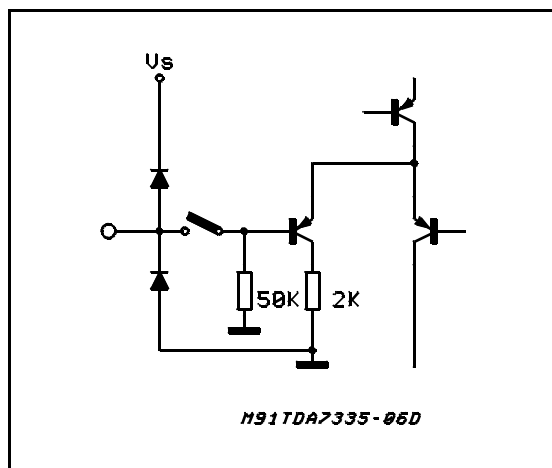
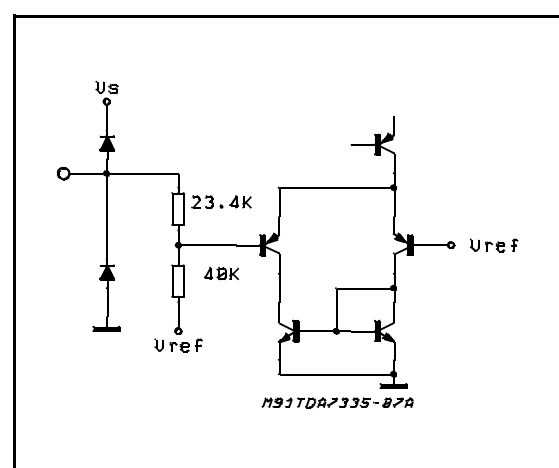
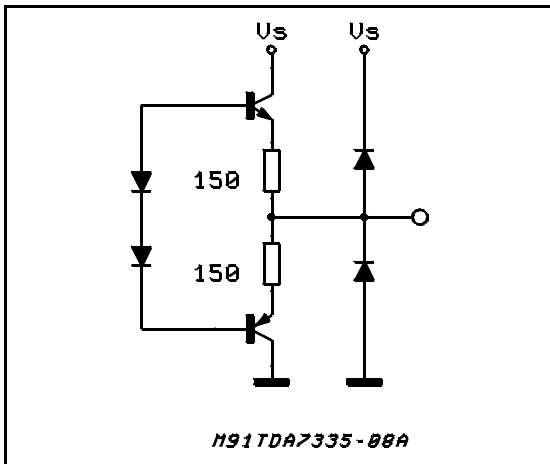


