

## Dual DPDT Ultra-Low $R_{ON}$ Analog Switch

### UM3699/UM3699A QFN16 3×3

#### General Description

The UM3699/UM3699A are dual independent ultra low  $R_{ON}$  DPDT analog switches. These devices are designed for low operating voltage, high current switching of speaker output for cell phone applications. They can switch a balanced stereo output and can handle a balanced microphone/speaker/ring-tone generator in a monophone mode. The UM3699 has a 3.8K $\Omega$  internal shunt resistors that automatically discharge the capacitance at the normally open (NO) and normally closed (NC) terminals when they are not connected. This reduces click-and-pop noises that occur when switching audio signals between precharged points. The UM3699A has no internal shunt resistors, which make it compatible for switching data lines that keep a specific voltage when the NO or NC terminals are not connected, avoiding power loss on the shunt resistors. Both devices have a break-before-make feature that further reduces popping.

#### Applications

Cell Phone Speaker/Microphone Switching  
 Ring-tone Chip/Amplifier Switching  
 Four Unbalanced (Single-Ended) Switches  
 Stereo Balanced (Push-Pull) Switching

#### Features

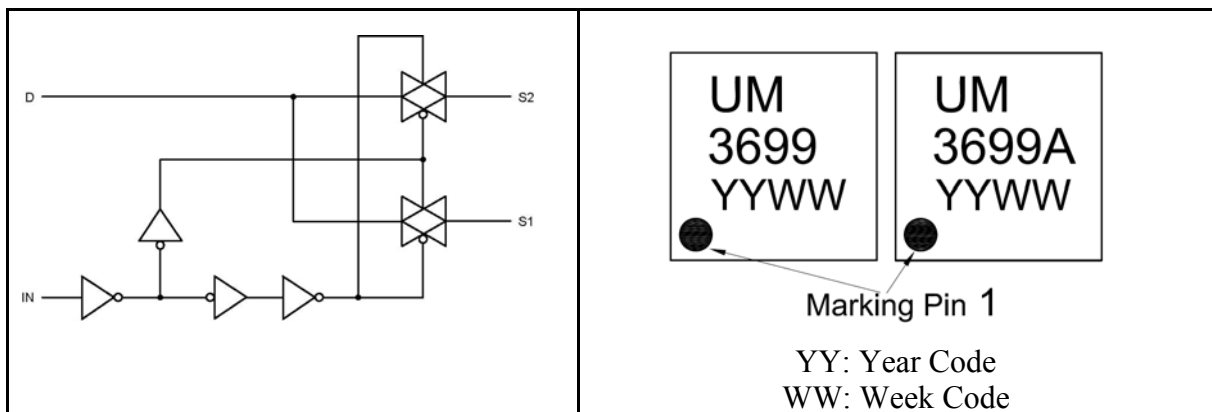
Single Supply Operation: 1.65 to 5.5 V  $V_{CC}$   
 Function Directly from Battery  
 Maximum Breakdown Voltage: 6 V  
 Tiny 3x3mm QFN16 Pb-Free Package  
 Low Static Power  
 This is a Pb-Free Device  
 Internal Shunt Resistors Reduce Click-and-pop Noises (UM3699 only)

#### Important Information

ESD Protection: HBM (Human Body Model) > 4000 V MM (Machine Model) > 400 V  
 Continuous Current Rating Through each Switch  $\pm$ 300 mA  
 Conforms to: JEDEC MO-220, Issue H,

