

**FEATURES**

- Integrated Monolithic GaAs Upconverter
- Designed for Digital and Analog TV Tuners
- Very Low Oscillator Phase Noise
- Low Noise Figure and Low Distortion
- Low Power Consumption
- Small Size
- Can be Shut Down Remotely
- Operates from 5 Volt Power Supply
- High Reliability

**APPLICATIONS**

- CATV/TV Tuners
- Cable Modem Tuners

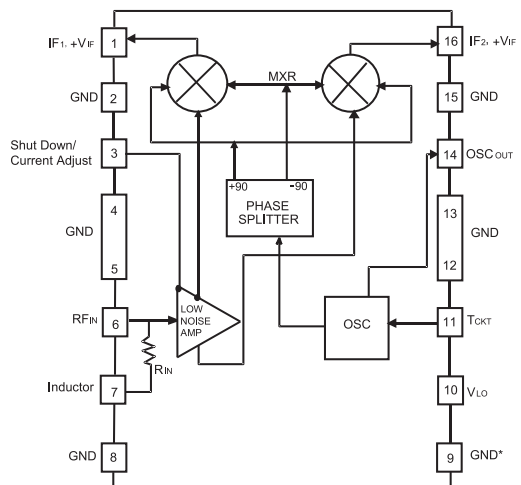


**PRODUCT DESCRIPTION**

The ACU2109 is a Monolithic GaAs IC incorporating all upconverter functions of a double conversion CATV, Cable Modem and TV tuner: gain block, oscillator and a double balanced mixer. The oscillator is optimized to meet the stability and phase noise requirements of 256QAM Digital TV, while the amplifier and mixer retain the low distortion necessary for Analog signals.

This upconverter IC is well suited for double conversion tuner designs in which small size and high performance for both Digital and Analog TV signals is important. It allows tuner manufacturers to reduce costs by lowering component count and dispensing with labor intensive production alignment steps, while improving performance and reliability.

The part is offered in a low profile 16-lead modified SOIC package, and it requires only a single +5 Volt power supply.



\* Varactor return. Do not connect to common ground

**Figure 1: Functional Block Diagram**

Table 1: Pin Description

PIN	NAME	DESCRIPTION	PIN	NAME	DESCRIPTION
1	IF <sub>1</sub> , V <sub>IF</sub>	Balanced IF output and supply	16	IF <sub>2</sub> , V <sub>IF</sub>	Balanced IF output and supply
2	GND	Ground	15	GND	Ground
3	V <sub>BIAS</sub>	Shut down/current adjust	14	OSC <sub>OUT</sub>	Oscillator output to Prescaler
4	GND	Ground	13	GND	Ground
5	GND	Ground	12	GND	Ground
6	RF <sub>IN</sub>	RF Input	11	T <sub>CKT</sub>	Oscillator tank circuit
7	I <sub>BIAS</sub>	Current Bias	10	V <sub>LO</sub>	Oscillator supply
8	GND	Ground	9	VC <sub>RTN</sub>	Varactor return

## ELECTRICAL CHARACTERISTICS

Table 2: Absolute Minimum and Maximum Ratings

PARAMETER	MIN	MAX	UNIT
V <sub>IF</sub> , V <sub>LO</sub> , V <sub>OSC</sub> (Pins 1, 10, 14 & 16)	0	+9	VDC
V <sub>RF</sub> /V <sub>TUNE</sub> (Pins 6 & 11)	-	0	VDC
RF Input Voltage	-	+60	dBmV
Storage Temperature	-55	+200	°C
Soldering Temperature	-	+260	°C
Soldering Time	-	5	Sec.

Stresses in excess of the absolute ratings may cause permanent damage. Functional operation is not implied under these conditions. Exposure to absolute ratings for extended periods of time may adversely affect reliability.

Table 3: Operating Ranges

PARAMETER	MIN	TYP	MAX	UNIT
Frequency				
RF	50	-	860	MHz
IF	900	-	1200	
LO	950	-	2060	
V <sub>IF</sub>	+4.70	+5.0	+5.25	VDC
V <sub>LO</sub>	+4.70	+5.0	+5.25	VDC
Tuning Voltage	+1.0	-	+27	V
Shutdown Voltage (Pin 3)	-	-2	-	V
Ambient Operating Temperature T <sub>A</sub> <sup>(1)</sup>	-40	-	+85	°C

The device may be operated safely over these conditions; however, parametric performance is guaranteed only over the conditions defined in the electrical specifications.

