



## 6 CHANNEL VOLUME CONTROLLER

PRODUCT PREVIEW

- 6 CHANNEL INPUTS
- 6 CHANNEL OUTPUTS
- VOLUME ATTENUATION RANGE OF 0 TO -79dB
- VOLUME CONTROL IN 1.0dB STEPS
- 6 CHANNEL INDEPENDENT CONTROL
- ALL FUNCTION ARE PROGRAMMABLE VIA SERIAL BUS



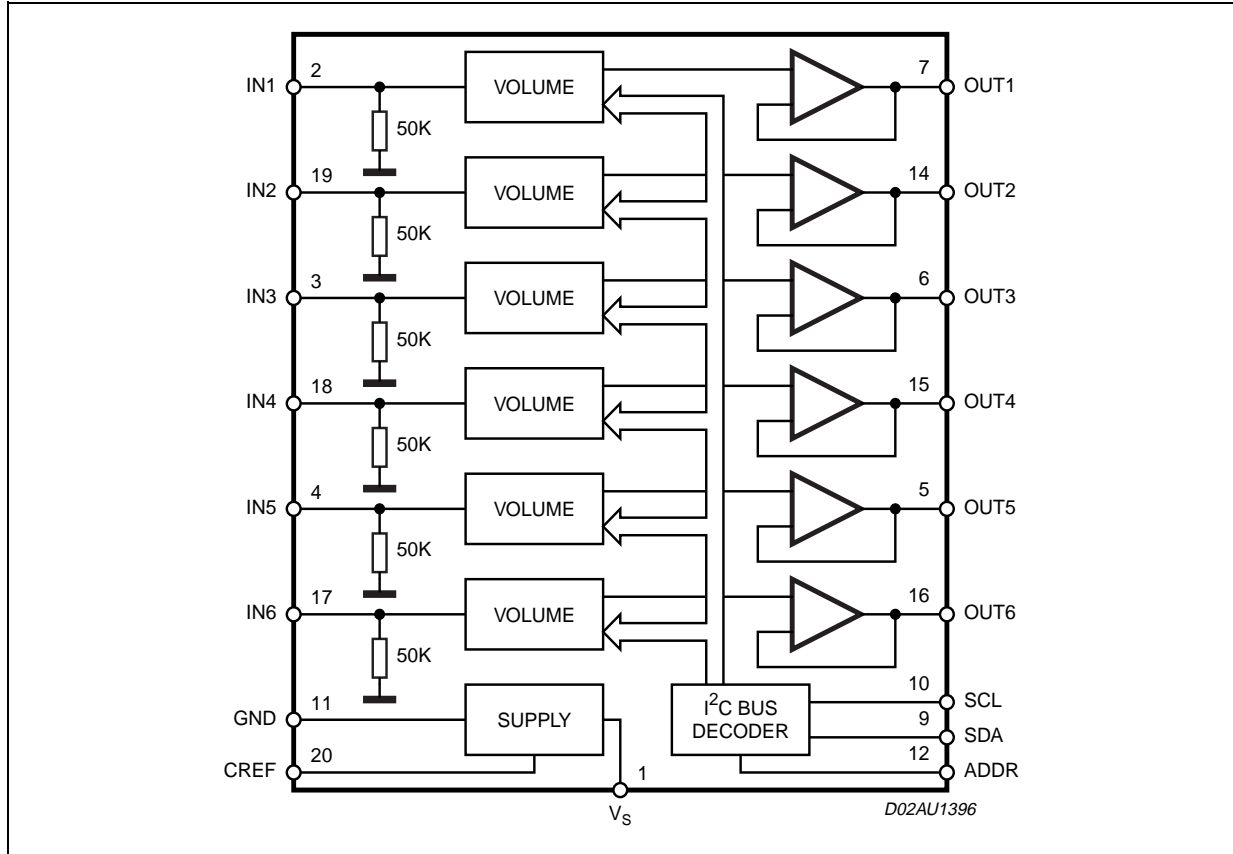
### DESCRIPTIO

The TDA7448 is a 6 channel volume controller for quality audio applications in Multi-Channels Audio Systems

Low Distortion, Low Noise and DC stepping are obtained.

Thanks to the used BIPOLAR/CMOS Technology,

### BLOCK DIAGRAM

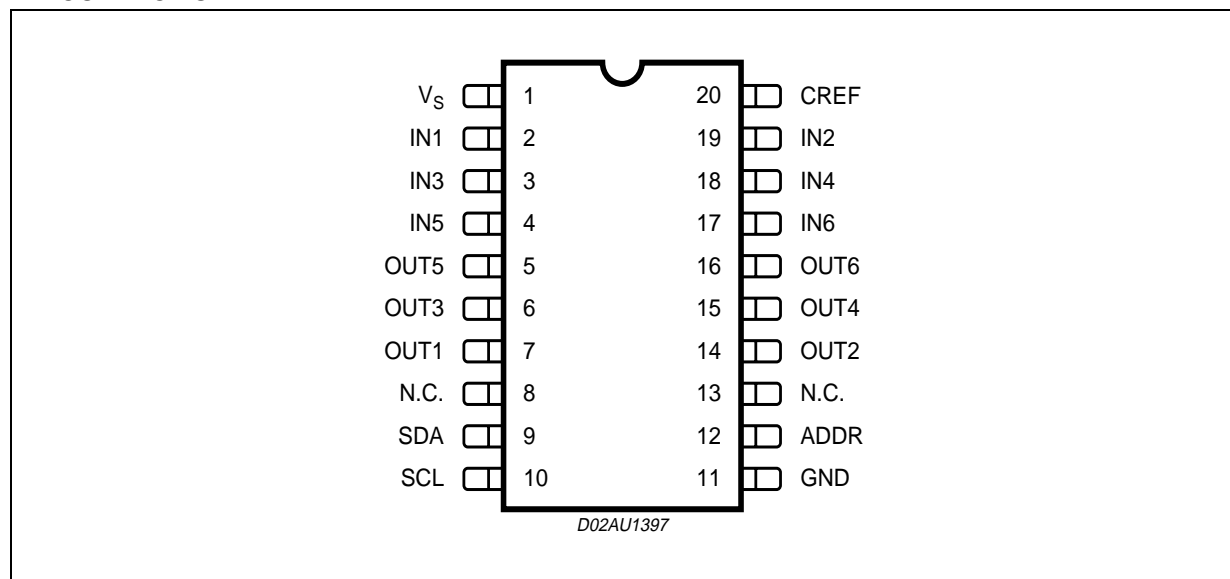


## TDA7448

### ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_S$	Operating Supply Voltage	10.5	V
$T_{amb}$	Operating Ambient Temperature	-10 to 85	°C
$T_{stg}$	Storage Temperature Range	-55 to 150	°C