Figure 6: PINS: 7 - 24

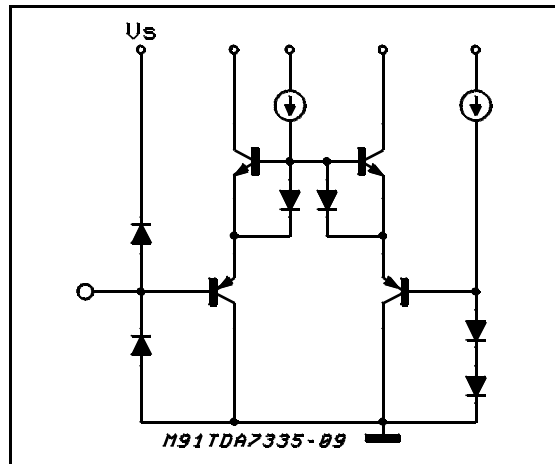


**PINS DESCRIPTION:** Internal Configuration

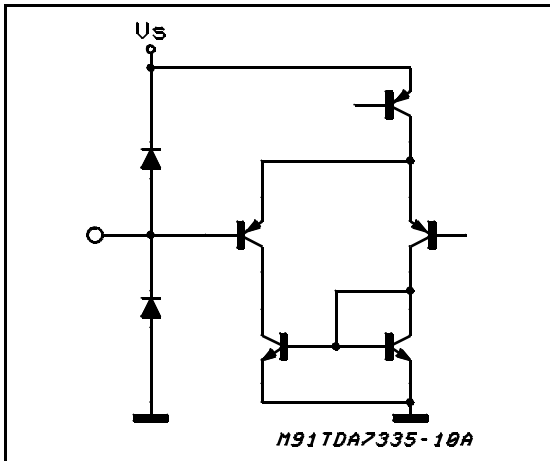
**Figure 7:** PINS: 13 - 18



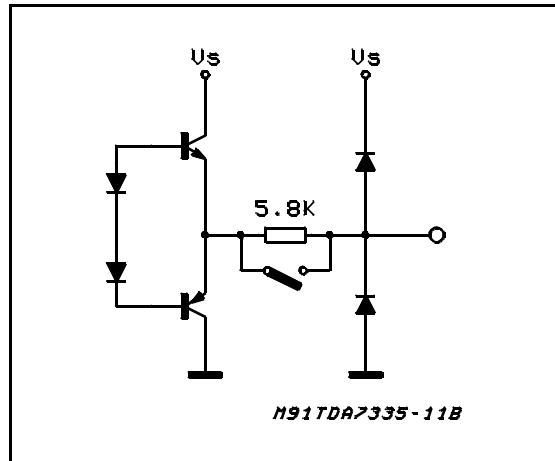
**Figure 8:** PIN: 9



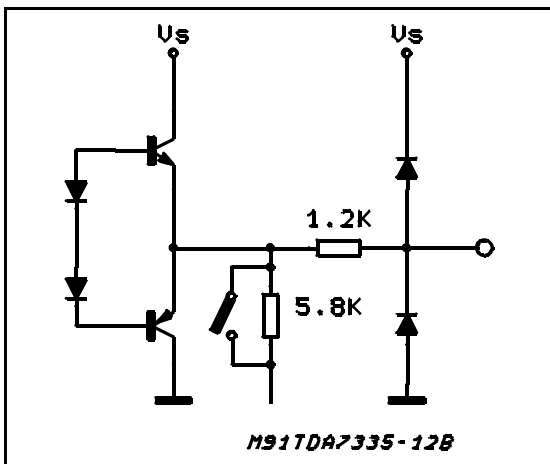
**Figure 9:** PINS: 4 - 27



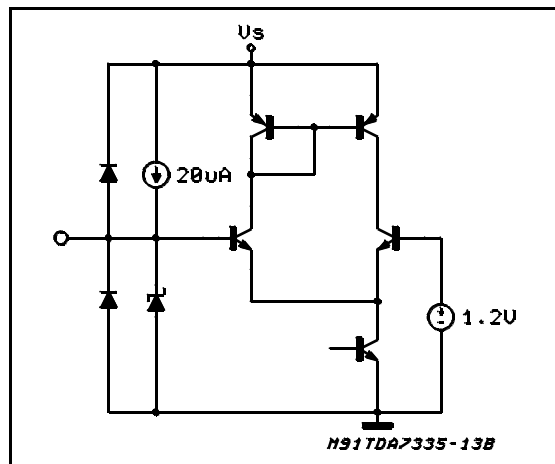
**Figure 10:** PINS: 5 - 26



**Figure 11:** PINS: 6 - 25



**Figure 12:** PINS: 8 - 15



PINS DESCRIPTION: Internal Configuration