#### Pin Configurations

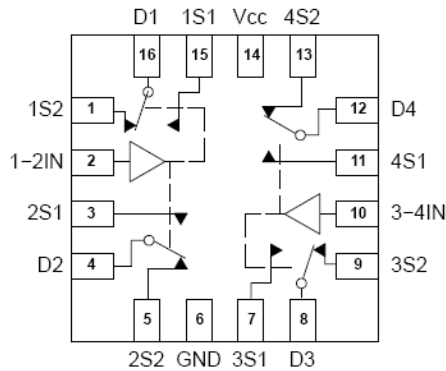
#### Top View



#### Ordering Information

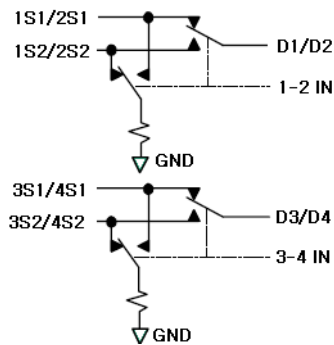
Device Order Number	Package Type	Marking ID	Tape & Reel Size
UM3699	QFN16 (Pb-Free)	UM3699	3000Units/13 Inch Reel
UM3699A	QFN16 (Pb-Free)	UM3699A	3000Units/13 Inch Reel

## Pin Configuration & Description

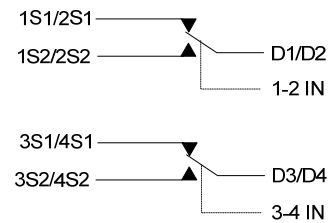


QFN PIN	Symbol	Name and Function
1, 3, 5, 7, 9, 11, 13, 15	1S1 to 4S1, 1S2 to 4S2	Independent Channels
2, 10	1-2IN, 3-4IN	Controls
4, 8, 12, 16	D1 to D4	Common Channels
6	GND	Ground (V)
14	V <sub>CC</sub>	Positive Supply Voltage

### Internal Diagram of UM3699



### Internal Diagram of UM3699A



### Truth Table

IN	S1	S2
H	ON	OFF
L	OFF	ON

## Maximum Ratings

Symbol	Parameter	Value	Unit
$V_{CC}$	Positive DC Supply Voltage	-0.5 to +5.5	V
$V_{IS}$	Analog Input Voltage ( $V_{NO\_}$ , $V_{NC\_}$ , or $V_{COM\_}$ )	$-0.5 \leq V_{IS} \leq V_{CC}$	V
$V_{IN}$	Digital Select Input Voltage	$-0.5 \leq V_I \leq 5.5$	V
$I_{anlI}$	Continuous DC Current from COM to NC/NO	$\pm 300$	mA
$I_{anl-pk}$	Peak Current from COM to NC/NO, 10 duty cycle (Note 1)	$\pm 500$	mA
$I_{clmp}$	Continuous DC Current into COM/NO/NC with respect to $V_{CC}$ or GND	$\pm 100$	mA
$t_r, t_f$	Input Rise or Fall Time, $V_{CC} = 3.0\text{ V} - 4.5\text{ V}$	0   10	ns/V

## Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
$V_{CC}$	DC Supply Voltage	1.65	5.5	V
$V_{IN}$	Digital Select Input Voltage	GND	$V_{CC}$	V
$V_{IS}$	Analog Input Voltage (NC, NO, COM)	GND	$V_{CC}$	V
$T_A$	Operating Temperature Range	-40	+85	°C
$t_r, t_f$	Input Rise or Fall Time, $V_{CC} = 3.0\text{ V} - 4.5\text{ V}$	0	10	ns/V

## DC Characteristics – Digital Section (Voltages Referenced to GND)

Symbol	Parameter	Condition	$V_{CC}$	Guaranteed Limit		Unit
				-40°C to 25°C	85°C	
$V_{IH}$	Minimum High Level Input Voltage, Select Inputs		1.8	1.2	1.2	V
			2.5	1.7	1.7	
			3.6	2.8	2.8	
$V_{IL}$	Maximum Low Level Input Voltage, Select Inputs		1.8	0.4	0.4	V
			2.5	0.5	0.5	
			3.6	1.0	1.0	
$I_{IN}$	Maximum Input Leakage Current, Select Inputs	$V_{IN} = V_{CC}$ or GND	3.6	0.1	1.0	$\mu\text{A}$
$I_{OFF}$	Power Off Leakage Current	$V_{IN} = V_{CC}$ or GND	0	0.5	2.0	$\mu\text{A}$
$I_{CC}$	Maximum Quiescent Supply Current(Note 1)	Select and $V_{IS} = V_{CC}$ or GND	1.65 to 5.5	1.0	2.0	$\mu\text{A}$