### PIN CONNECTION



### THERMAL DATA

Symbol	Parameter	Value	Unit
$R_{th\ j-pin}$	thermal Resistance junction-pins	150	°C/W

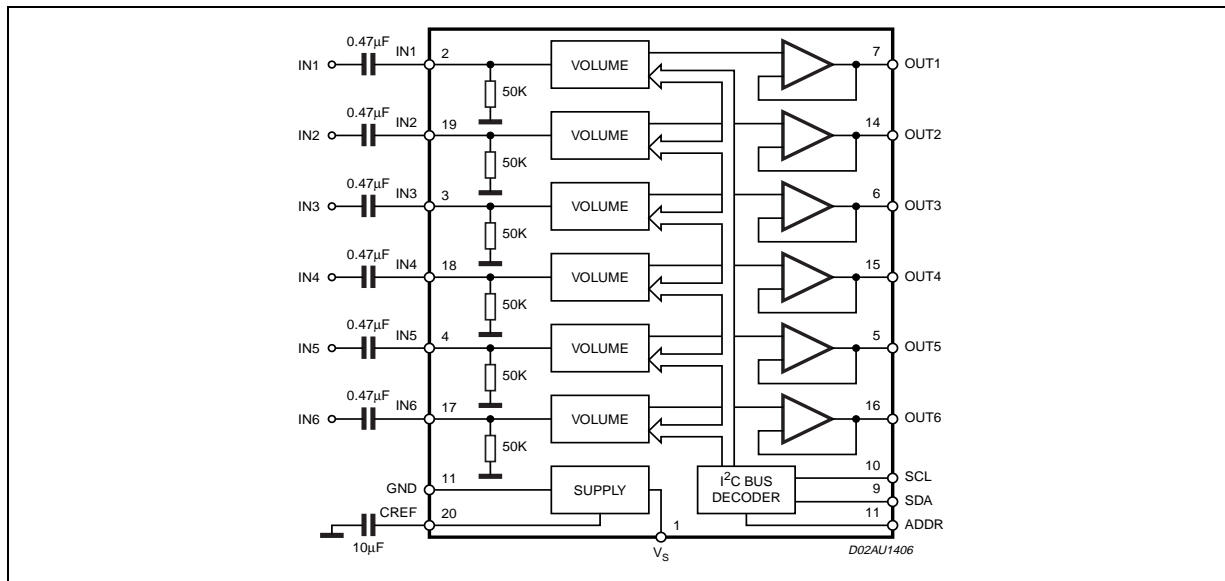
### QUICK REFERENCE DATA

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_S$	Supply Voltage	4.75	9	10	V
$V_{CL}$	Max Input Signal Handling	2			V <sub>rms</sub>
THD	Total Harmonic Distortion $V = 1V_{rms}$ $f = 1KHz$		0.01	0.1	%
S/N	Signal to Noise Ratio $V_{out} = 1V_{rms}$		100		dB
$S_c$	Channel Separation $f = 1KHz$		90		dB
	Volume Control (1dB step)	-79		0	dB
	Mute Attenuation		90		dB

**ELECTRICAL CHARACTERISTICS**(refer to the test circuit  $T_{amb} = 25^{\circ}\text{C}$ ,  $V_S = 9\text{V}$ ,  $R_L = 10\text{K}\Omega$ ,  $R_G = 600\Omega$ , unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
<b>SUPPLY</b>						
$V_S$	Supply Voltage		4.75	9	10	V
$I_S$	Supply Current			7		mA
SVR	Ripple Rejection			80		dB
<b>INPUT STAGE</b>						
$R_{IN}$	Input Resistance		35	50	65	$\text{K}\Omega$
$V_{CL}$	Clipping Level	THD = 0.3%	2	2.5		V <sub>rms</sub>
$S_{IN}$	Input Separation	The selected input is grounded through a 2.2 $\mu$ capacitor		90		dB
<b>VOLUME CONTROL</b>						
$C_{RANGE}$	Control Range			79		dB
$A_{VMAX}$	Max. Attenuation			79		dB
$A_{STEP}$	Step Resolution		0.5	1	1.5	dB
$E_A$	Attenuation Set Error	$A_V = 0$ to -24dB	-1	0	1	dB
		$A_V = -24$ to -79dB	-2.0	0	2.0	dB
$E_T$	Tracking Error	$A_V = 0$ to -24dB	-1	0	1	dB
		$A_V = -24$ to -79dB	-2	0	2	dB
$V_{DC}$	DC Step	adjacent attenuation steps	-3	0	3	mV
$A_{mute}$	Mute Attenuation			90		db
<b>AUDIO OUTPUTS</b>						
$V_{CLIP}$	Clipping Level	THD = 0.3%	2	2.5		V <sub>rms</sub>
$R_L$	Output Load Resistance		2			$\text{K}\Omega$
$V_{DC}$	DC Voltage Level			4.5		V
<b>GENERAL</b>						
$E_{NO}$	Output Noise	BW = 20Hz to 20KHz All gains = 0dB, Flat		10	15	$\mu\text{V}$
S/N	Signal to Noise Ratio	All gains = 0dB; $V_O = 1\text{V}_{rms}$		100		dB
$S_C$	Channel Separation left/Right		80	90		dB
THD	Distortion	$A_V = 0$ ; $V_I = 1\text{V}_{rms}$		0.01	0.1	%
<b>BUS INPUT</b>						
$V_{II}$	Input Low Voltage				1	V
$V_{IH}$	Input High Voltage		2.5			V
$I_{IN}$	Input Current	$V_{IN} = 0.4\text{V}$	-5		5	$\mu\text{A}$
$V_O$	Output Voltage SDA Acknowledge	$I_O = 1.6\text{mA}$		0.4	0.8	V

Figure 1. Test circuit



**APPLICATION SUGGESTIONS**

The volume control range is 0 to -79dB, by 1dB step resolution.