Notes:

(1) Case temperature is 15 °C higher than Ambient Temperature, when Ambient Temperature is ≤ +65 °C, using PC Board Layout shown in Figures 19 - 20.

**Table 4: DC Electrical Specifications**  
( $T_A = +25\text{ }^\circ\text{C}^{(1)}$ ,  $V_{DD} = +5\text{ VDC}$ )

PARAMETER	MIN	TYP	MAX	UNIT
IF Supply Current (Pins 1 & 16)	-	72	85	mA
LO Supply Current (Pin 10)	-	82	95	mA
Power Consumption	-	770	900	mW
Thermal Resistance	-	-	25	$^\circ\text{C}/\text{W}$

Notes:

(1) Case temperature is  $15\text{ }^\circ\text{C}$  higher than Ambient Temperature, when Ambient Temperature is  $\leq +65\text{ }^\circ\text{C}$ , using PC Board Layout shown in Figures 19 - 20.

**Table 5: AC Electrical Specifications**  
( $T_A = +25\text{ }^\circ\text{C}^{(8)}$ ,  $V_{DD} = +5\text{ VDC}$ )

PARAMETER	MIN	TYP	MAX	UNIT
Conversion Gain <sup>(1)</sup>	6.0	8.0	10	dB
Gain Flatness <sup>(1)</sup>	-	0.8	-	dB
SSB Noise Figure <sup>(1)</sup>	-	6.5	8.0	dB
CSO <sup>(2), (4)</sup> CSO <sup>(3), (4)</sup>	-	-66 -62	-59 -57	dBc
CTB <sup>(2), (4)</sup> CTB <sup>(3), (4)</sup>	-	-68 -68	-66 -66	dBc
AM Cross Modulation <sup>(2), (4), (5)</sup> AM Cross Modulation <sup>(3), (4), (5)</sup>	-	-70 -65	-60 -60	dBc
2-Tone 2nd Order Input IP <sup>(6)</sup>	-	+95	-	dBmV
2-Tone 3rd Order Input IP <sup>(6)</sup>	-	+70	-	dBmV
LO Phase Noise at 10 kHz Offset <sup>(4), (7)</sup>	-	-89	-84	dBc/Hz
LO Power to Prescaler	-1	+2.5	-	dBm
LO to RF Leakage	-	+20	-	dBmV
LO to IF Leakage	-	+34	-	dBmV

Notes:

(1) As measured on ANADIGICS Evaluation Board shown in Figures 19 - 20.

(2) 138 channels, 0 dB tilt, +7 dBmV flat

(3) 138 channels, -10 dB tilt, +7 dBmV at 55.25 MHz

(4) As measured in ANADIGICS test fixture, using Anaren 3 dB 180° coupler (part no. 30055) and external bias-tees.

(5) All channels 99% AM modulated at 15 kHz, including adjacents

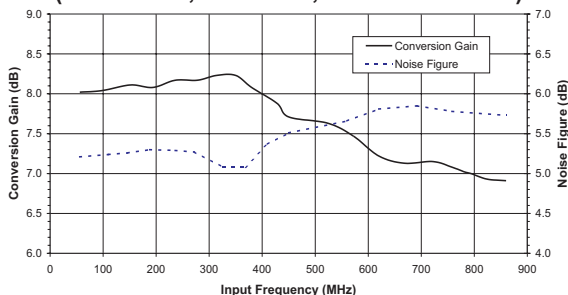
(6) Two tones, -15 dBm (+33.75 dBmV) each

(7) At 250 kHz comparison frequency, 3 kHz loop bandwidth

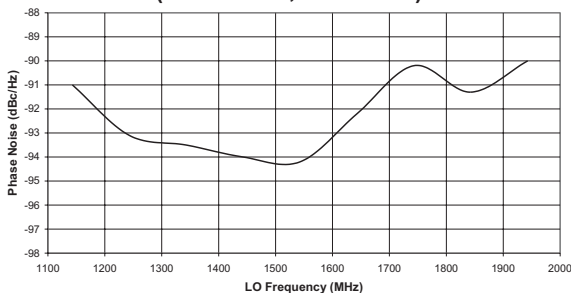
(8) Case temperature is  $15\text{ }^\circ\text{C}$  higher than Ambient Temperature, when Ambient Temperature is  $\leq +65\text{ }^\circ\text{C}$ , using PC Board Layout shown in Figures 19 - 20.