Figure 13: PINS: 12 - 19

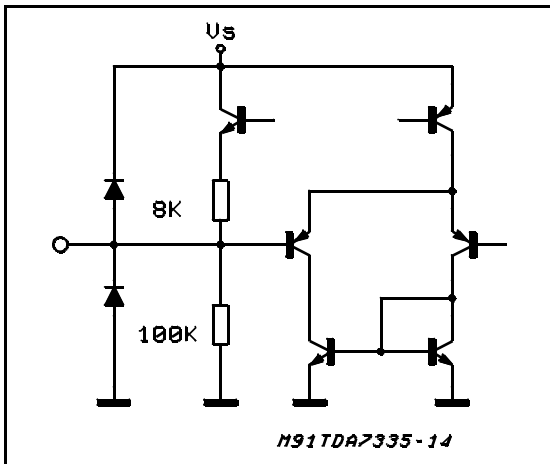


Figure 14: PIN: 14

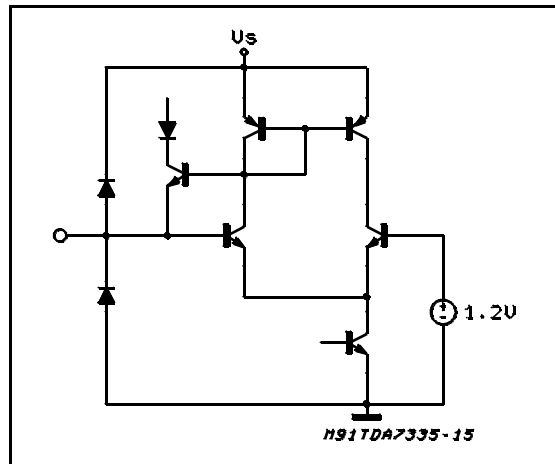


Figure 15: PIN: 10

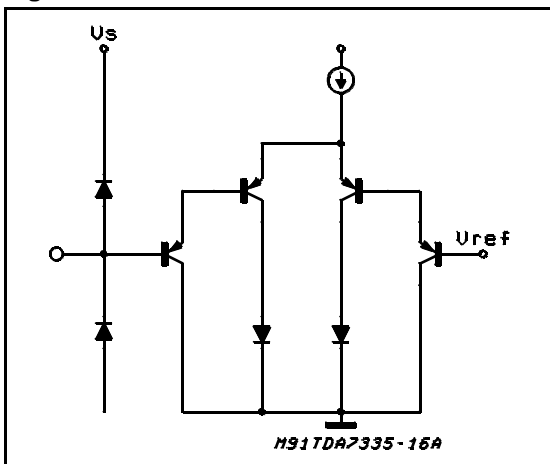


Figure 16: PIN: 22

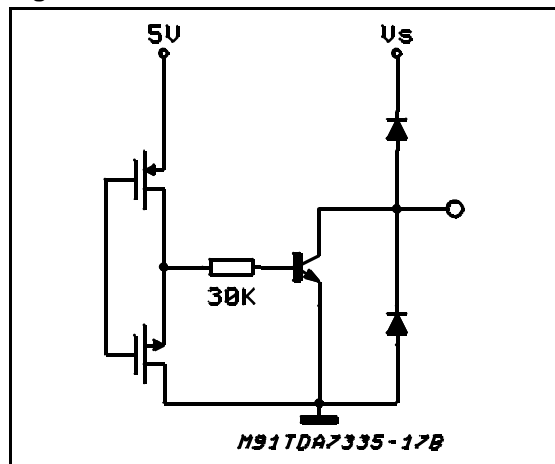


Figure 17: PIN: 21

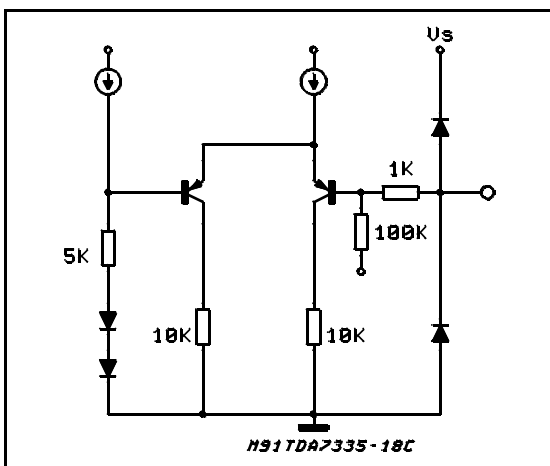
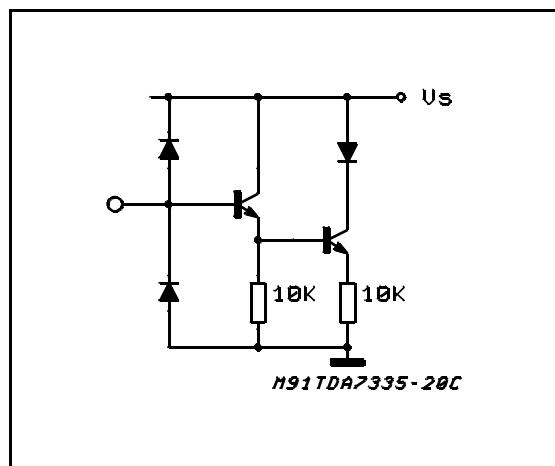
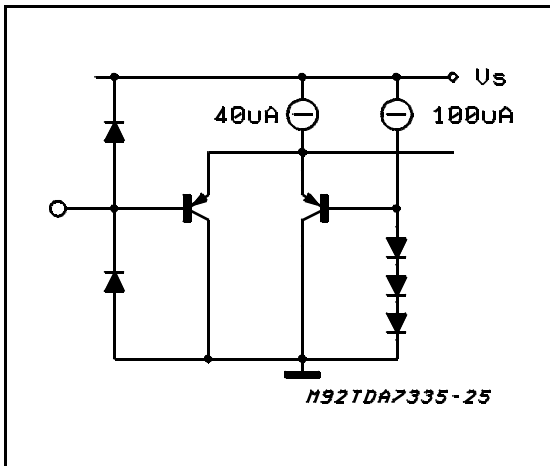