The very high resolution allows the implementation of systems free from any noise acoustical effect.

**CREF**

The suggested 10µF reference capacitor (CREF) value can be reduced to 4.7µF if the application requires faster power ON.

Figure 2. THD vs. frequency

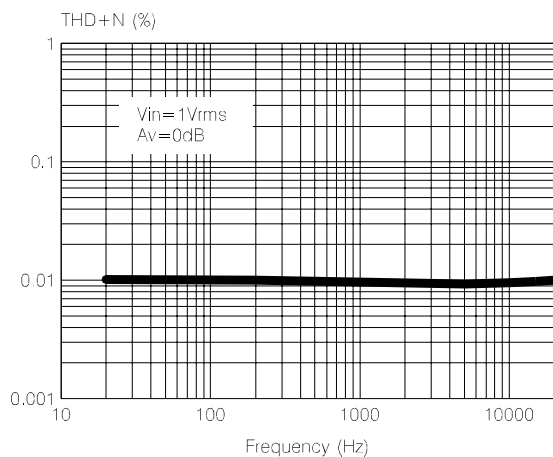


Figure 3. THD vs. RLOAD

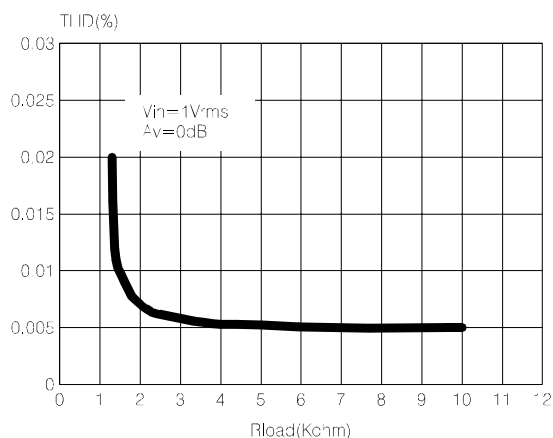
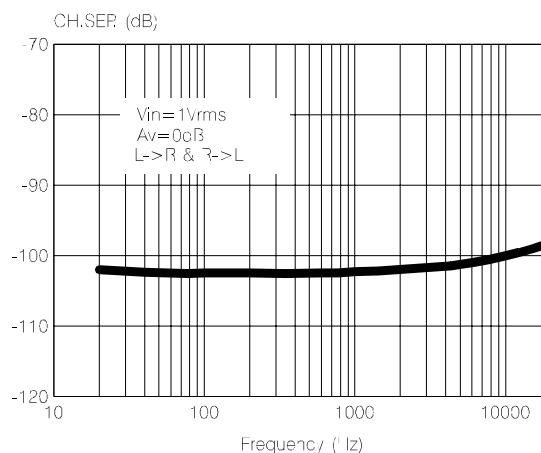


Figure 4. Channel separation vs. frequency



## I<sup>2</sup>C BUS INTERFACE

Data transmission from microprocessor to the TDA7448 and vice versa takes place through the 2 wires I<sup>2</sup>C BUS interface, consisting of the two lines SDA and SCL (pull-up resistors to positive supply voltage must be connected).

### Data Validity

As shown in fig. 1, the data on the SDA line must be stable during the high period of the clock. The HIGH and LOW state of the data line can only change when the clock signal on the SCL line is LOW.

### Start and Stop Conditions

As shown in fig. 2 a start condition is a HIGH to LOW transition of the SDA line while SCL is HIGH. The stop condition is a LOW to HIGH transition of the SDA line while SCL is HIGH.

### Byte Format

Every byte transferred on the SDA line must contain 8 bits. Each byte must be followed by an acknowledge bit. The MSB is transferred first.

### Acknowledge

The master ( $\mu$ P) puts a resistive HIGH level on the SDA line during the acknowledge clock pulse (see fig. 5). The peripheral (audio processor) that acknowledges has to pull-down (LOW) the SDA line during this clock pulse.

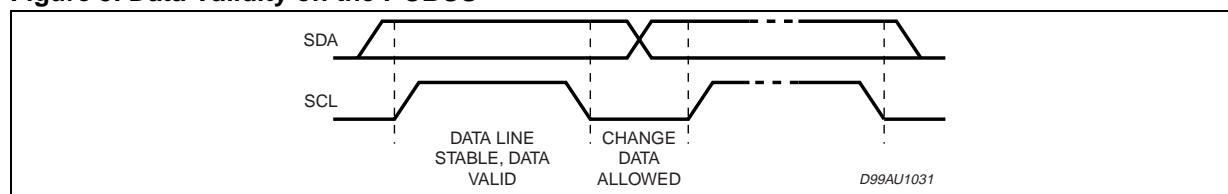
The audio processor which has been addressed has to generate an acknowledge after the reception of each byte, otherwise the SDA line remains at the HIGH level during the ninth clock pulse time. In this case the master transmitter can generate the STOP information in order to abort the transfer.

### Transmission without Acknowledge

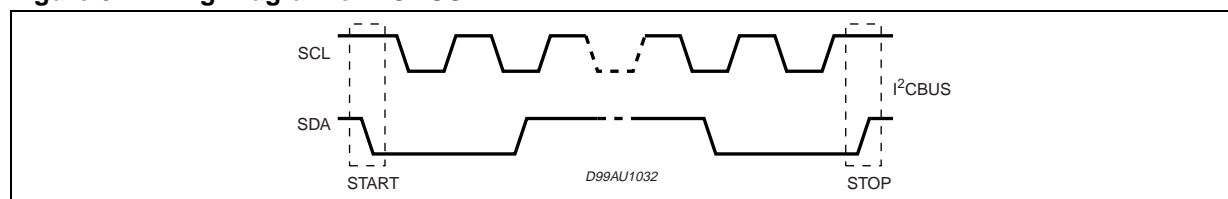
Avoiding to detect the acknowledge of the audio processor, the  $\mu$ P can use a simpler transmission: simply it waits one clock without checking the slave acknowledging, and sends the new data.