## DC Electrical Characteristics – Analog Section

Symbol	Parameter	Condition	V <sub>CC</sub>	Guaranteed Maximum Limit				Unit
				-40°C to 25°C		85°C		
				Min	Max	Min	Max	
R <sub>ON</sub>	NC/NO On Resistance (Note 1)	V <sub>IN</sub> ≤ V <sub>IL</sub> or V <sub>IN</sub> ≥ V <sub>IH</sub> V <sub>IS</sub> = GND to V <sub>CC</sub> , I <sub>INI</sub> ≤ 100 mA	2.5		0.65		0.75	Ω
			3.0		0.6		0.75	
			3.6		0.55		0.7	
R <sub>FLAT</sub>	NC/NO On Resistance Flatness(Notes 1, 3)	I <sub>COM</sub> = 100 mA V <sub>IS</sub> = 0 to V <sub>CC</sub>	2.5		0.15		0.15	Ω
			3.0		0.15		0.15	
			3.6		0.15		0.15	
ΔR <sub>ON</sub>	On-Resistance Match Between Channels (Notes 1 and 2)	V <sub>IS</sub> = 1.3 V; I <sub>COM</sub> = 100 mA	2.5		0.06		0.06	Ω
			3.0		0.05		0.05	
			3.6		0.05		0.05	
I <sub>NC(OFF)</sub> I <sub>NO(OFF)</sub>	NC or NO Off Leakage Current (Note 1)	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>COM</sub> = 3.3 V	3.6	-5	5	-10	10	nA
I <sub>COM(ON)</sub>	COM ON Leakage Current (Note 1)	V <sub>IN</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>COM</sub> = 0.3V/3.3V V <sub>NO</sub> or V <sub>NC</sub> = 0.3V/3.3V or floating	3.6	-10	10	-100	100	nA

1. Guaranteed by design. Resistance measurements do not include test circuit or package resistance.
2.  $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$  between nS1 or nS2.
3. Flatness is defined as the difference between the maximum and minimum value of on resistance as measured over the specified analog signal ranges.

## AC Electrical Characteristics (Input $t_r = t_f = 3.0$ ns)

Symbol	Parameter	Test Conditions	$V_{CC}$ (V)	$V_{IS}$ (V)	Guaranteed Maximum Limit		Unit
					-40°C to 25°C	85°C	
$t_{ON}$	Turn-On Time	$R_L = 50\Omega$ , $C_L = 35$ pF (Figure 2&3)	2.3 – 4.5	1.5	50	60	ns
$t_{OFF}$	Turn-Off Time	$R_L = 50\Omega$ , $C_L = 35$ pF (Figure 2&3)	2.3 – 4.5	1.5	30	40	ns
$t_{BBM}$	Minimum Break-Before-Make Time	$V_{IS} = 3.0$ $R_L = 50\Omega$ , $C_L = 35$ pF (Figure 1)	3.0	1.5	15	15	ns

		Typical @ 25, $V_{CC} = 4.5$ V	
$C_{IN}$	Control Pin Input Capacitance	7.0	pF
$C_{SN}$	Sn Port Capacitance	72	pF
$C_D$	D Port Capacitance When Switch is Enabled	230	pF