PERFORMANCE DATA

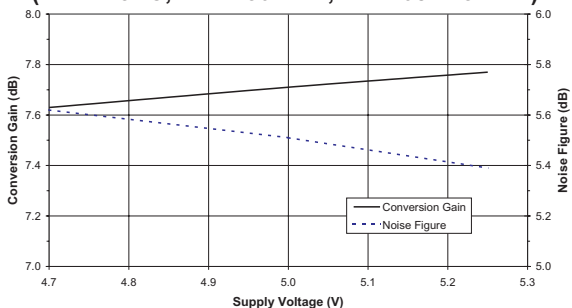
**Figure 2: Typical Conversion Gain and Noise Figure vs. Input Frequency**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ ,  $f_{IF} = 1087.75\text{ MHz}$ )



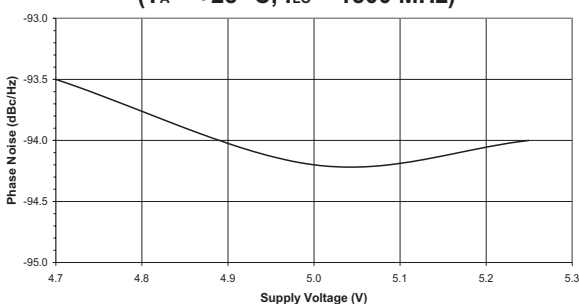
**Figure 3: Typical Phase Noise at 10 kHz Offset vs. LO Frequency**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ )



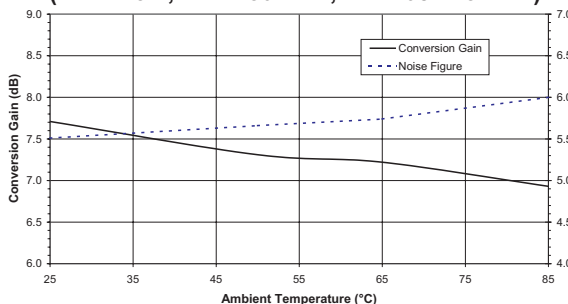
**Figure 4: Typical Conversion Gain and Noise Figure vs. Supply Voltage**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $f_{RF} = 450\text{ MHz}$ ,  $f_{IF} = 1087.75\text{ MHz}$ )



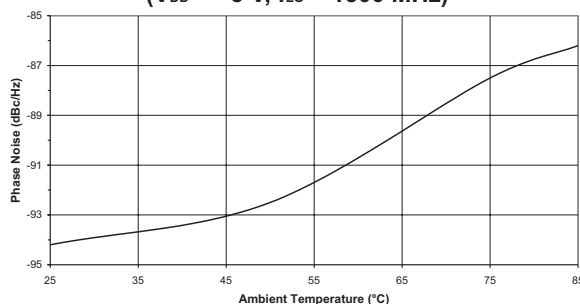
**Figure 5: Typical Phase Noise at 10 kHz Offset vs. Supply Voltage**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $f_{LO} = 1500\text{ MHz}$ )



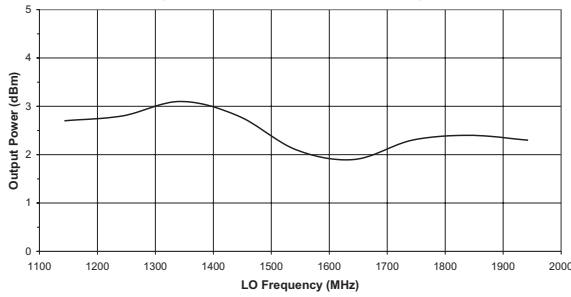
**Figure 6: Typical Conversion Gain and Noise Figure vs. Ambient Temperature**  
 ( $V_{DD} = +5\text{ V}$ ,  $f_{RF} = 450\text{ MHz}$ ,  $f_{IF} = 1087.75\text{ MHz}$ )