This approach of course is less protected from misworking.

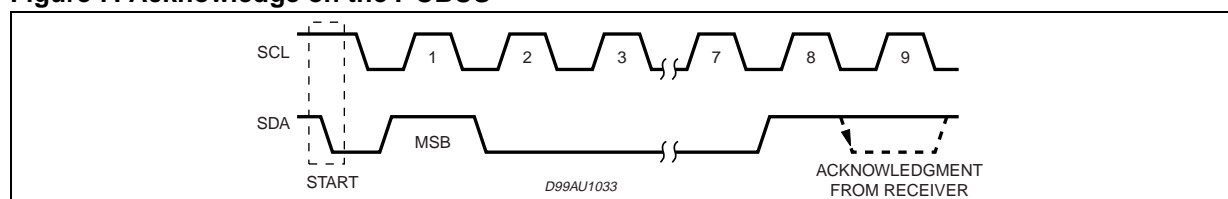
**Figure 5. Data Validity on the I<sup>2</sup>C BUS**



**Figure 6. Timing Diagram of I<sup>2</sup>C BUS**



**Figure 7. Acknowledge on the I<sup>2</sup>C BUS**

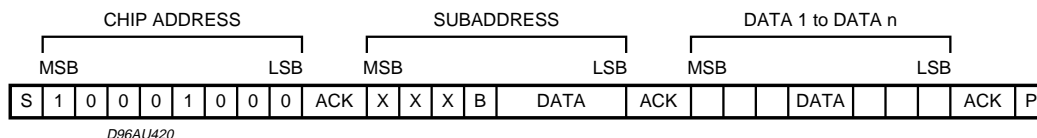


**SOFTWARE SPECIFICATION**

Interface Protocol

The interface protocol comprises:

- A start condition (S)
- A chip address byte, containing the TDA7448 address
- A subaddress bytes
- A sequence of data (N byte + acknowledge)
- A stop condition (P))

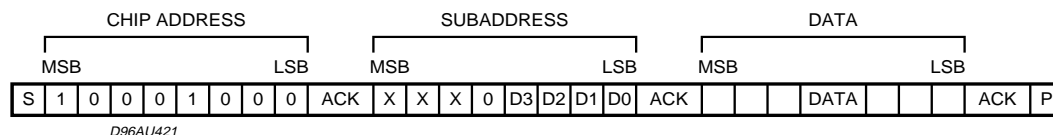


ACK = Acknowledge;    S = Start;    P = Stop;    A = Address;    B = Auto Increment

**EXAMPLES**

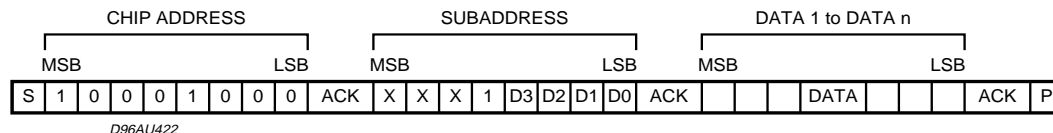
**No Incremental Bus**

The TDA7448 receives a start condition, the correct chip address, a subaddress with the B = 0 (no incremental bus), N-data (all these data concern the subaddress selected), a stop condition.



**Incremental Bus**

The TDA7448 receives a start conditions, the correct chip address, a subaddress with the B = 1 (incremental bus): now it is in a loop condition with an autoincrease of the subaddress whereas SUBADDRESS from "XXX1000" to "XXX1111" of DATA are ignored. The DATA 1 concern the subaddress sent, and the DATA 2 concern the subaddress sent plus one in the loop etc, and at the end it receives the stop condition.



**DATA BYTES**

Address= 88 (HEX) (10001000): ADDR open; 8A (HEX) (10001010): connect to supply

FUNCTION SELECTION: subaddress

CHIP ADDRESS							SUBADDRESS	SUBADDRESS
MSB							LSB	
D7	D6	D5	D4	D3	D2	D1	D0	
X	X	X	B	0	0	0	0	SPEAKER ATTENUATION OUT 1
X	X	X	B	0	0	0	1	SPEAKER ATTENUATION OUT 2
X	X	X	B	0	0	1	0	SPEAKER ATTENUATION OUT 3
X	X	X	B	0	0	1	1	SPEAKER ATTENUATION OUT 4
X	X	X	B	0	1	0	0	SPEAKER ATTENUATION OUT 5
X	X	X	B	0	1	0	1	SPEAKER ATTENUATION OUT 6
X	X	X	B	0	1	1	0	NOT USED"
X	X	X	B	0	1	1	1	NOT USED

B=1: INCREMENTAL BUS; ACTIVE  
 B=0: NO INCREMENTAL BUS  
 X= DON'T CARE



In Incremental Bus Mode, the three “not used” functions must be addressed in any case. For example to refresh “Speaker Attenuation 3 = 0dB and Speaker Attenuation 6 = -40 dB”; the following bytes must be sent:

SUBADDRESS	XXX10010
SPEAKER ATTENUATION OUT 1	XXXXXXXX
SPEAKER ATTENUATION OUT 2	XXXXXXXX
SPEAKER ATTENUATION OUT 3	00000000
SPEAKER ATTENUATION OUT 4	XXXXXXXX
SPEAKER ATTENUATION OUT 5	XXXXXXXX
SPEAKER ATTENUATION OUT 6	00101111

