TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC9455F,TC9455N,TC9488F,TC9488N

#### Digital Echo IC for Karaoke

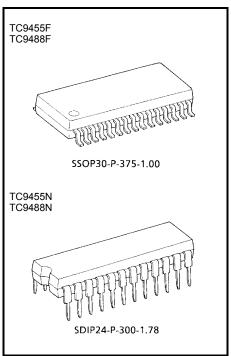
The TC9455 series are digital echo ICs for karaoke. The ICs incorporate microphone amps and volume controllers, enabling a digital echo system to be configured on a single chip.

#### Features

- Incorporates a two-channel microphone amp with auto level control (ALC), AD/DA converter, delay memory, and electronic volume controllers.
- Incorporates a 32-kHz sampling, 12-bit successive comparison AD/DA converter.
- Incorporates a delay memory (16-Kbit DRAM) which enables • 128-ms (typ.) delay.
- Microphone and echo levels are controlled by built-in volume ٠ controllers. They are controlled either by DC voltage or controlled in serial by the MCU.

TC9455F/N: Supports I<sup>2</sup>C bus interface TC9488F/N: Supports three-lead interface

- The system clock is generated by the CR oscillator circuit.
- The echo feedback amount is configured using analog circuits. The feedback level can be freely set.
- The IC comes in 30-pin flat package or 24-pin shrink DIP.



Weight: SSOP30-P-375-1.00: 1.08 g (typ.) SDIP24-P-300-1.78: 1.2 g (typ.)

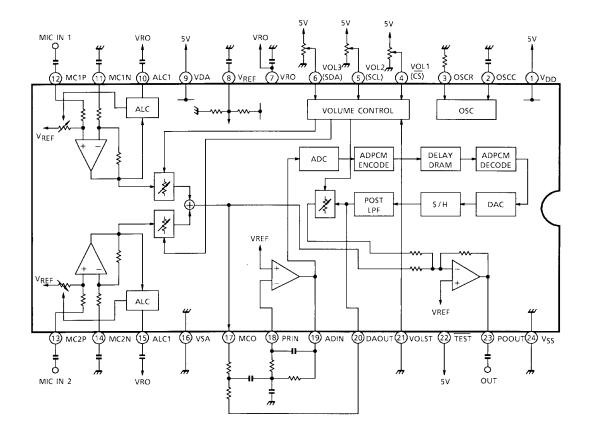
### **Pin Connection**

		$\sim$	
VDD	1	24	Vss
oscc	2	23	POOUT
OSCR	3	22	TEST
VOL1	4	21	VOLST
VOL2	5	20	DAOUT
VOL3	6	19	ADIN
VRO	7	18	PRIN
VREF	8	17	мсо
VDA	9	16	VSA
ALC1	10	15	ALC2
MC1N	11	14	MC2N
MC1P	12	13	MC2P
	-		
тс	9455	N, ⊤C9488	3N

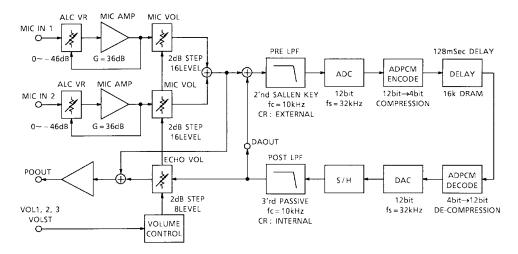
V <sub>DD</sub>	10	30	Vss
oscc	2	29	POOUT
OSCR	3	28	TEST
NC	4	27	NC
VOL1	5	26	VOLST
VOL2	6	25	DAOU
VOL3	7	24	NC
NC	8	23	ADIN
VRO	9	22	PRIN
VREF	10	21	мсо
VDA	11	20	VSA
NC	12	19	NC
ALC1	13	18	ALC2
MC1N	14	17	MC2N
MC1P	15	16	MC2P
	TC9455	F, TC9488F	