Figure 18: PIN: 30

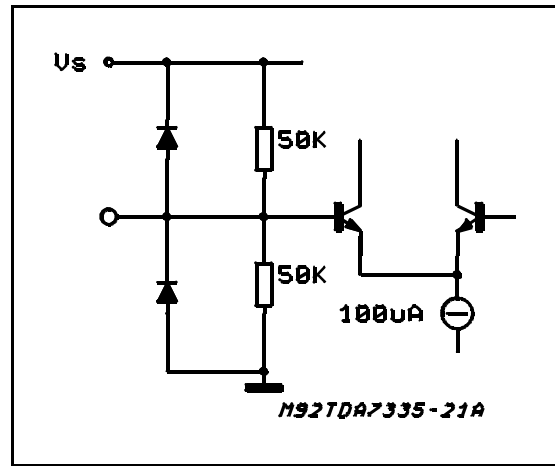


**PINS DESCRIPTION: Internal Configuration**

**Figure 19: PIN: 20 - 11**

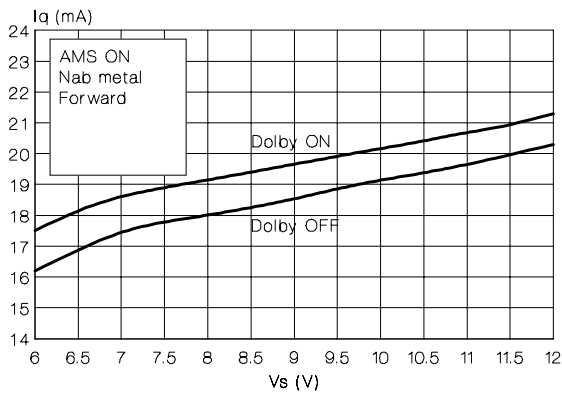


**Figure 20: PIN: 17**

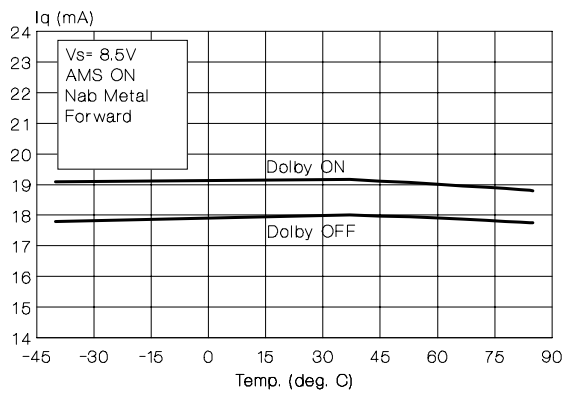


**DEVICE CHARACTERISTICS**

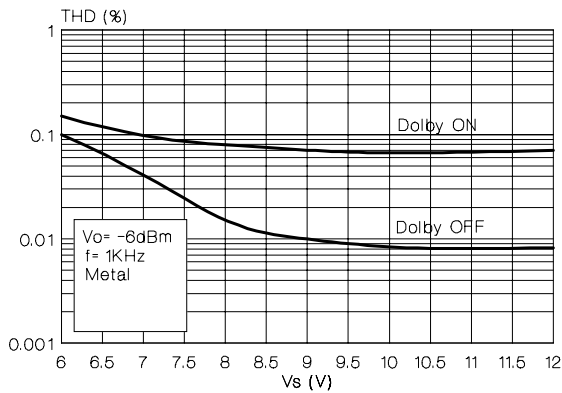
**Figure 21: Quiescent Current vs. Supply Voltage**



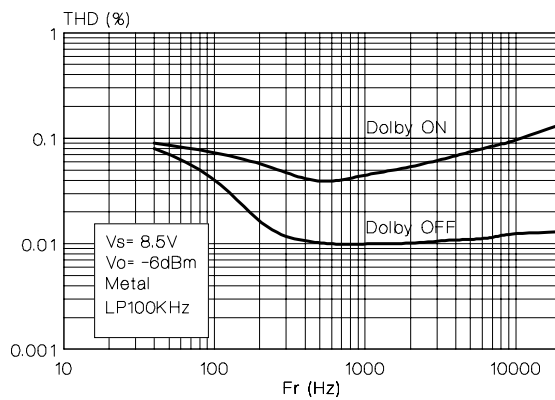
**Figure 22: Quiescent Current vs. Temperature**



**Figure 23: THD vs Supply Voltage**



**Figure 24: THD vs Frequency**



DEVICE CHARACTERISTICS (continued)

