BCT4699

0.5Ω, 3.3V Quad-SPDT Analog Switch

General Description

The BCT4699 is configured as a quad-SPDT switch with two common control inputs. Each digital input controls two pairs of SPDT switches. The switches are fully bi-directional, allowing both multiplexing and de-multiplexing operation. Break-before-make operation is guaranteed.

The device operates from a +2.5V to +5.0V supply and over the extended -40℃ to +85℃ temperature range. It is offered in 16-pin 3mm x 3mm TQFN package.

Features

- Low 0.5Ω R_{ON} （+2.7Vsupply）
- 0.05Ω On-Resistance Flatness
- Excellent 0.05Ω On-Resistance Matching
- Low 0.02% THD into 8Ω
- Low 0.015% THD into 32Ω
- Rail-to-Rail Signal Switching Range
- Fast Switching Speed：20nsTYP at 3.3V
- High Off Isolation: -66dB
- Crosstalk Rejection: -86dB
- -3dB bandwidth: 100MHz
- Audio Signal Routing
- Space-Saving, 3mm x 3mm TQFN Package

Applications

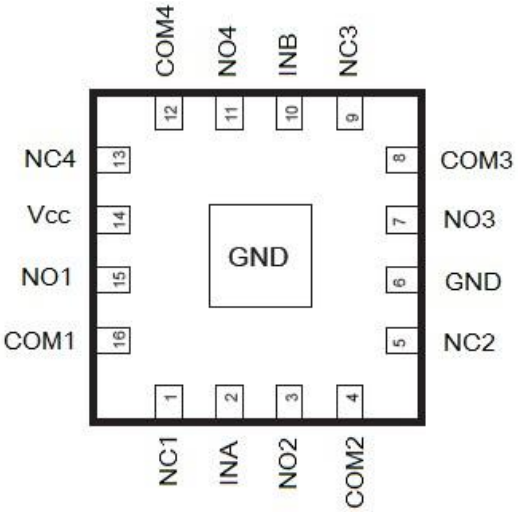
Cell Phones
Digital Still Cameras
PDAs and Palmtop Devices
MP3/MP4 Players
PCMCIA Cards
Modems
Hard Drives

Ordering Information

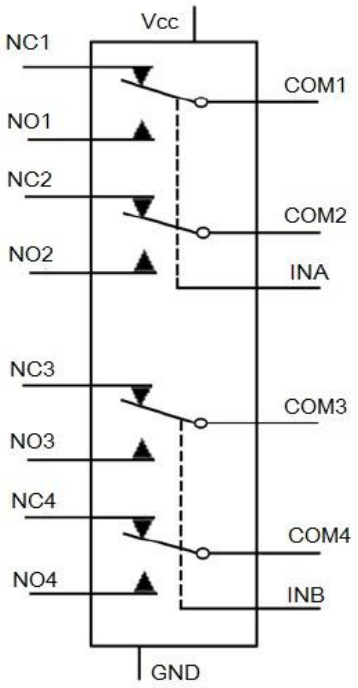
Ordering Code	Package Description	Temp Range	Top Marking
BCT4699ETE	16PIN TQFN	-40℃ to +85℃	XXXXX

Notes: XXX=INTERNAL CODE
XX=FOUNDRY NAME

Pin Configurations



Typical Application Circuit



0.5Ω, 3.3V Quad-SPDT Analog Switch

Absolute Maximum Ratings

V_{CC}, INA, INB to GND.....-0.3V to +6.0V
All Other Pins to GND (Note 1).....-0.3V to (VCC + 0.3V)
Continuous Current (NO_, NC_, COM_)..... ±400mA
Peak Current (NO_, NC_, COM_)
(pulsed at 1ms, 10% duty cycle).....±500mA

Continuous Power Dissipation (TA = +70℃)
16-Pin TQFN (15.6mW/℃ above +70℃) ……..1.25W
Operating Temperature Range .....-40℃ to +85℃
Storage Temperature Range.....-65℃ to +150℃
Junction Temperature.....+150℃
Lead Temperature (soldering, 10s).....+300℃

Note 1: Signals on NO_, NC_, COM_ , INA and INB exceeding VCC or GND are clamped by internal diodes. Limit forward-diode current to maxium current rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

(VCC = 2.7V to 4.2V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at VCC = 3V, TA = +25℃. (Note 2)