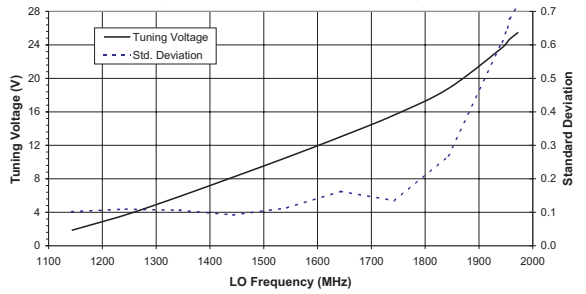
**Figure 7: Typical Phase Noise at 10 kHz Offset vs. Ambient Temperature**  
 ( $V_{DD} = +5\text{ V}$ ,  $f_{LO} = 1500\text{ MHz}$ )



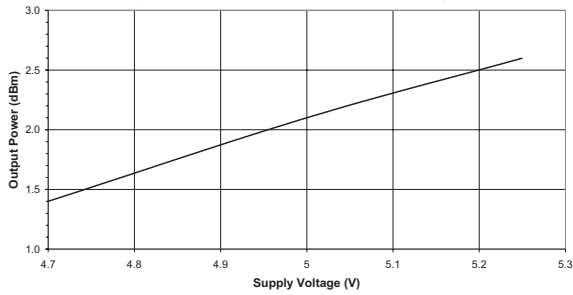
**Figure 8: Typical Local Oscillator Output Power vs. Frequency**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ )



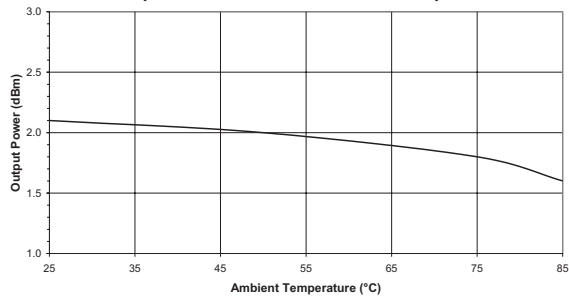
**Figure 9: Typical Tuning Voltage vs. Local Oscillator Frequency**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ )



**Figure 10: Typical Local Oscillator Output Power vs. Supply Voltage**  
 ( $T_A = +25\text{ }^\circ\text{C}$ ,  $f_{LO} = 1500\text{ MHz}$ )

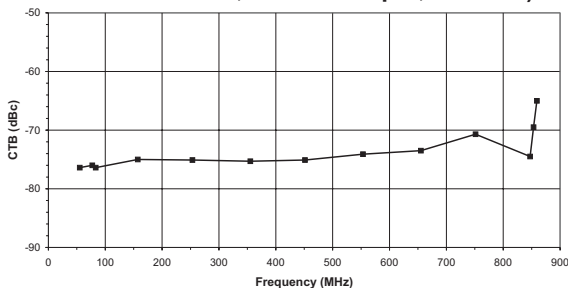


**Figure 11: Typical Local Oscillator Output Power vs. Ambient Temperature**  
 ( $V_{DD} = +5\text{ V}$ ,  $f_{LO} = 1500\text{ MHz}$ )



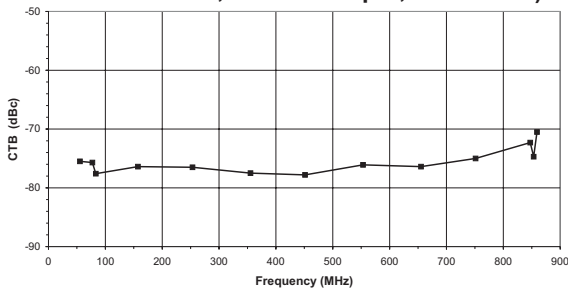
**Figure 12: Typical Composite Triple Beat vs. RF Frequency**

( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ ,  $f_{IF} = 1087.75\text{ MHz}$ , 138 Channels, +7 dBmV Input, 0 dB Tilt)