Figure 25: THD vs. Output Signal

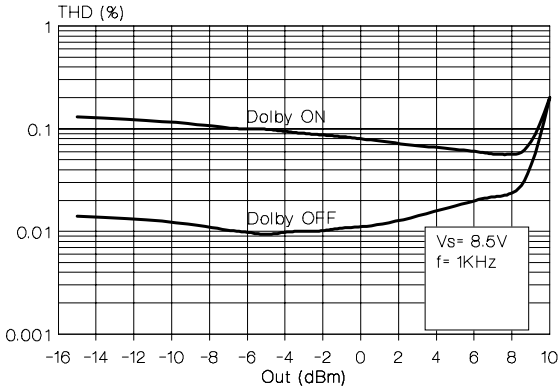


Figure 27: Channel Separation vs. Frequency

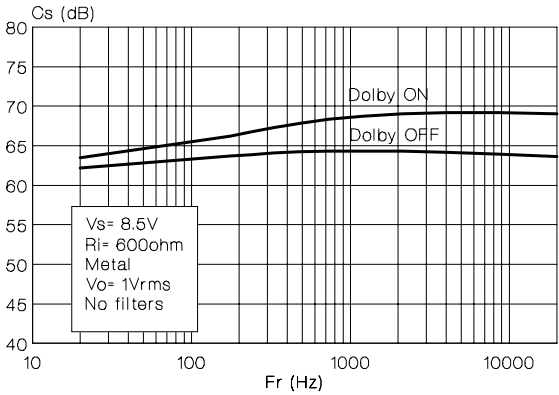


Figure 29: Ripple Rejection vs. Frequency

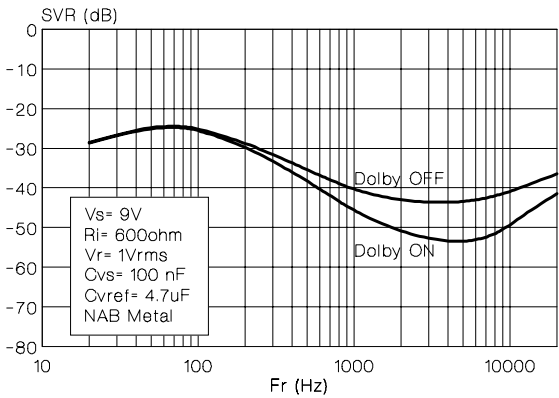


Figure 26: THD + N vs. Frequency

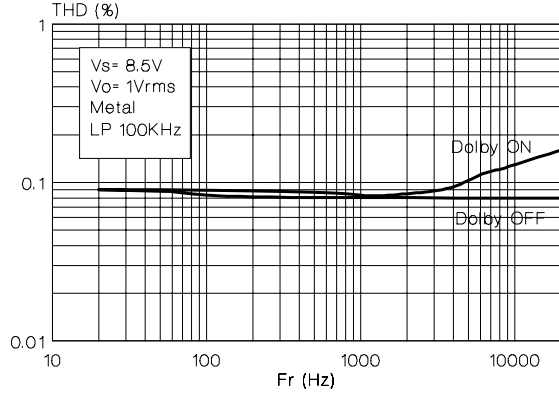


Figure 28: Cross Talk vs. Frequency

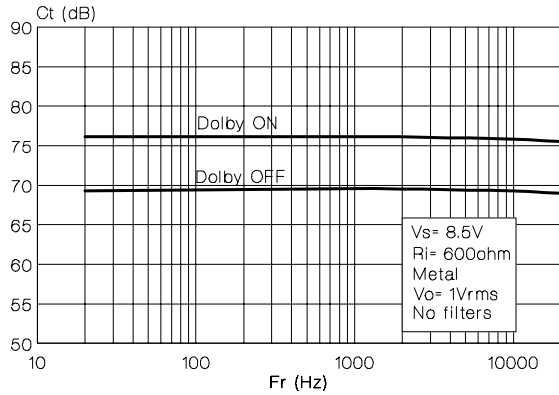
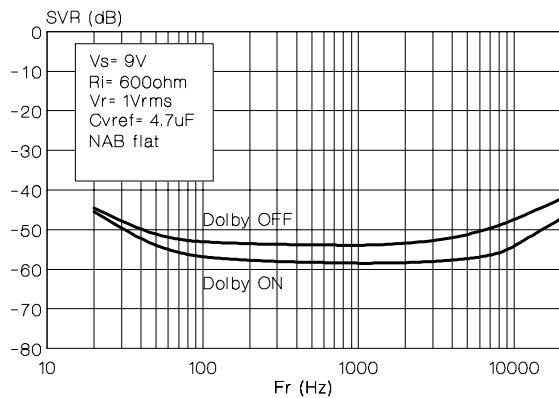


Figure 30: Ripple Rejection vs. Frequency



DEVICE CHARACTERISTICS (continued)

Figure 31: Ripple Rejection vs. Frequency

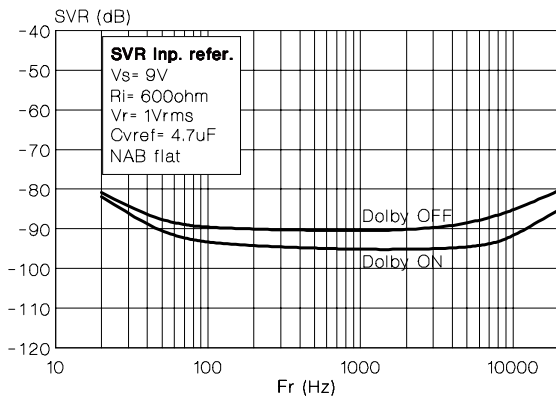


Figure 33: Mute Threshold

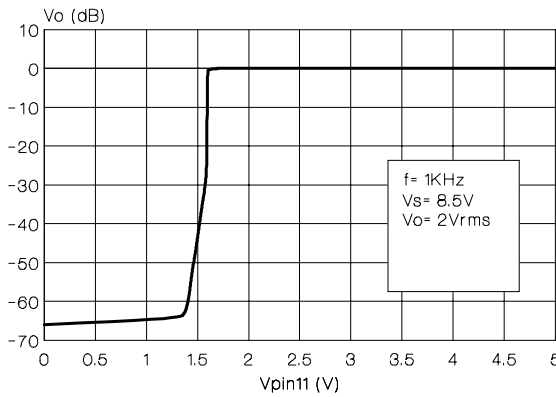


Figure 35:  $V_{ref.}$  &  $I_{ref.}$  vs. Temperature

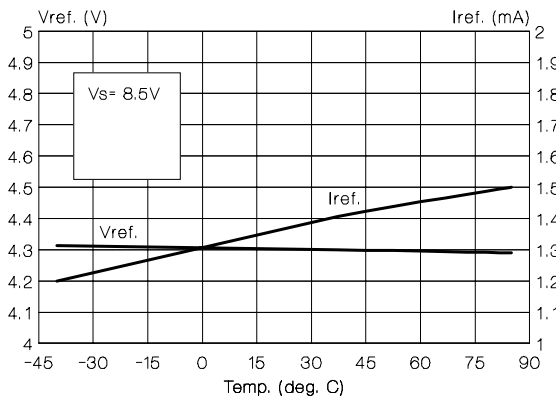


Figure 32: Mute Attenuation vs. Frequency

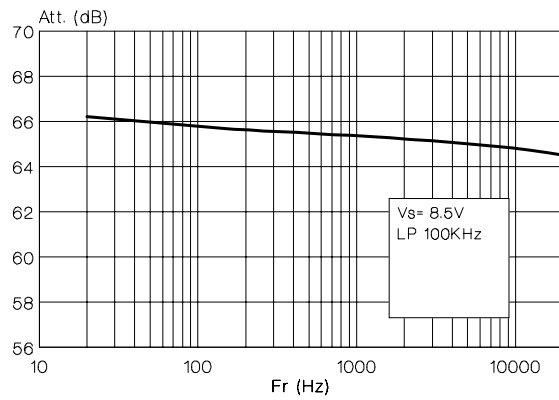


Figure 34:  $V_{ref.}$  &  $I_{ref.}$  vs.  $V_{supply}$

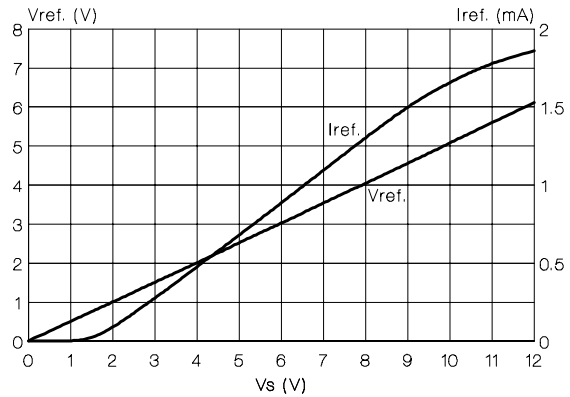
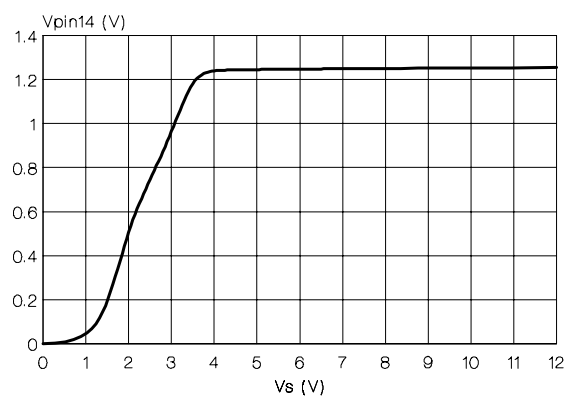