Parameter	Symbol	Conditions		Min	Typ	Max	Units
POWER SUPPLY							
Supply Voltage Range	V_{CC}			2.5		5.0	V
Supply Current	I_{CC}	V_{CC}= 3.6V, $V_{IN\_}$ = 0 or V_{CC}, NO_ = NC_ = COM_ = floating			0.02	1	uA
ANALOG SWITCH							
Analog Signal Range		NO_, NC_, COM_		0		VCC	V
On-Resistance	R_{ON}	V_{CC}= 2.7V, $I_{COM\_}$ = 100mA, $V_{NO\_}$ or $V_{NC\_}$ = 0 to V_{CC}(3)	T_A = +25°C		0.5	0.8	Ω
			T_A= T_{MIN} to T_{MAX}			0.9	
On-Resistance Match	ΔR_{ON}	V_{CC}= 2.7V, $I_{COM\_}$ = 100mA, $V_{NO\_}$ or $V_{NC\_}$ = 1.5V(3,4)	T_A = +25°C		0.05	0.09	Ω
			T_A= T_{MIN} to T_{MAX}			0.1	
On-Resistance Flatness	R_{FLAT}	V_{CC}= 2.7V; $I_{COM\_}$ = 100mA; $V_{NO\_}$ or $V_{NC\_}$ = 0.6V, 1.2V, 1.8V(5)	T_A = +25°C		0.06	0.1	Ω
			T_A= T_{MIN} to T_{MAX}			0.12	
NO_ or NC_ Off-Leakage Current	I_{OFF}	V_{CC}= 3.3V; $V_{COM\_}$ = 3V, 0.3V or floating; $V_{NO\_}$ or $V_{NC\_}$ = 0.3V, 3V or floating	T_A = +25°C			20	nA
			T_A= T_{MIN} to T_{MAX}			100	
COM_ On-Leakage Current	I_{ON}	V_{CC}= 3.3V; $V_{NO\_}$ or $V_{NC\_}$ = 0.3V, 3V or floating; $V_{COM\_}$ = 0.3V, 3V or floating	T_A = +25°C			20	nA
			T_A= T_{MIN} to T_{MAX}			100	

0.5Ω, 3.3V Quad-SPDT Analog Switch

Electrical Characteristics (continued)

(V_{CC} = 2.7V to 4.2V, T_A = T_{MIN} to T_{BCT}, unless otherwise noted. Typical values are at V_{CC} = 3V, T_A = +25℃.) (2)

Parameter	Symbol	Conditions		Min	Typ	Max	Units
DYNAMIC CHARACTERISTICS							
Turn-On Time	T_{ON}	V_{CC} = 2.7V, V_{NO}_ or V_{NC}_ =1.5V, R_L = 50Ω, C_L = 35pF, Figure 1	T_A = +25℃		20	30	ns
			T_A = T_{MIN} to T_{MAX}			50	
Turn-Off Time	T_{OFF}	V_{CC} = 2.7V, V_{NO}_ or V_{NC}_ =1.5V, R_L = 50Ω, C_L = 35pF, Figure 1	T_A = +25℃		15	40	ns
			T_A = T_{MIN} to T_{MAX}			50	
Break-Before-Make Time	t_{BBM}	V_{CC} = 2.7V, V_{NO}_ or V_{NC}_ =1.5V, R_L = 50Ω, C_L = 35pF,Figure2(6)	T_A = +25℃	2	15		ns
			T_A = T_{MIN} to T_{MAX}	2			
Charge Injection	Q	V_{GEN} = 0V, R_{GEN} = 0Ω, C_L = 1nF, Figure 3			100		pC
On-Channel Bandwidth -3dB	BW	R_L = 50Ω, Figure 4			100		MHz
Off-Isolation	V_{ISO}	V_{COM}_ = 1VRMS, R_L = 50Ω, f = 100kHz, C_L = 5pF, Figure 4(7)			-66		dB
Crosstalk	V_{CT}	V_{COM}_ = 1VRMS, R_L = 50Ω, f = 100kHz, C_L = 5pF, Figure 4(8)			-86		dB
Total Harmonic Distortion Plus Noise	THD+N	f = 20Hz to 20kHz; V_{NC}_, V_{NO}_, V_{COM}_ = 0.5VP-P; R_L = 32Ω			0.02		%
NC_ or NO_ Off-Capacitance	C_{NC}_(OFF), C_{NO}_(OFF)	f = 1MHz, V_{NO}_ = V_{NC}_ = V_{COM}_ = 1.5V, Figure 5			30		pF
COM_ On-Capacitance	C_{COM}_(ON)	f = 1MHz, V_{NO}_ = V_{NC}_ = V_{COM}_ = 1.5V, Figure 5			100		pF
Power-Supply Rejection Ratio	PSRR	V_{AC} = 100mVP-P, V_{COM}_ = 1.5V, R_L = 50Ω, f = 100kHz			-34		dB
DIGITAL INPUTS							
Input-Logic High	V_{IH}	V_{CC}=2.7V to 4.2V,		1.4			V
Input-Logic Low	V_{IL}					0.5	V
Input Leakage Current	I_{IN}	V_{IN}_ = 0 or V_{CC} ,				±1	uA