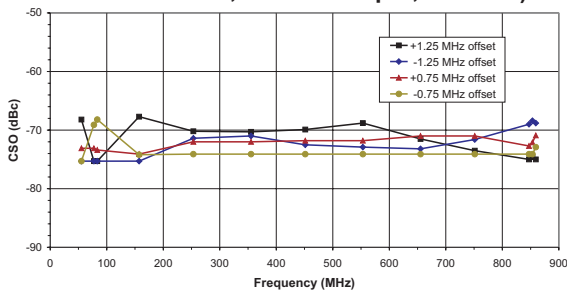
**Figure 13: Typical Composite Triple Beat vs. RF Frequency**

( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ ,  $f_{IF} = 1087.75\text{ MHz}$ , 138 Channels, +7 dBmV Input, -9.6 dB Tilt)



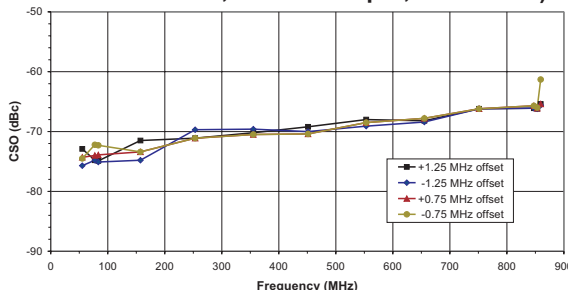
**Figure 14: Typical Composite Second Order vs. RF Frequency**

( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ ,  $f_{IF} = 1087.75\text{ MHz}$ , 138 Channels, +7 dBmV Input, 0 dB Tilt)



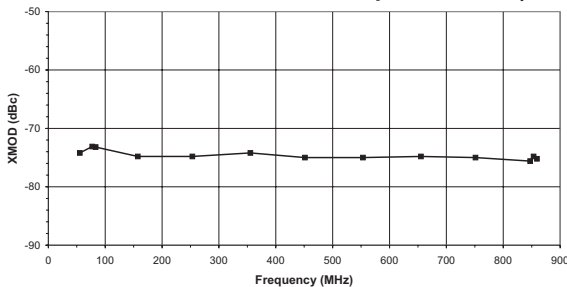
**Figure 15: Typical Composite Second Order vs. RF Frequency**

( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ ,  $f_{IF} = 1087.75\text{ MHz}$ , 138 Channels, +7 dBmV Input, -9.6 dB Tilt)



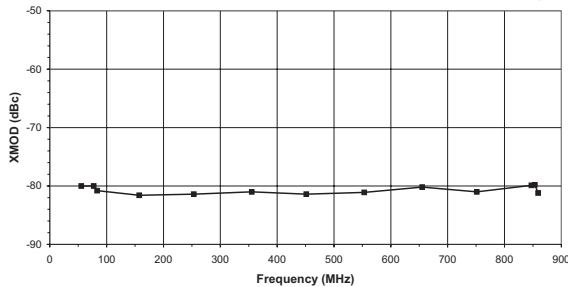
**Figure 16: Typical Cross Modulation vs. RF Frequency**

( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ ,  $f_{IF} = 1087.75\text{ MHz}$ , 138 Channels, +7 dBmV Input, 0 dB Tilt)



**Figure 17: Typical Cross Modulation vs. RF Frequency**

( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{DD} = +5\text{ V}$ ,  $f_{IF} = 1087.75\text{ MHz}$ , 138 Channels, +7 dBmV Input, -9.6 dB Tilt)



APPLICATION INFORMATION

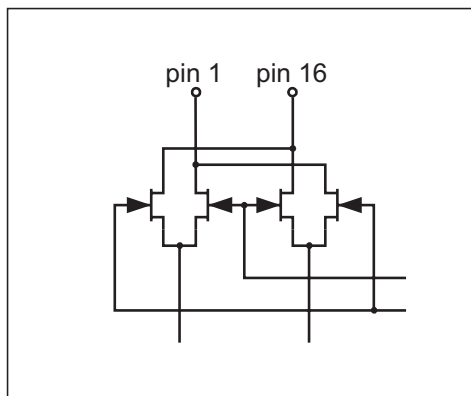
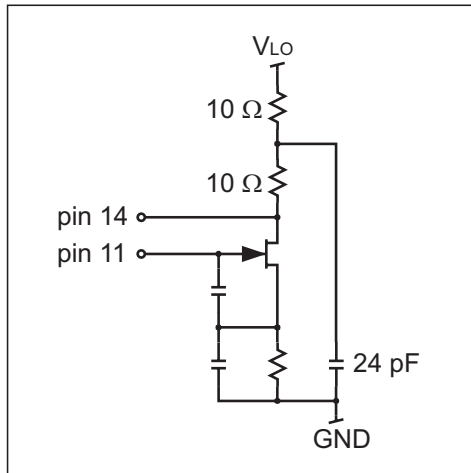
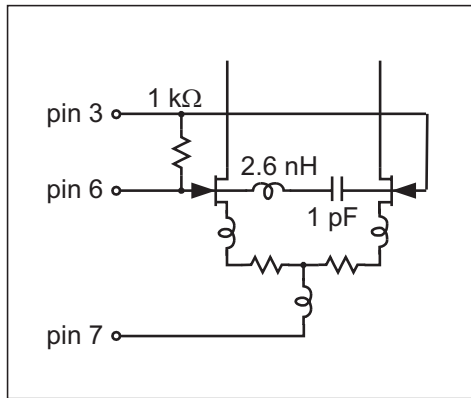