Downloaded from Elcodis.com electronic components distributor

## **Block Diagram**



## System Block Diagram



## Pin Description (Note 1)

Pin Number					
TC9455N TC9488N	TC9455F TC9488F	Symbol	I/O	Function	Remarks
1	1	V <sub>DD</sub>	_	Digital supply voltage pin	
2	2	CSCC	Ι	Capacitor connecting pin for CR oscillator (C = 68 pF)	
3	3	OSCR	Ι	Resistor connecting pin for CR oscillator (R = 5.6 k $\Omega$ )	
4	5	VOL1 ( CS )	Ι	When VOLST = "H" level, $\overline{CS}$ signal input pin When VOLST = "L" level, DC control pin for MIC1 volume	
5	6	VOL2 (SCL)	Ι	When VOLST = "H" level, clock input pin When VOLST = "L" level, DC control pin for MIC2 volume	Open drain output
6	7	VOL3 (SDA)	I	When VOLST = "H" level, data input pin When VOLST = "L" level, DC control pin for echo volume	Open drain output
7	9	VRO	I	Reference voltage pin	
8	10	V <sub>REF</sub>	_	Reference voltage pin (1/2 V <sub>DD</sub> )	
9	11	VDA	_	Analog supply voltage pin	
10	13	ALC1	Ι	Auto level control pin 1	
11	14	MC1N	Ι	MIC1 feedback signal input pin	
12	15	MC1P	Ι	MIC1 signal input pin	
13	16	MC2P	Ι	MIC2 signal input pin	
14	17	MC2N	Ι	MIC2 feedback signal input pin	
15	18	ALC2	Ι	Auto level control pin 2	
16	20	VSA	_	Analog ground pin	
17	21	MCO	0	MIC addition signal output pin	
18	22	PRIN	Ι	Pre-filter input pin	
19	23	ADIN	Ι	Pre-filter output signal or DC input pin	
20	25	DAOUT	0	Post-filter output pin	
21	26	VOLST	I	Electronic volume control mode select pin When VOLST = "H" level, serial control (I <sup>2</sup> C bus/three-lead) When VOLST = "L" level, DC level control	
22	28	TEST	Ι	Test pin. Fix to "H" level for normal use	
23	29	POOUT	0	Microphone echo signal output pin	
24	30	V <sub>SS</sub>	_	Digital ground pin	

Note 1: With the TC9455F and TC9488F, pins 4, 8, 12, 19, 24, and 27 are not connected (NC pins). NC pins are normally open.

## Operation

#### 1. Oscillator circuit

The TC9455F/N and TC9488F/N generate an internal system clock using the CR oscillator circuit. Connecting a capacitance (C) of 68 pF and a resistance (R) of 5.6 k $\Omega$  sets the oscillator frequency to approx. 4 MHz and the sampling frequency to 32 kHz.

Varying the external capacitance enables the oscillator frequency and sampling frequency for the system clock to be adjusted. Varying the system clock enables the delay time to be adjusted. Figure 1 shows the CR oscillator circuit.

#### 1.1 How to determine oscillator frequency (f)

$$\begin{split} {\rm f}\,[{\rm MHz}] &= 1532/({\rm C}\,[{\rm pF}]\times {\rm R}\,[{\rm k}\Omega]) \\ &= 1532/(68\times 5.6) \\ &\approx 4.0\;{\rm MHz}\;({\rm Note}\;2) \end{split}$$

Note 2: The oscillator frequency is a typical value (Ta =  $25^{\circ}$ C). Set the resistance to between 4.7 k $\Omega$  and 6.8 k $\Omega$ .

#### 1.2 How to determine sampling frequency (fs)

fs [kHz] = f/128 = 4.0/128 $\approx 32 \text{ kHz}$ 

#### 2. Microphone amps

The IC incorporates microphone amps with auto level control (ALC). The microphone amp gain is typically 36dB.

When a signal from 0 to -46dB is input, the ALC circuit can control the output signal level. Changing the external capacitor connected to the ALC circuit to a resistor sets the ALC circuit to off. Figure 2 shows the microphone amp circuit.

When C = 4.7  $\mu F,$  the attack and release times are as follows:

Attack time = Approx. 29 ms Release time = Approx. 1.6 s

Setting the capacitance (C) to a smaller value enables the attack and release times to be adjusted. When the ALC circuit is not used, change the capacitor (\*1) to a resistor (approx. 10 k $\Omega$ ), and connect to GND line.

At power on, while the capacitor is being charged, no sound is output. So, use a capacitance of 4.7  $\mu F$  or less.

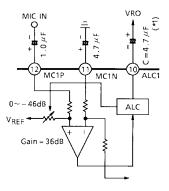
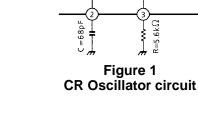


Figure 2 Microphone amp with ALC



CR oscillator circuit

### 3. AD/DA converter and digital delay circuit

The AD/DA converter is a 12-bit successive comparison type. The sampling frequency when the system clock operates at 4 MHz is 32 kHz.