Note 2: Devices are 100% tested at TA = +25℃. Limits across the full temperature range are guaranteed by design and correlation.
Note 3: R_{ON} and RON matching specifications are guaranteed by design for BCT4699ETE only.
Note 4: $\Delta R_{ON} = R_{ON}(MAX) - R_{ON}(MIN)$.
Note 5: Flatness is defined as the difference between the maximum and minimum value of on-resistance, as measured over the specified analog signal ranges.
Note 6: Guaranteed by design, not production tested.
Note 7: Off-isolation = 20log10 [V_{COM}_ / (V_{NO}_ or V_{NC}_)], V_{COM}_ = output, V_{NO}_ or V_{NC}_ = input to off switch.
Note 8: Between any two switches.

0.5Ω, 3.3V Quad-SPDT Analog Switch

Timing Circuits/Timing Diagrams

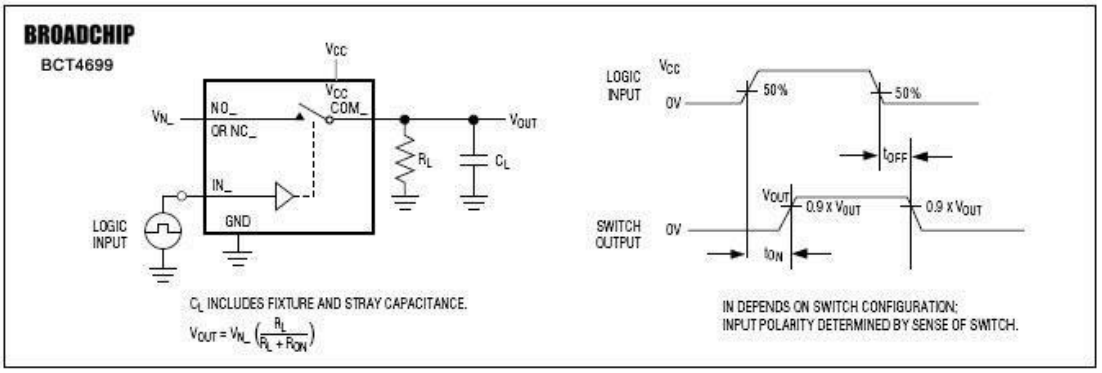


Figure 1. Switching Time

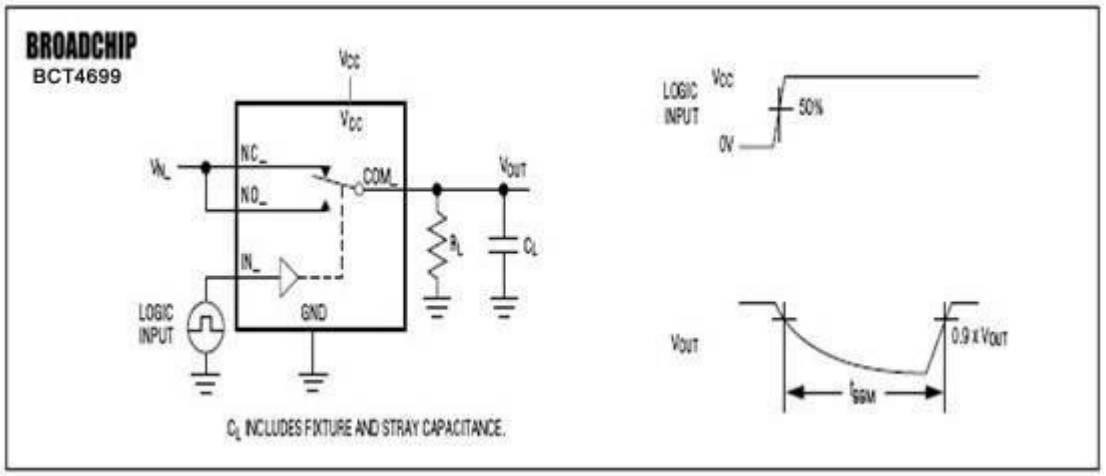


Figure 2. Break-Before-Make Interval

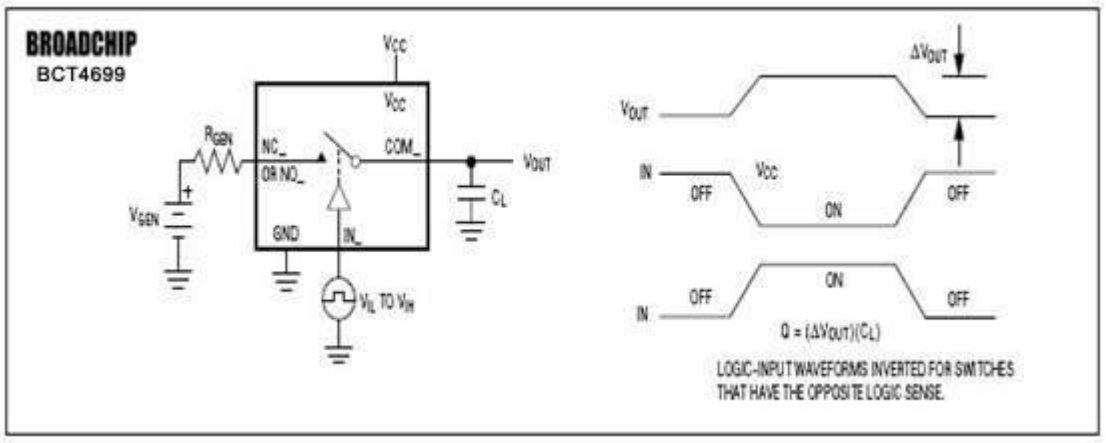


Figure 3. Charge Injection

0.5Ω, 3.3V Quad-SPDT Analog Switch

Timing Circuits/Timing Diagrams(continued)