### SPEAKER ATTENUATION SELECTION

MSB							LSB		SPEAKER ATTENUATION
D7	D6	D5	D4	D3	D2	D1	D0		
					0	0	0	0dB	
					0	0	1	-1dB	
					0	1	0	-2dB	
					0	1	1	-3dB	
					1	0	0	-4dB	
					1	0	1	-5dB	
					1	1	0	-6dB	
					1	1	1	-7dB	
0	0	0	0	0				-0dB	
0	0	0	0	1				-8dB	
0	0	0	1	0				-16dB	
0	0	0	1	1				-24dB	
0	0	1	0	0				-32dB	
0	0	1	0	1				-40dB	
0	0	1	1	0				-48dB	
0	0	1	1	1				-56dB	
0	1							-64dB	
1	0							-72dB	
1	1							MUTE	

value = 0 to -79dB and MUTE

Figure 8. PIN:20

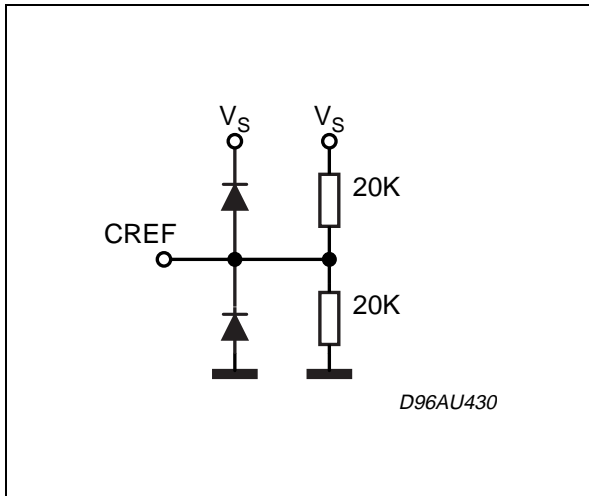