The analog signal input from the AD converter is converted to 12-bit digital data. The digital delay circuit compresses the 12-bit signal to 4-bit, writes it to delay RAM, then reads it. The 4-bit data read from delay RAM is de-compressed to 12-bit. The 12-bit data are converted to analog signals by the DA converter and output.

The area for delay RAM memory is 4096 words  $\times$  4 bits. The echo delay time is 4096 words  $\times$  (1/32 kHz) = 128 ms.

Figure 3 is a block diagram of the echo circuit.

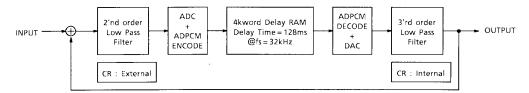


Figure 3 Block diagram of echo circuit

#### 4. Electronic volume controllers

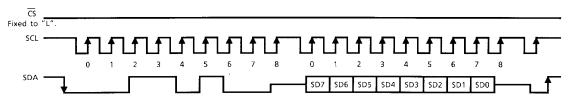
The IC incorporates microphone input 1 (MIC1) and microphone input 2 (MIC2) volume and echo volume controllers. The built-in volume controller operates in 16 steps. Using an external variable resistor, volume can be controlled by the DC level or from the MCU using serial data.

The TC9455F/N supports an I $^2\mathrm{C}$  bus interface; the TC9488F/N, a three-lead interface.

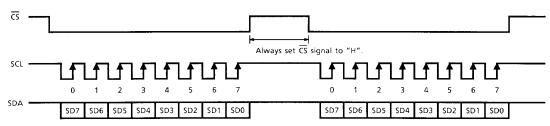
#### 4.1 Serial control timing

Figure 4 shows the serial control timing.

TC9455F/N  $l^2C$  bus control timing (slave address: 34 h)



TC9488F/N three-lead control timing



#### Figure 4 Serial control timing

Table 1 lists bits used to set the volume.

					3			
MODE	DA7	DA6	DA5	DA4	DA3	DA2	DA1	DA0
VOL1 setting	M3	M2	M1	M0	0	0	0	0
VOL2 setting	М3	M2	M1	MO	0	1	0	0
VOL3 setting	M3	M2	M1	M0	1	0	0	0
VOL1, 2, 3 setting	M3	M2	M1	MO	1	1	0	0

Table 1 Volume setting bits

M3, M2, M1, M0: Volume setting data

#### 4.2 Setting of microphone and echo volumes

Table 2 lists the microphone setting values and attenuation; Table 3 lists the echo volume setting values and attenuation. The DC level settings are typical values.

-			•	•	,
DC Level Setting (V)	S	erial Da	Attenuation (dB)		
	М3	M2	M1	MO	Allenuation (ub)
5.0	0	0	0	0	0
4.4	0	0	0	0	0
4.2	0	0	0	1	-2
3.9	0	0	1	0	-4
3.7	0	0	1	1	-6
3.5	0	1	0	0	-8
3.2	0	1	0	1	-10
3.0	0	1	1	0	-12
2.7	0	1	1	1	-14
2.5	1	0	0	0	-16
2.3	1	0	0	1	-18
2.0	1	0	1	0	-20
1.8	1	0	1	1	-22
1.5	1	1	0	0	-24
	1	1	0	1	-26
1.3	1	1	1	0	-28
1.1	1	1	1	1	-∞
0.0	1	I	I		-∞

#### Table 2 Microphone volume (VOL1, VOL2) attenuation

#### Table 3 Echo volume (VOL3) attenuation

DC Level Setting (V)	S	erial Da	Attonuction (dB)		
	М3	M2	M1	M0	Attenuation (dB)
5.0	0	0	0	0	0
4.4	0	0	0	0	0
4.2	0	0	0	1	-1
3.9	0	0	1	0	-2
3.7	0	0	1	1	-3
3.5	0	1	0	0	-4
3.2	0	1	0	1	-5
3.0	0	1	1	0	-6
2.7	0	1	1	1	-7
2.5	1	0	0	0	-8
2.3	1	0	0	1	-9
2.0	1	0	1	0	-10
1.8	1	0	1	1	-11
1.5	1	1	0	0	-12
1.3	1	1	0	1	-13
1.1	1	1	1	0	-14
0.0	1	1	1	1	-∞
0.0		•	•	•	

## Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rat	Unit	
Supply voltage	V <sub>DD</sub>	-0.3	V	
Input voltage	V <sub>in</sub>	-0.3~V <sub>DD</sub> + 0.3		V
Devues dis sin etian	P-	TC9455/88F	200	mW
Power dissipation	PD	TC9455/88N 300		11100
Operating temperature	T <sub>opr</sub> –25~85		-25~85	
Storage temperature	T <sub>stg</sub>	-55	~150	°C