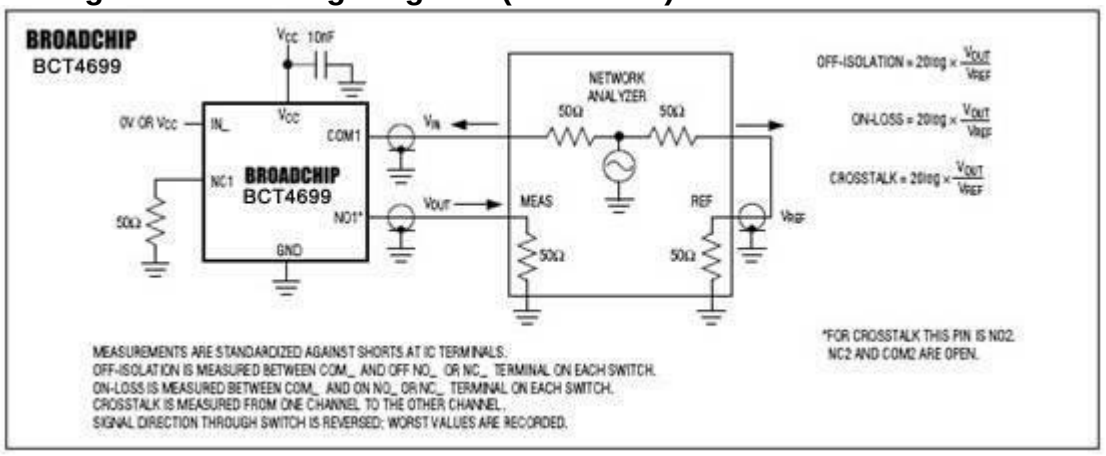


Figure 4. On-Loss, Off-Isolation, and Crosstalk

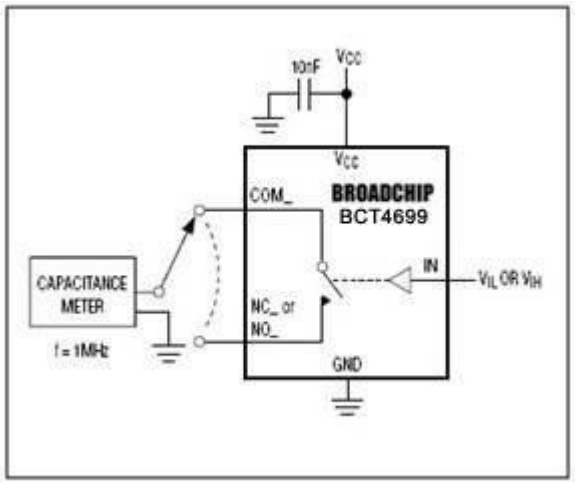


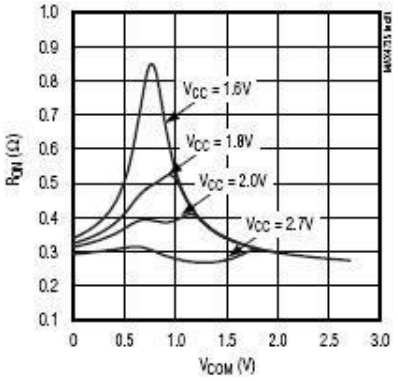
Figure 5. Channel On-/Off-Capacitance

0.5Ω, 3.3V Quad-SPDT Analog Switch

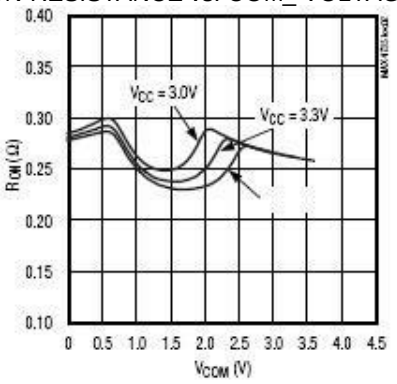
Typical Operating Characteristics

(VCC = 3V, TA = +25℃, unless otherwise noted.)

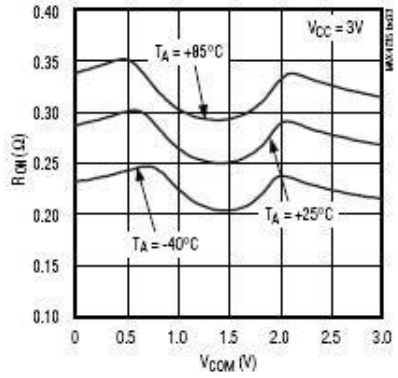
ON-RESISTANCE vs. COM_ VOLTAGE



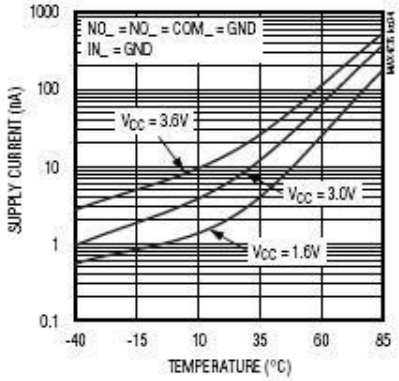
ON-RESISTANCE vs. COM_ VOLTAGE



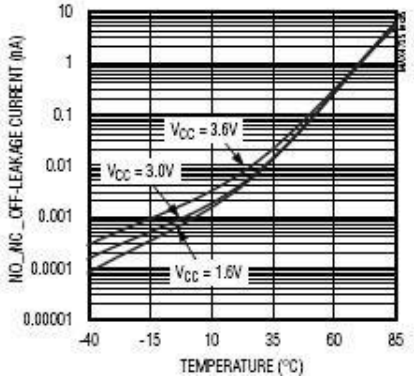
ON-RESISTANCE vs. COM_ VOLTAGE AND TEMPERATURE