## Additional Application Characteristics (Voltages Referenced to GND Unless Noted)

Symbol	Parameter	Condition	$V_{CC}$ (V)	Typical	Unit
BW	Maximum On-Channel -3dB Bandwidth or Minimum Frequency Response (Figure 11)	$V_{IN}$ centered between $V_{CC}$ and GND (Figure 4)	1.65 – 4.5	70	MHz
$V_{ONL}$	Maximum Feed-through On Loss	$V_{IN} = 0$ dBm @ 100 kHz to 50 MHz $V_{IN}$ centered between $V_{CC}$ and GND (Figure 4)	1.65 – 4.5	-0.06	dB
$V_{ISO}$	Off-Channel Isolation (Figure 12)	$f = 100$ kHz; $V_{IS} = 1$ V RMS; $C_L = 5$ pF $V_{IN}$ centered between $V_{CC}$ and GND (Figure 4)	1.65 – 4.5	-62	dB
Q	Charge Injection Select Input to Common I/O (Figure 7)	$V_{IN} = V_{CC}$ to GND, $R_{IS} = 0\Omega$ , $C_L = 1$ nF $Q = C_L \times V_{OUT}$ (Figure 5)	1.65 – 4.5	50	pC
THD	Total Harmonic Distortion THD + Noise (Figure 6)	$F_{IS} = 20$ Hz to 20 kHz, $R_L = R_{gen} = 600\Omega$ , $C_L = 50$ pF $V_{IS} = 2$ V <sub>PP</sub>	4.5	0.01	%
$V_{CT}$	Channel-to-Channel Crosstalk	$f = 100$ kHz; $V_{IS} = 1$ V RMS, $C_L = 5$ pF, $R_L = 50\Omega$ $V_{IN}$ centered between $V_{CC}$ and GND (Figure 4)	1.65 – 4.5	-62	dB

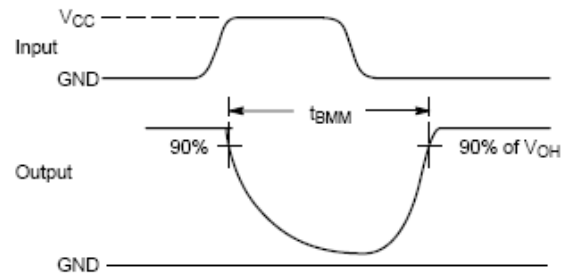
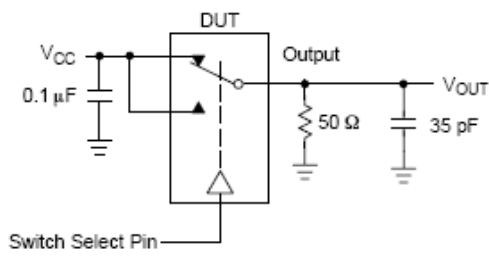


Figure 1.  $t_{BMM}$  (Time Break-Before-Make)

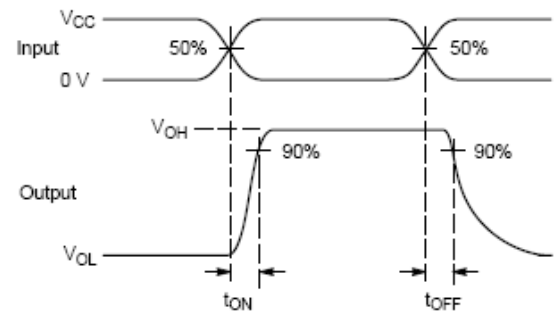
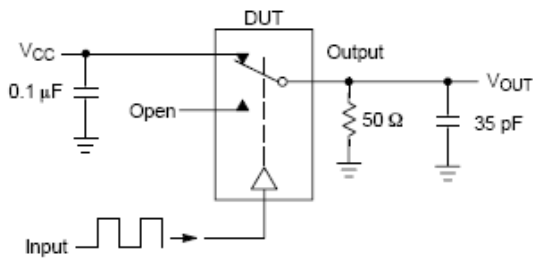