Figure 36: D.C. Voltage pin 14 vs.  $V_{supply}$



DEVICE CHARACTERISTICS (continued)

Figure 37: Equalizer Threshold

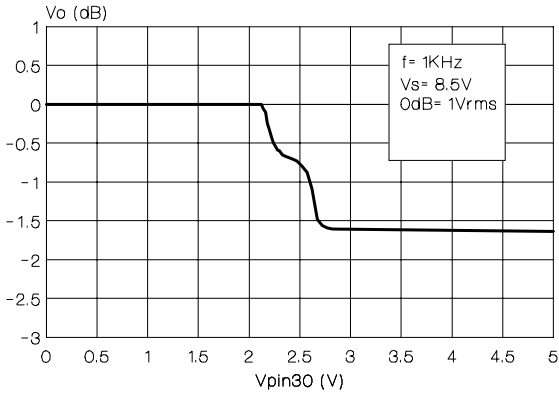


Figure 38: Forward/Reverse Threshold

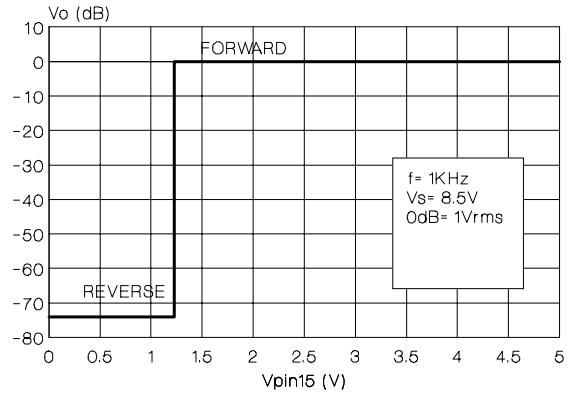


Figure 39: Noise Reduction Threshold

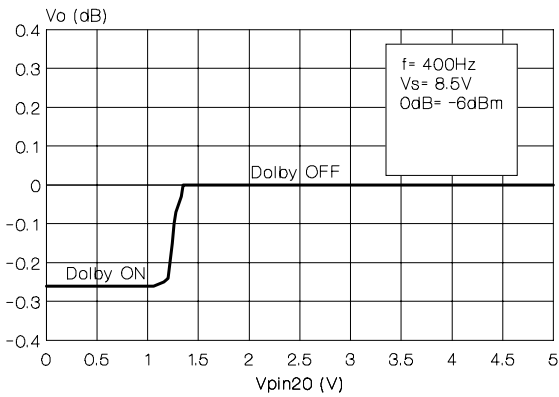


Figure 40: Load Characteristics

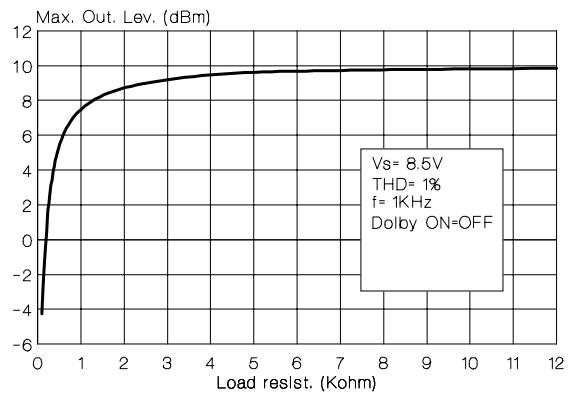


Figure 41: Signal Handling vs. Vsupply

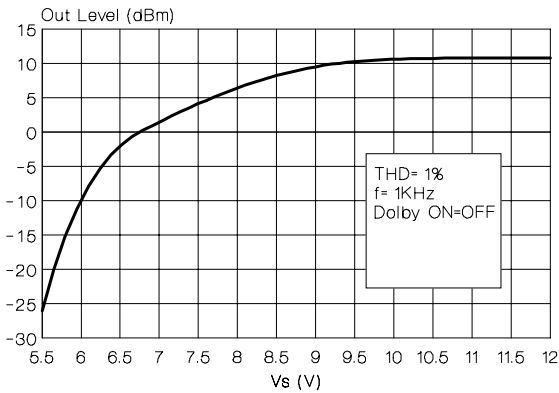
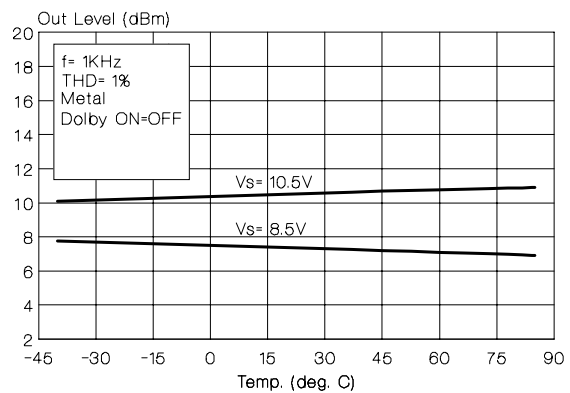