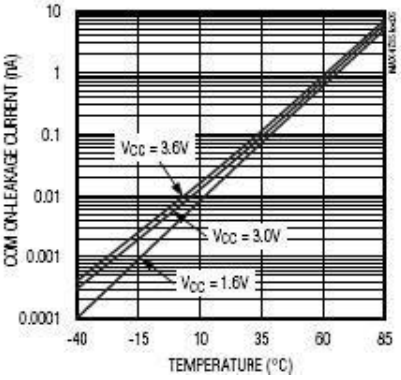
SUPPLY CURRENT vs. TEMPERATURE



NO_/NC_ OFF-LEAKAGE CURRENT vs. TEMPERATURE



COM_ ON-LEAKAGE CURRENT vs. TEMPERATURE



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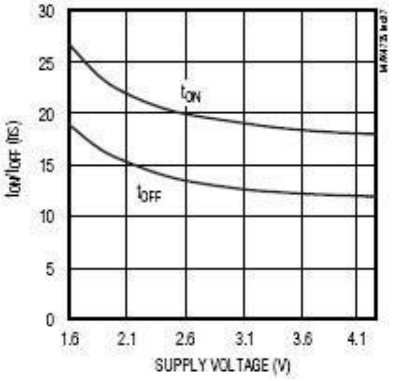
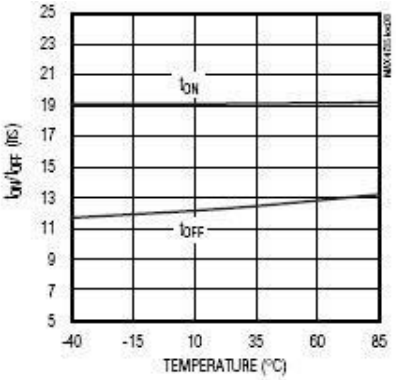
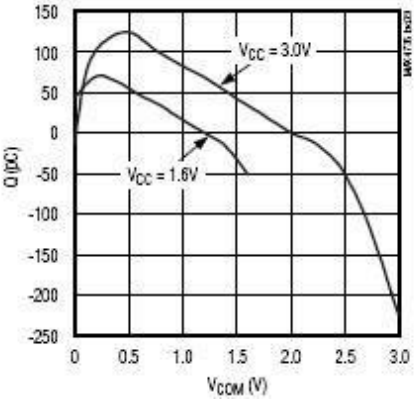
TURN-ON/OFF TIME vs. SUPPLY VOLTAGE