Figure 2.  $t_{ON}/t_{OFF}$

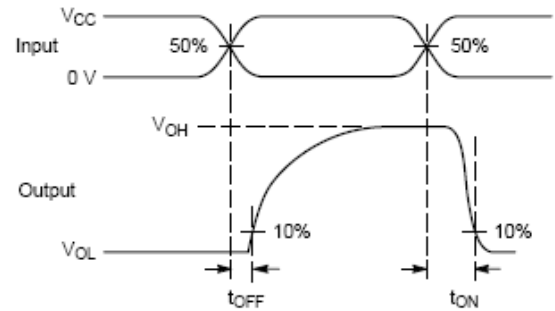
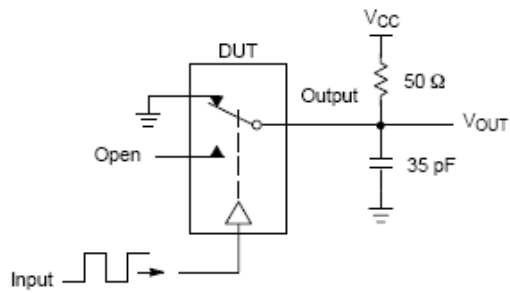
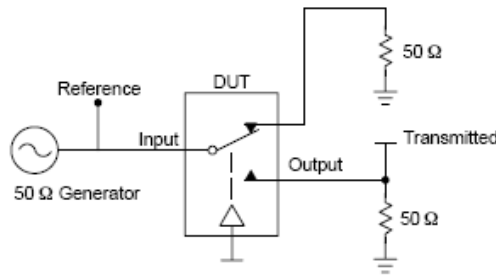


Figure 3.  $t_{ON}/t_{OFF}$



Channel switch control/s test socket is normalized. Off isolation is measured across an off channel. On loss is the bandwidth of an On switch.  $V_{ISO}$ , Bandwidth and  $V_{ONL}$  are independent of the input signal direction.

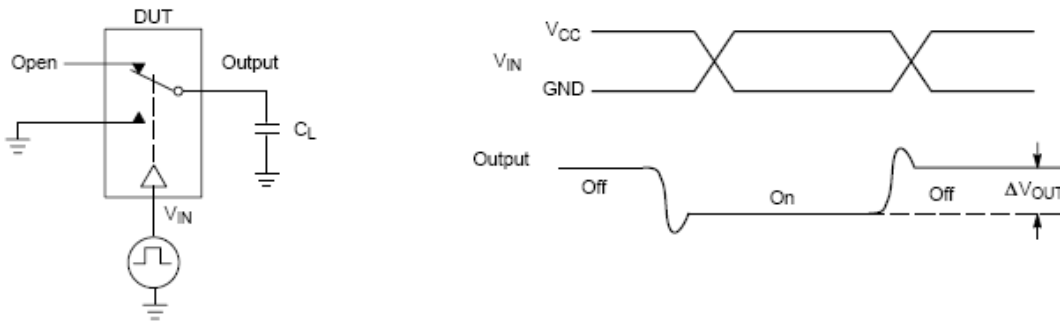
$$V_{ISO} = \text{Off Channel Isolation} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz}$$

$$V_{ONL} = \text{On Channel Loss} = 20 \text{ Log} \left( \frac{V_{OUT}}{V_{IN}} \right) \text{ for } V_{IN} \text{ at } 100 \text{ kHz to } 50 \text{ MHz}$$

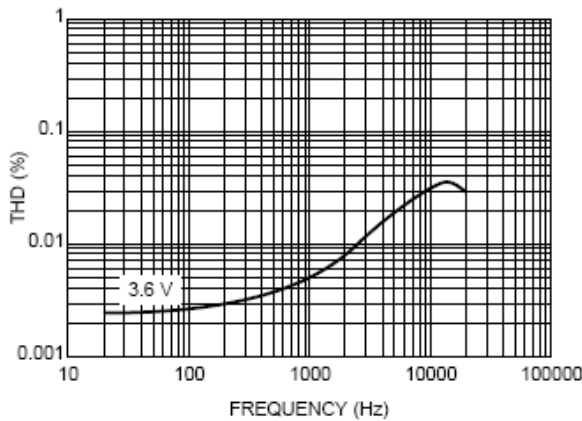
Bandwidth (BW) = the frequency 3 dB below  $V_{ONL}$

$V_{CT}$  = Use  $V_{ISO}$  setup and test to all other switch analog input/outputs terminated with 50  $\Omega$