Figure 11. PINS: 10

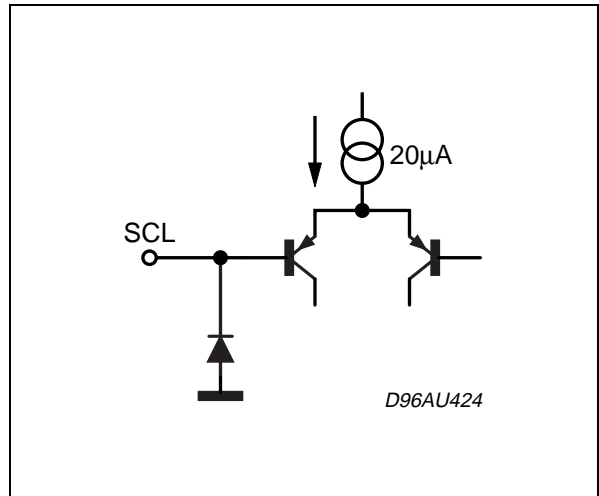


Figure 9. PINS: 5, 6, 7, 14, 15, 16

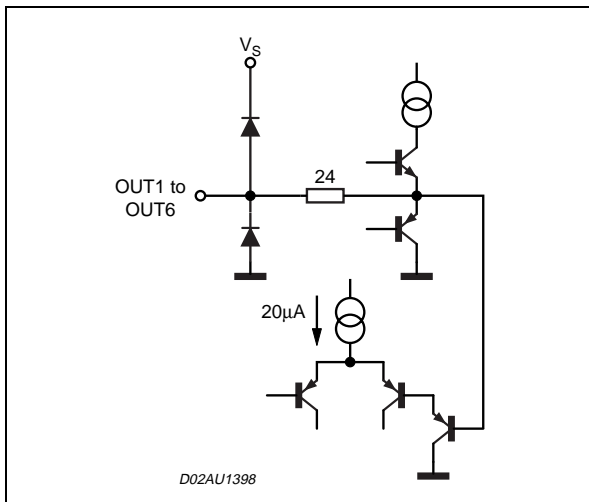


Figure 12. PINS: 9

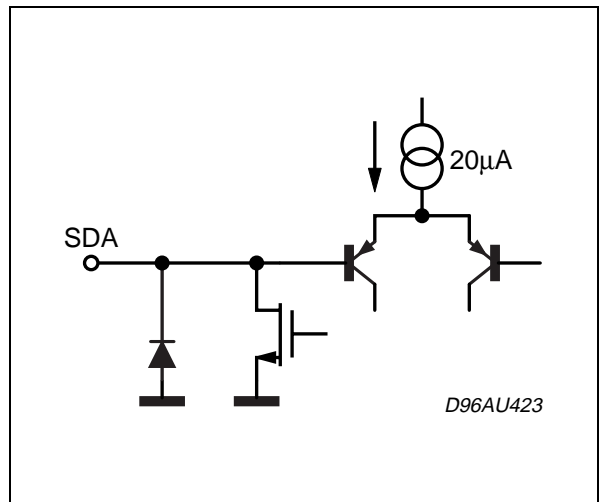


Figure 10. PINS: 2, 3, 4, 17, 18, 19

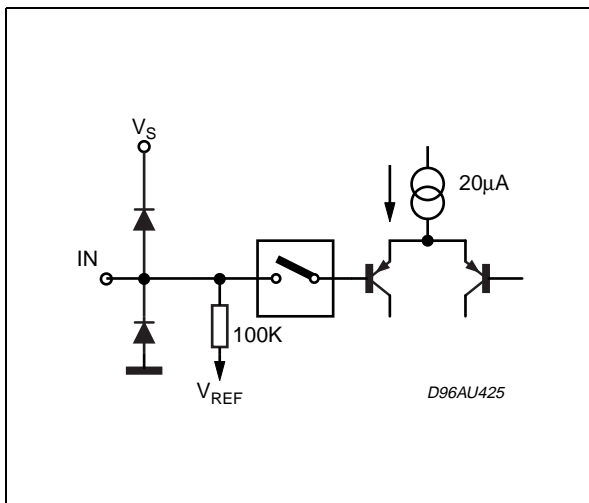




Figure 13. Test and Application Circuit

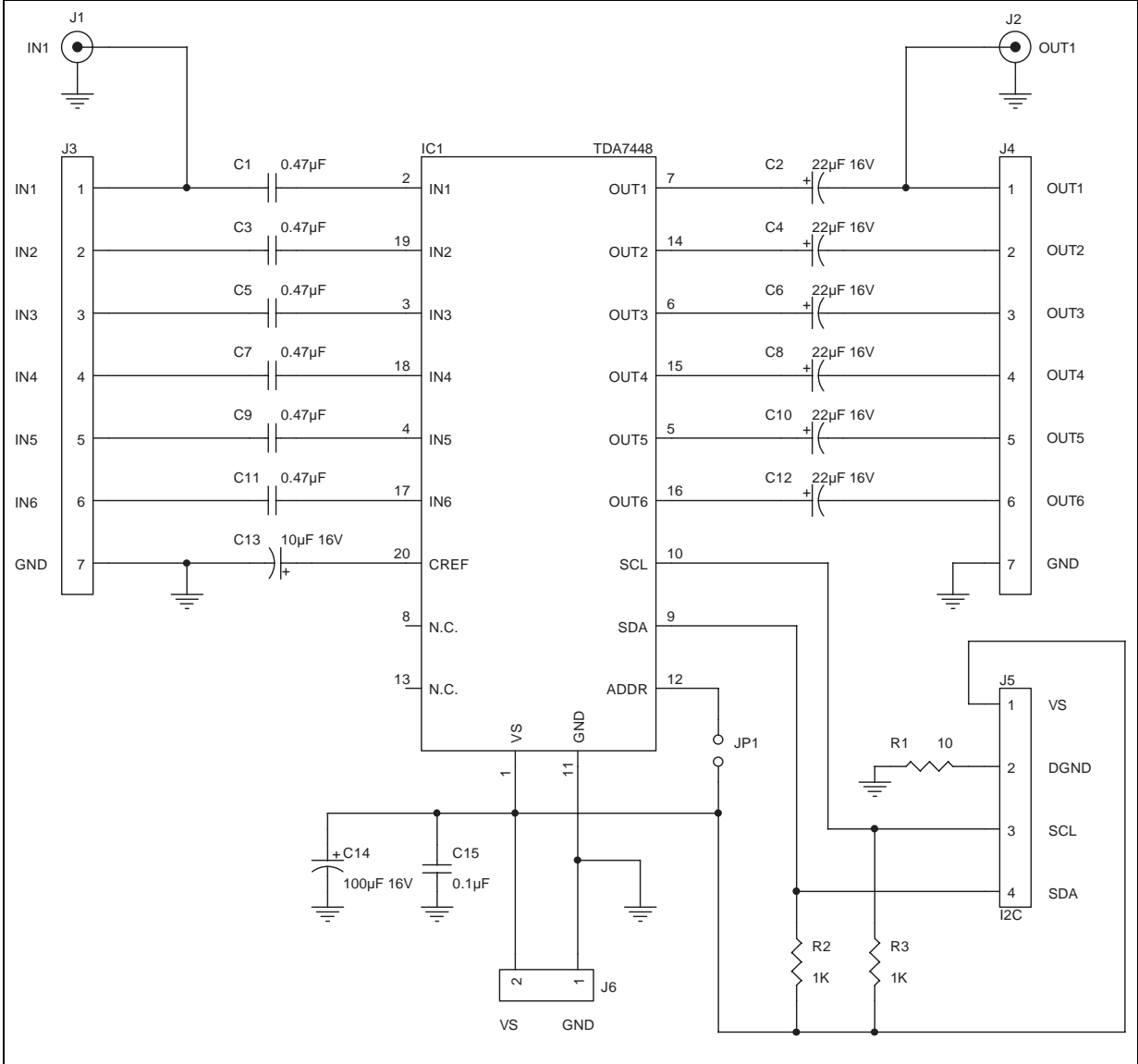


Figure 14. Component Layout (65 x 72mm)

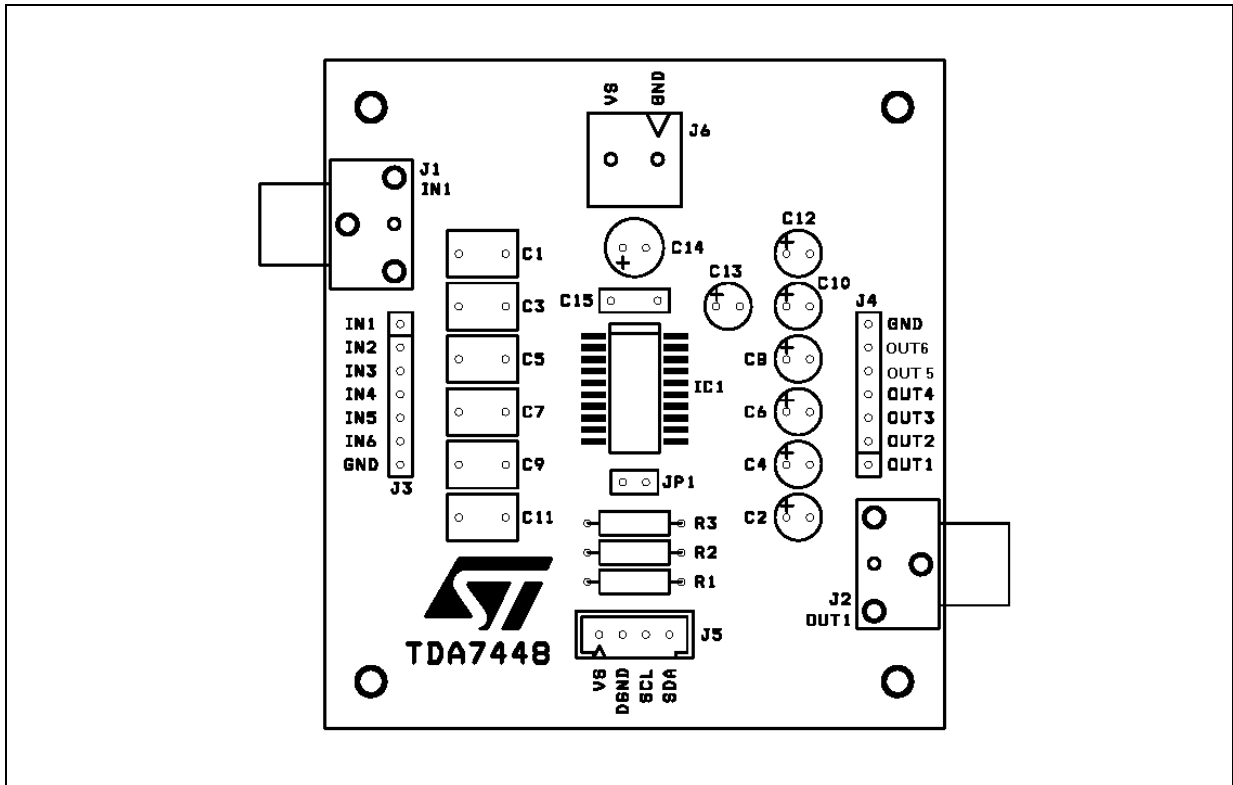


Figure 15. PC Board (Component side)