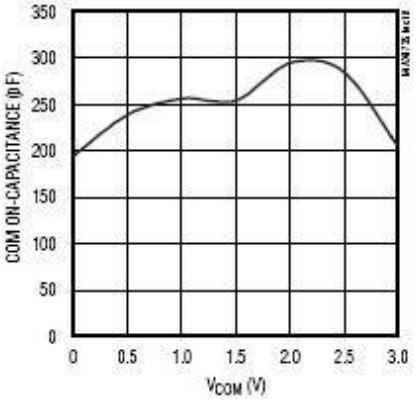
TURN-ON/OFF TIME vs. TEMPERATURE



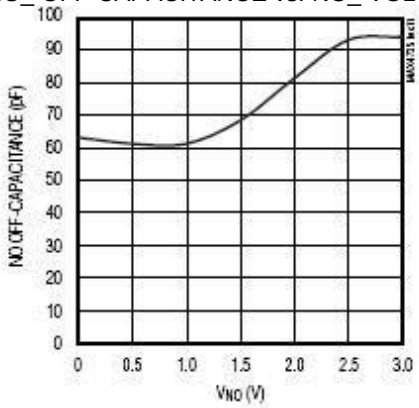
CHARGE INJECTION vs. COM_ VOLTAGE



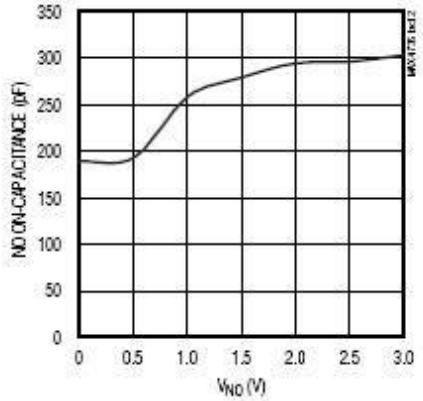
COM_ ON-CAPACITANCE vs. COM_ VOLTAGE



NO_ OFF-CAPACITANCE vs. NO_ VOLTAGE



NO_ ON-CAPACITANCE vs. NO_ VOLTAGE



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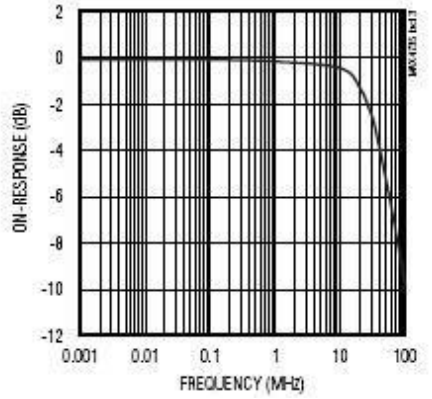
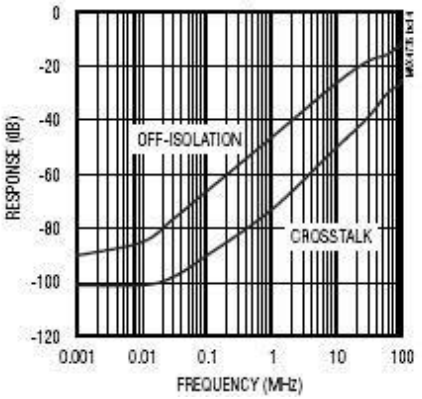
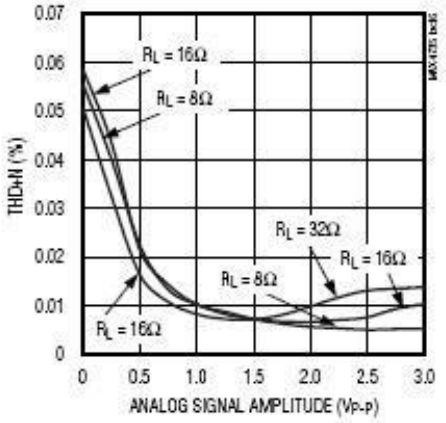
ON-RESPONSE vs. FREQUENCY



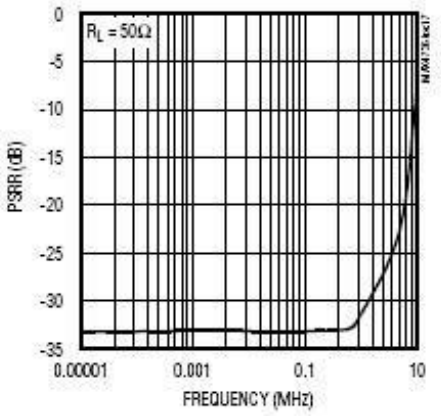
OFF-ISOLATION AND CROSSTALK vs. FREQUENCY



TOTAL HARMONIC DISTORTION PULSE NOISE vs. SIGNAL AMPLITUDE



POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



Pin Description

Pin	Name	Function
15	NO1	Normally Open Terminal Switch 1
16	COM1	Common Terminal Switch 1
1	NC1	Normally Closed Terminal Switch 1
2	INA	Select Input, control switch 1 and switch 2
3	NO2	Normally Open Terminal Switch 2
4	COM2	Common Terminal Switch 2
5	NC2	Normally Closed Terminal Switch 2
6	GND	Ground
7	NO3	Normally Open Terminal Switch 3
8	COM3	Common Terminal Switch 3
9	NC3	Normally Closed Terminal Switch 3
10	INB	Select Input, control switch 3 and switch 4
11	NO4	Normally Open Terminal Switch 4
12	COM4	Common Terminal Switch 4
13	NC4	Normally Closed Terminal Switch 4
14	VCC	Positive Power Supply