Figure 42: Signal handling vs. Temperature





DEVICE CHARACTERISTICS (continued)

Figure 43: AMS Threshold vs. Frequency

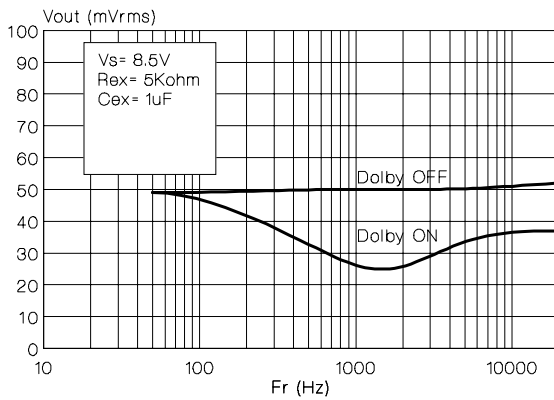


Figure 45: AMS Reset Time vs. Cex

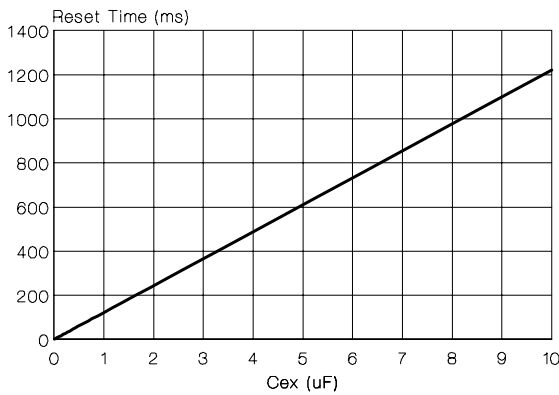


Figure 47: Interprogram Charging Current

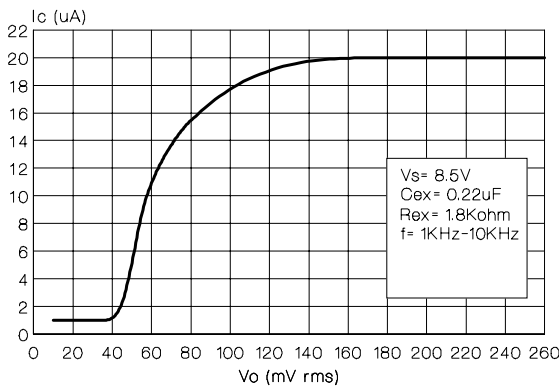


Figure 44: AMS Threshold vs. Rex

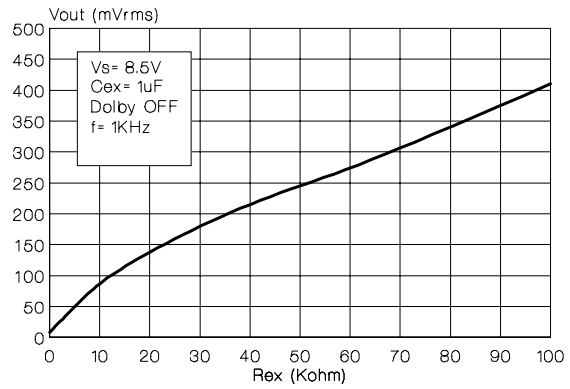


Figure 46: AMS Interprogram vs. C7

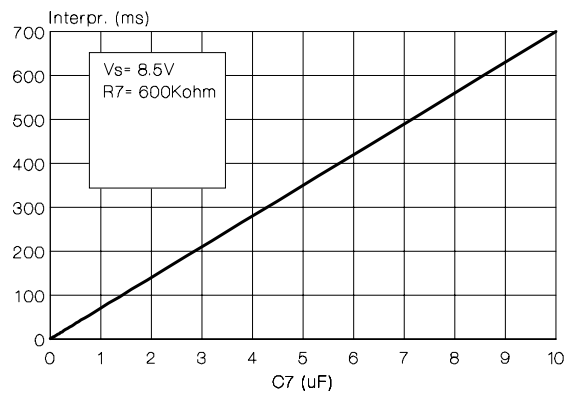
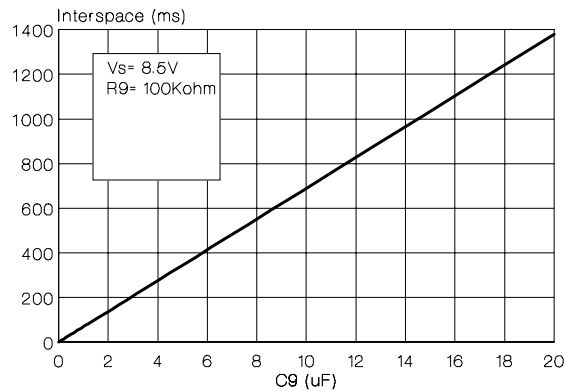


Figure 48: Interspace vs. C9



DEVICE CHARACTERISTICS (continued)