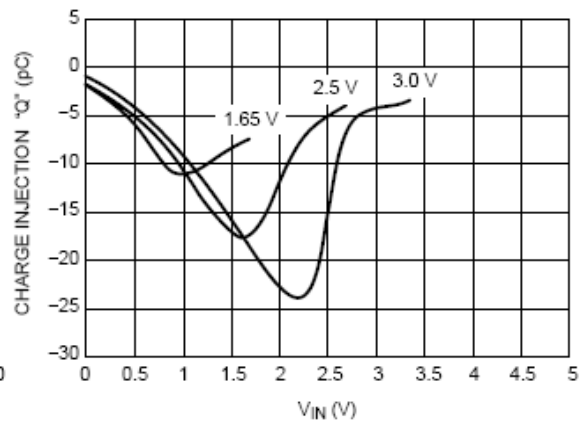
**Figure 4. Off Channel Isolation/On Channel Loss (BW)/Crosstalk (On Channel to Off Channel)/ $V_{ONL}$**



**Figure 5. Charge Injection: (Q)**



**Figure 6. Total Harmonic Distortion Plus Noise Versus Frequency**



**Figure 7. Charge Injection versus  $V_{IS}$**

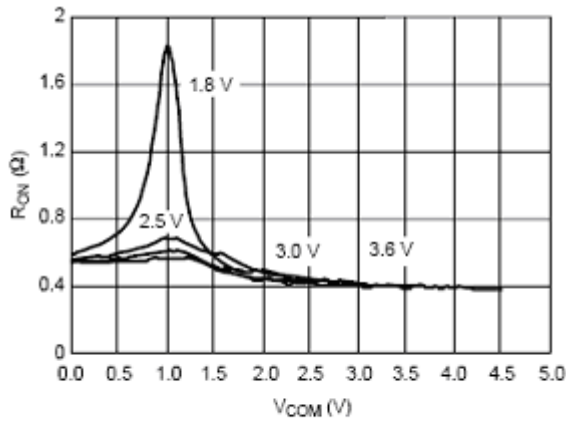


Figure 8. On-Resistance vs. COM Voltage

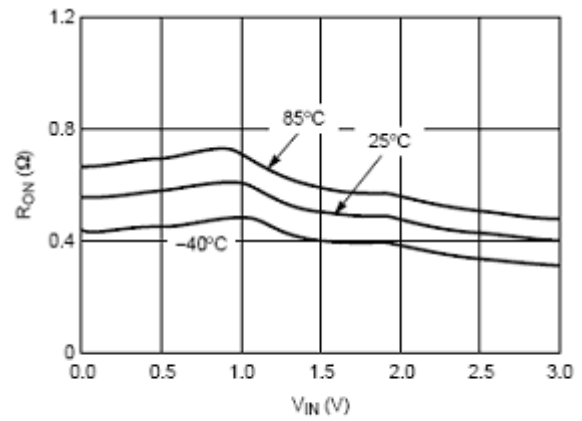