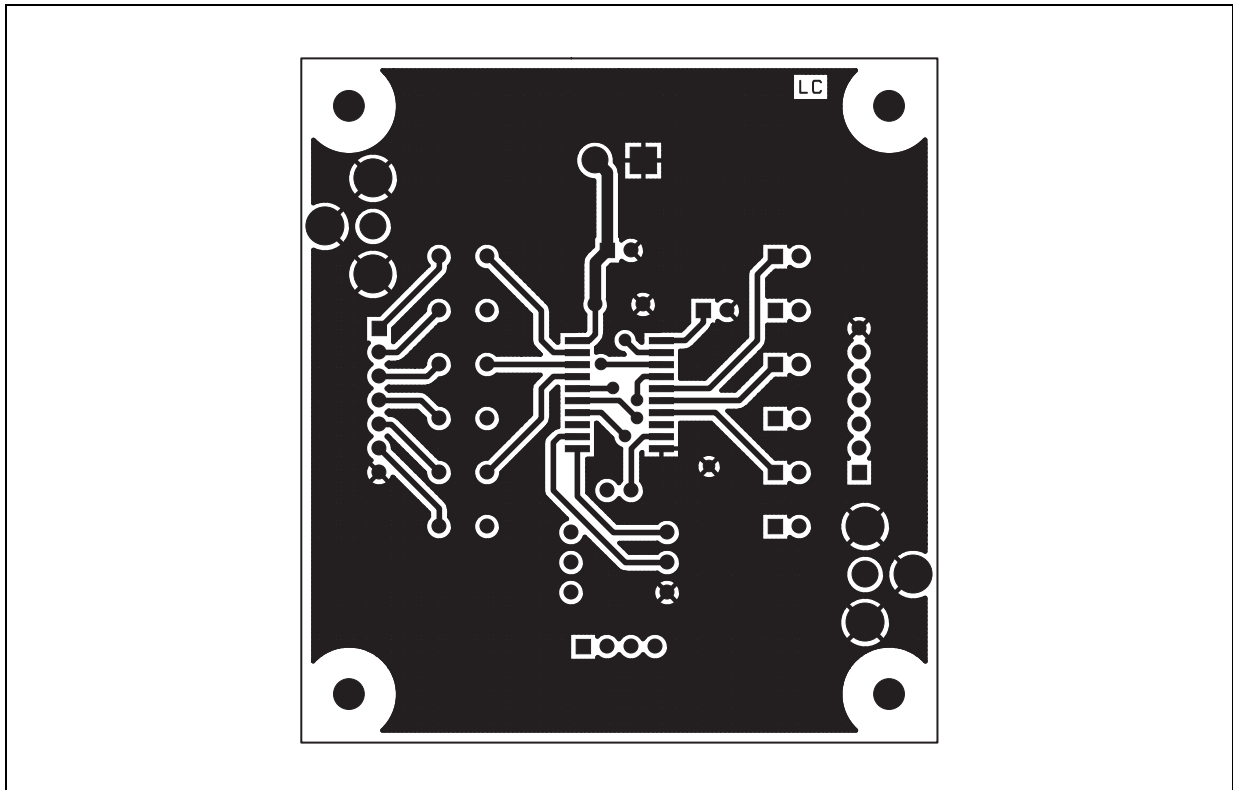
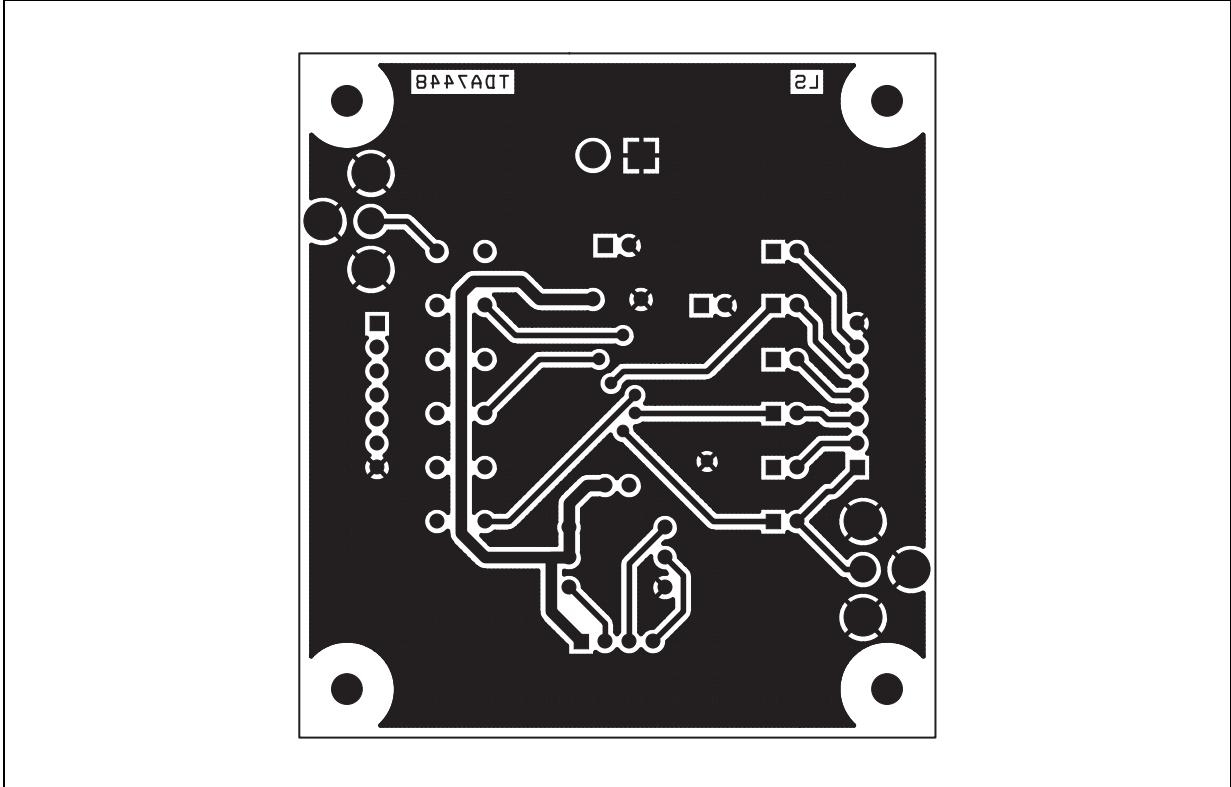
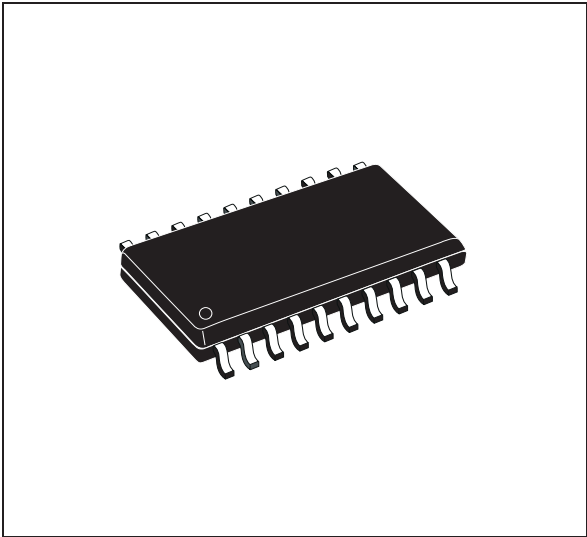