Figure 49: NAB Network

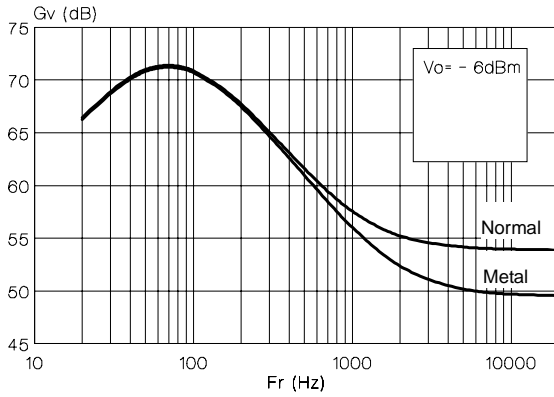
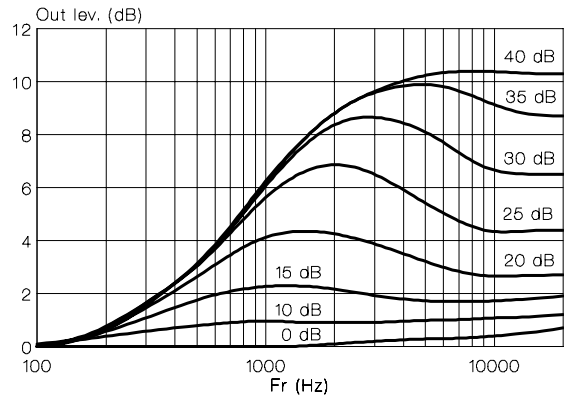
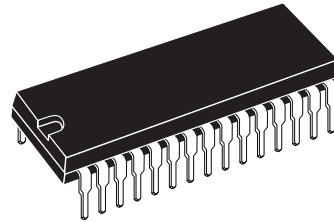


Figure 50: Dolby-B Table

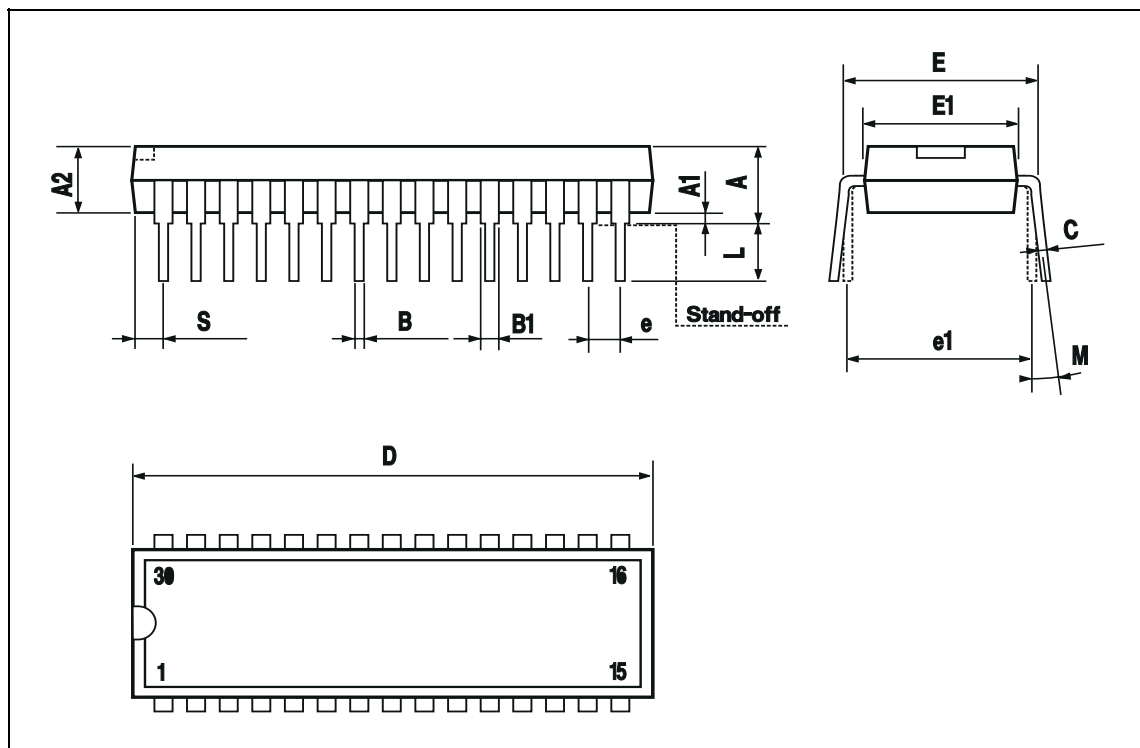


DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5.08			0.20
A1	0.51			0.020		
A2	3.05	3.81	4.57	0.12	0.15	0.18
B	0.36	0.46	0.56	0.014	0.018	0.022
B1	0.76	0.99	1.40	0.030	0.039	0.055
C	0.20	0.25	0.36	0.008	0.01	0.014
D	27.43	27.94	28.45	1.08	1.10	1.12
E	10.16	10.41	11.05	0.400	0.410	0.435
E1	8.38	8.64	9.40	0.330	0.340	0.370
e		1.778			0.070	
e1		10.16			0.400	
L	2.54	3.30	3.81	0.10	0.13	0.15
M	0°(min.), 15°(max.)					
S	0.31			0.012		

## OUTLINE AND MECHANICAL DATA



## SDIP30 (0.400")



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