### Electrical Characteristics (unless otherwise specified, Ta = $25^{\circ}$ C, V<sub>DD</sub> = 5.0 V) DC characteristics

Charac	teristics	Symbol	Test Circuit	Test Condition	Min	Тур.	Max	Unit
Operating supply v	oltage	V <sub>DD</sub>	-	Ta = −25~85°C	4.5	5.0	5.5	V
Operating supply c	urrent	I <sub>DD</sub>	_	Fmck = 4 MHz	_	20	30	mA
Operating frequence	су	Fmck	_	fs = 32 kHz typ.	_	4.0	_	MHz
Power-on reset vol	tage	V <sub>por</sub>	_		_	4.0	4.25	V
Input voltage	"H" level	V <sub>IH</sub>	_		V <sub>DD</sub> × 0.8	_	V <sub>DD</sub>	V
Input voltage	"L" level	V <sub>IL</sub>	_		0	_	V <sub>DD</sub> × 0.2	v
Input current	"H" level	IIH	_		_	_	1.0	
input current	"L" level	١ <sub>L</sub>	—		-1.0	_	—	μA

## Volume control (when VOLST = "L")

Characteristics	Symbol	Test Circuit	Test Condition	Min	Тур.	Max	Unit
Hysteresis voltage	VH	_		_	0.12	_	V
Input step width	VST	_		_	0.26	_	V
Min level input voltage	VImin	—		_	1.1	0.8	V
Max level input voltage	Vlmax	-		4.95	4.8		V

#### **AC Characteristics**

#### Microphone amps and volumes

Characteristics	Symbol	Test Circuit	Test Condition		Min	Тур.	Max	Unit
Microphone amp gain	MICG	-	Input 1-kHz sine −50dBV, MCO p		47.5	49.5	51.5	dBV
MCO Output at ALC Operation	VM	_	Input 1-kHz sine −25dBV.	e wave,	-0.8	1.7	3.2	dBV
Maximum Input at No ALC Operation	VL	_	Input 1-kHz sine	e wave.	_	-47.5		dBV
Maximum Input 1 at ALC Operation	VA1	_	Input 1-kHz sine output clip limit v volume		_	-4.0		dBV
Maximum Input 2 at ALC Operation	VA2	_	Input 1-kHz sine output clip limit microphone amp	value at	_	6.5	I	dBV
POOUT output noise 1	NO1	_	VOL1~3: min		_	-90	-85	dBV
POOUT output noise 2	NO2	-	VOL1: max, VO VOL3: min	L2: min,	—	-63	-58	dBV
POOUT output noise 3	NO3	-	VOL1: min, VOL VOL3: min	.2: max,	—	-64	-59	dBV
POOUT output noise 4	NO4	_	VOL1: min, VOL2: min, VOL3: max		_	-65	-54	dBV
POOUT output noise 5	NO5	_	VOL1: max, VO VOL3: min	L2: max,	_	-60	-54	dBV
POOUT output noise 6	NO6	_	VOL1: max, VO VOL3: min	L2: min,	_	-62	-54	dBV
POOUT output noise 7	NO7	_	VOL1: min, VOL VOL3: max	.2: max,	_	-62	-54	dBV
POOUT output noise 8	NO8	_	VOL1~3: max		_	-59	-52	dBV
Volume 1, 2 attenuation	ATT1	-	Ratio with one le (excluding the m		_	-2.0	-	dB
Volume 3 attenuation	ATT2	-	Ratio with one le (excluding the m		_	-1.0	_	dB
Attack time	T		1 kHz Sine wave input,	C = 47 µF (Note 3)	_	120	_	ma
	Т <sub>АТК</sub>		−20dBV → −10dBV	C = 0.47 µF (Note 3)	_	10	_	ms
Delegas time	т.		1 kHz Sine wave input,	C = 47 µF (Note 3)	_	1.6	_	
Release time	T <sub>RLS</sub>		−10dBV → −20dBV	C = 0.47 µF (Note 3)	_	0.15	_	S