0.5Ω, 3.3V Quad-SPDT Analog Switch

Detailed Description

The BCT4699 quad-SPDT analog switch operates from a single +2.5V to +5.0V supply. These devices are fully specified for +3V applications. The BCT4699 features fully bidirectional, rail-to-rail CMOS analog switch channels. They can be configured as dual-DPDT switches, dual 4:2 multiplexers/de-multiplexers, or as a single 8:4 multiplexer/de-multiplexer.

Applications Information

As seen in the Typical Operating Characteristics, the on-resistance of the BCT4699 is inversely proportional to the supply voltage. Best performance is obtained by using the highest supply voltage available within the +2.5V to +5.0V range.

Digital Logic Inputs

Digital control inputs INA and INB control the position of the switches in the BCT4699. These inputs are diode clamped to GND only. It is acceptable to leave these pins driven in the absence of a V_{CC} power supply.
For best performance, drive INA and INB to the full supply voltage range of the BCT699.
The two switch sections of the BCT4699 operate independently. Drive INA low to connect COM1 to NC1 and connect COM2 to NC2. Drive INA high to connect COM1 to NO1 and connect COM2 to NO2. Drive INB low to connect COM3 to NC3 and connect COM4 to NC4. Drive INB high to connect COM3 to NO3 and connect COM4 to NO4. See Table 1.