Figure 16. PC Board (Solder side)

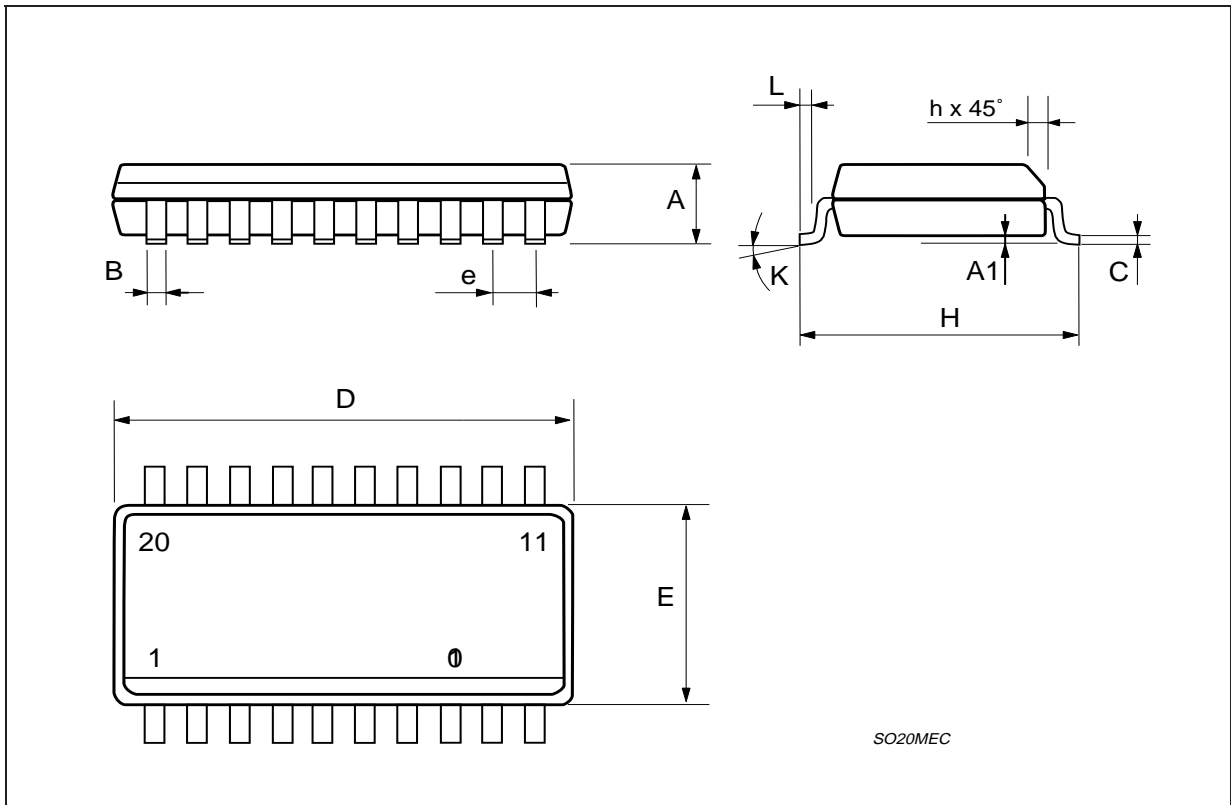


DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.35		2.65	0.093		0.104
A1	0.1		0.3	0.004		0.012
B	0.33		0.51	0.013		0.020
C	0.23		0.32	0.009		0.013
D	12.6		13	0.496		0.512
E	7.4		7.6	0.291		0.299
e		1.27			0.050	
H	10		10.65	0.394		0.419
h	0.25		0.75	0.010		0.030
L	0.4		1.27	0.016		0.050
K	0° (min.)8° (max.)					

**OUTLINE AND MECHANICAL DATA**



**SO20**



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