Note 3: External capacitor of ALC pin

## Microcontroller interface (when VOLST = "H")

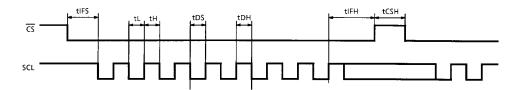
Characteristics	Symbol	Test Circuit	Test Condition	Min	Тур.	Max	Unit
Interface setup time	tIFS	-	(Note 4)	0.25	_	_	μs
Shift clock "L" duration	tL	_		0.25	_	_	μs
Shift clock "H" duration	tH	_		0.25	_	_	μs
Data setup time	tDS	_		0.25	_	_	μs
Data hold time	tDH	_		0.25	_	_	μs
Interface hold time	tIFH	_	(Note 4)	1.0	_	_	μs
CS "H" duration	tCSH	_	(Note 4)	0.25	_	_	μs

Note 4: With TC9488F and TC9488N

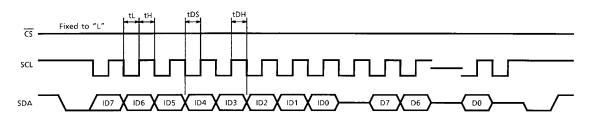
## <u>TOSHIBA</u>

### **AC Characteristics Test Points**

1. TC9488F/N three-lead interface

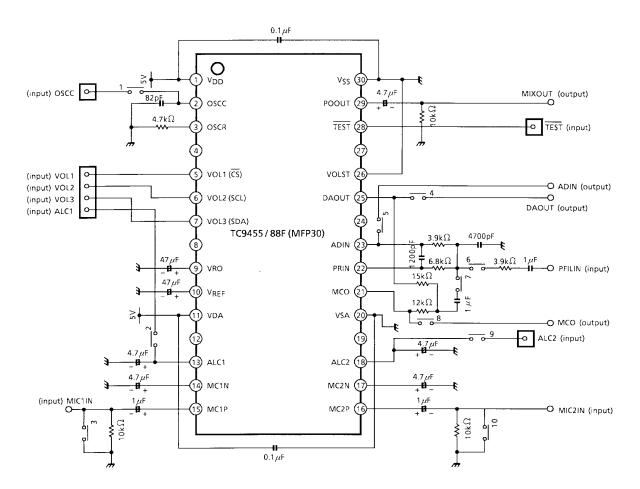


## 2. TC9455F/N I<sup>2</sup>C bus interface

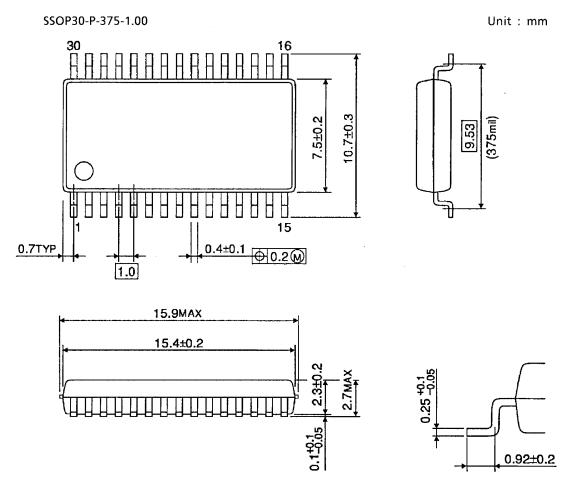


Purchase of TOSHIBA I<sup>2</sup>C components conveys a license under the Phillips I<sup>2</sup>C Patent Right to use the components in an I<sup>2</sup>C system, provided that the system conforms to the I<sup>2</sup>C Standard Specification as defined by Phillips.

## TC9455/88F AC Test Circuit



## **Package Dimensions**

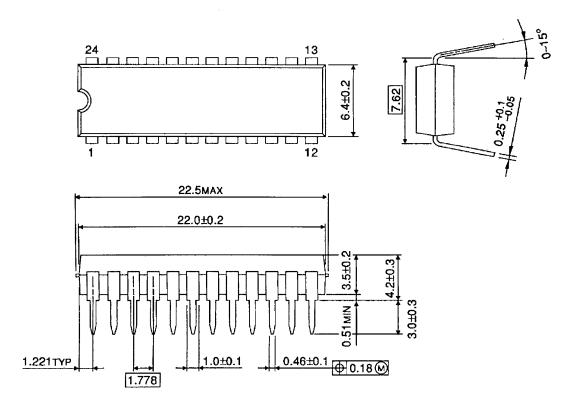


Weight: 1.08 g (typ.)

## **Package Dimensions**

SDIP24-P-300-1.78

Unit : mm



Weight: 1.2 g (typ.)

#### **RESTRICTIONS ON PRODUCT USE**

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
- In developing your designs,p lease ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.