INA and INB have typical hysteresis of 100mV by including positive feedback in the internal buffer. Thus, for applications using DC or very slow ramp rate of the digital input voltage level, connect a 100pF capacitor from IN_ to GND to limit the I_{CC} current at the trip point. The switching point is typically 0.7V between V_{IL} and V_{IH} levels.

Power Supply The BCT4699 operates from a +2.5V to +5.0V power supply. For best results, bypass V_{CC} to GND with a 0.1µF ceramic chip capacitor located close to the IC.

Audio Signal Routing The BCT4699's low R_{ON} makes it an excellent choice for multiplexing loudspeakers in portable equipment. THD performance is inversely proportional to load impedance. Within the audio signal range, there is no frequency component to THD. The only distortion mechanism is the R_{ON} flatness' modulation of the signal into a load. Therefore, for best distortion performance, use higher impedance transducers.

Analog Signal Range The CMOS switches in the BCT4699 function on any signal within the power-supply voltages. If any channel exceeds V_{CC}, it is clamped to V_{CC} by a silicon diode. If any channel goes below GND, it is clamped to GND by a silicon diode. Ensure that if either of these diodes becomes forward biased, the continuous and peak cur-rents do not exceed those listed in the Absolute maximum Ratings section of this data sheet.

Table 1. Truth Table

INA	INB	SWITCH 1 AND SWITCH 2 STATE	SWITCH 3 AND SWITCH 4 STATE
0	—	COM1 to NC1 COM2 to NC2	—
1	—	COM1 to NO1 COM2 to NO2	—
—	0	—	COM3 to NC3 COM4 to NC4
—	1	—	COM3 to NO3 COM4 to NO4

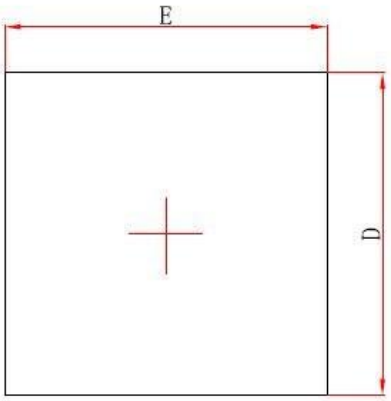
Each switch channel on the BCT4699 has an absolute maximum rating 300mA continuous current, and 400mA peak current at 50% duty cycle. When driving low-impedance loudspeakers, the peak signal amplitude should be limited so these peak currents are not exceeded. For an 8Ω load, this corresponds to $2.3V_{RMS}$. For a 4Ω load, this is $1.1V_{RMS}$.

Package Information

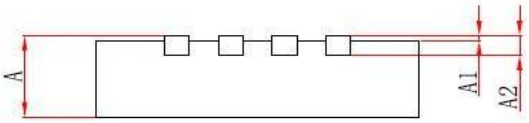
The BCT4699 is offered in 16-pin 3mm x 3mm x 0.8mm TQFN packages. The mechanical drawings for these packages are located at the end of this data sheet.
The TQFN package is rated for a peak power dissipation of 1.25W at +70°C, with a θJA of 64℃/W on a single-layer PC board.

0.5Ω, 3.3V Quad-SPDT Analog Switch

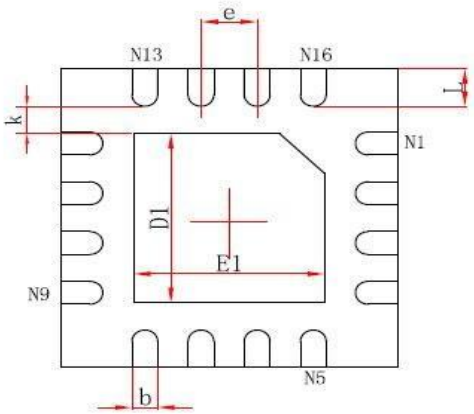
Packaging Mechanical: 16-Pin TQFN



Top VIew



Side View



Bottom View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A2	0.153	0.253	0.006	0.010
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
D1	1.600	1.800	0.063	0.071
E1	1.600	1.800	0.063	0.071
k	0.200MIN.		0.008MIN.	
b	0.180	0.300	0.007	0.012
e	0.500TYP.		0.500TYP.	
L	0.300	0.500	0.012	0.020