Figure 9.  $R_{ON}$  vs.  $V_{IN}$  vs. Temperature @  $V_{CC} = 3.0\text{ V}$

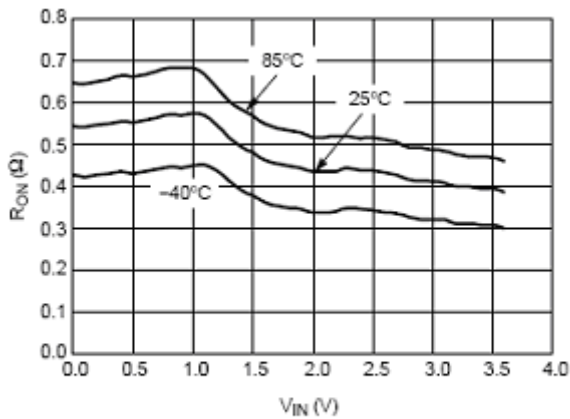


Figure 10.  $R_{ON}$  vs.  $V_{IN}$  vs. Temperature @  $V_{CC} = 3.6\text{ V}$

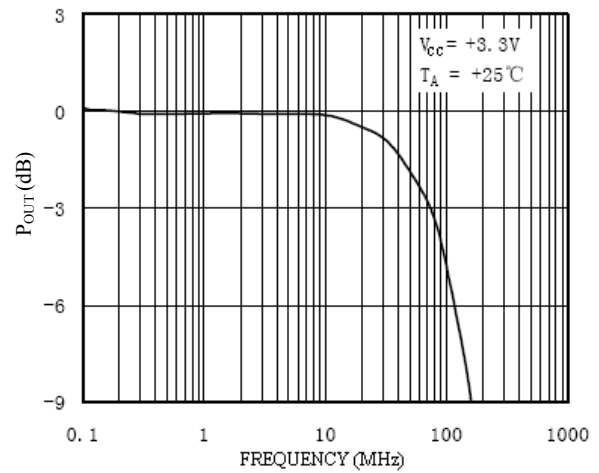


Figure 11. Bandwidth vs. Frequency

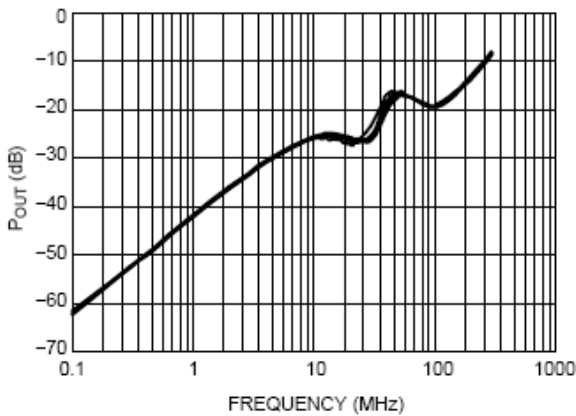


Figure 12. Off-Isolation vs. Frequency @  $V_{CC} = 1.65\text{ V to }3.6\text{ V}$

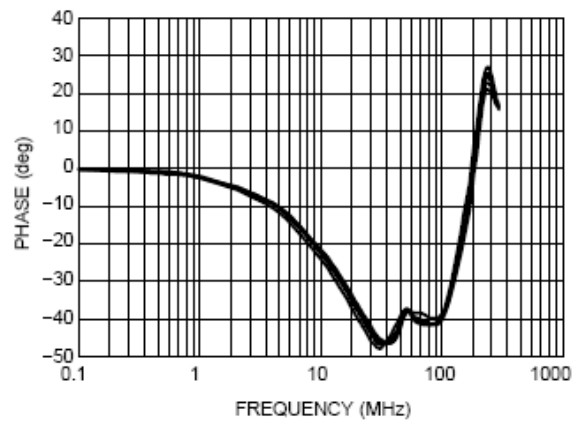
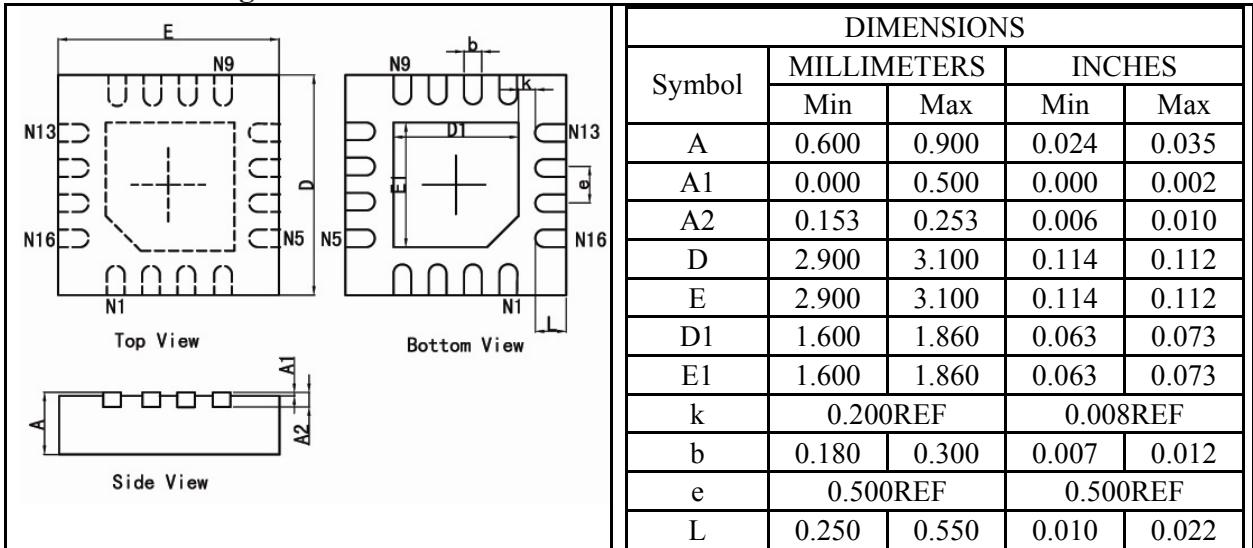


Figure 13. Phase Angle vs. Frequency @  $V_{CC} = 1.65\text{ V to }3.6\text{ V}$

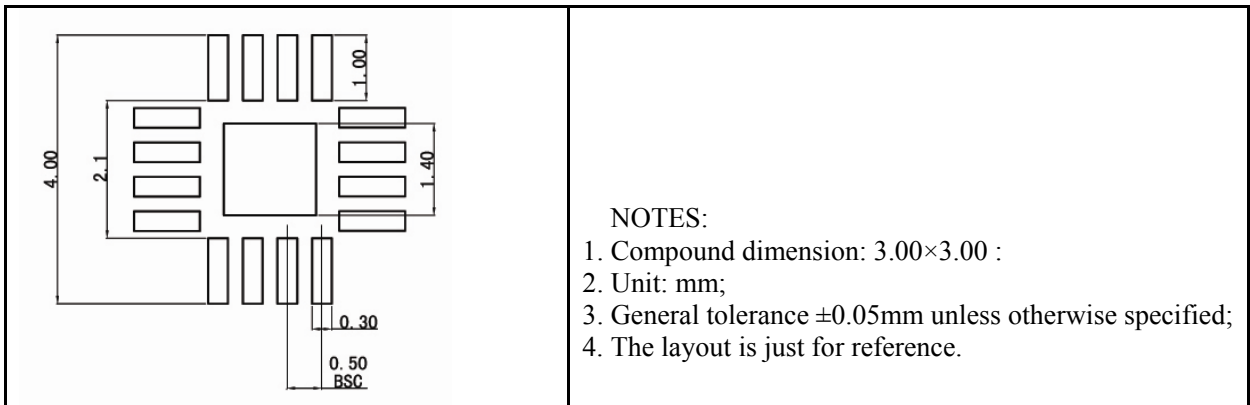
## Package Information

### UM3699/UM3699A QFN16 3×3

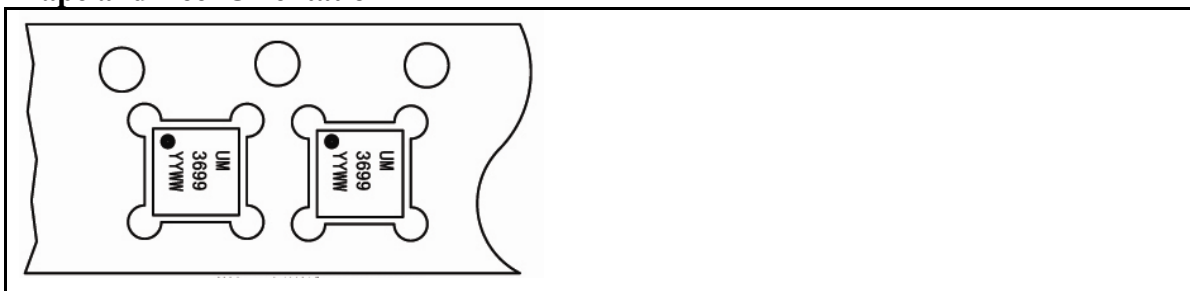
#### Outline Drawing



#### Land Pattern



#### Tape and Reel Orientation



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