Figure 18: Equivalent Circuits



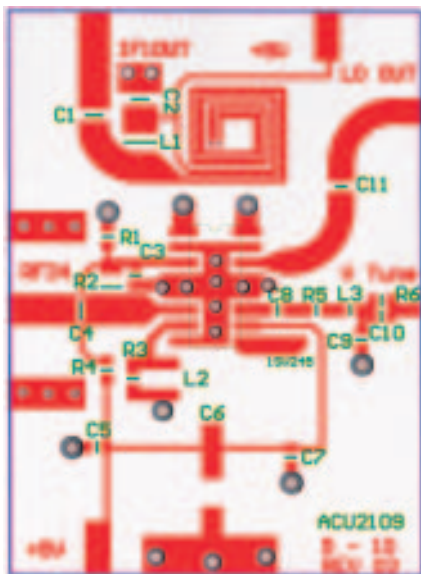


Figure 19: ACU2109 Evaluation Board Top View

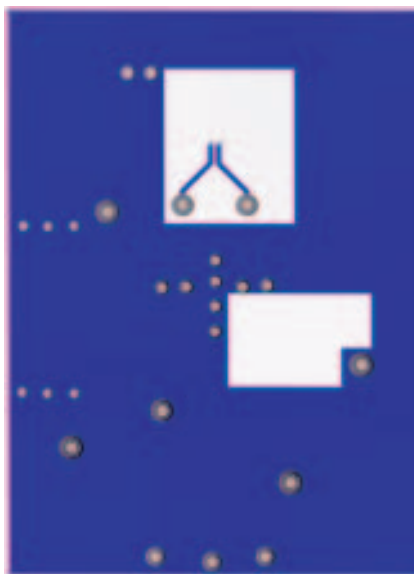


Figure 20: ACU2109 Evaluation Board Bottom View

Table 6: Evaluation Board Parts List

ITEM #	VALUE	SIZE	DESCRIPTION	PART #	QTY	VENDOR
C1, C2, C3, C4, C5, C10	0.01uF	0603	Chip capacitor	GRM39X7R103K25V	6	Murata North America
C6	220uF		10V VA Series SMD	PCE2040CT-ND	1	Digi-Key Corp
C7, C9	0.1uF	0603	Chip capacitor	GRM39X7R104K16	4	Murata
C8	9.1pF	0603	Chip capacitor	100A9R1JP150X	1	ATC
C11	100pF	0603	Chip capacitor	GRM39COG101J50V	1	Murata
R1	820	0805	Chip resistor	ERJ-6GEYJ821	1	Digi-Key Corp
R2	240	0805	Chip resistor	ERJ-6GEYJ241	1	Digi-Key Corp
R3	2K	0603	Chip resistor	ERJ-3GSYJ202	1	Digi-Key Corp
R4, R6	12K	0603	Chip resistor	ERJ-3GSYJ123	1	Digi-Key Corp
R5	47	0603	Chip resistor	ERJ-3GSYJ470	1	Digi-Key Corp
L1, L2	3.3uH	1008	Self mount inductor	1008CS-332XKBC	2	Coilcraft
L3	68nH	0603	Chip inductor	LL2012-F68NK	1	Toko America
D1	1SV245	SOD-323	Varactor diode	1SV245	1	Toshiba

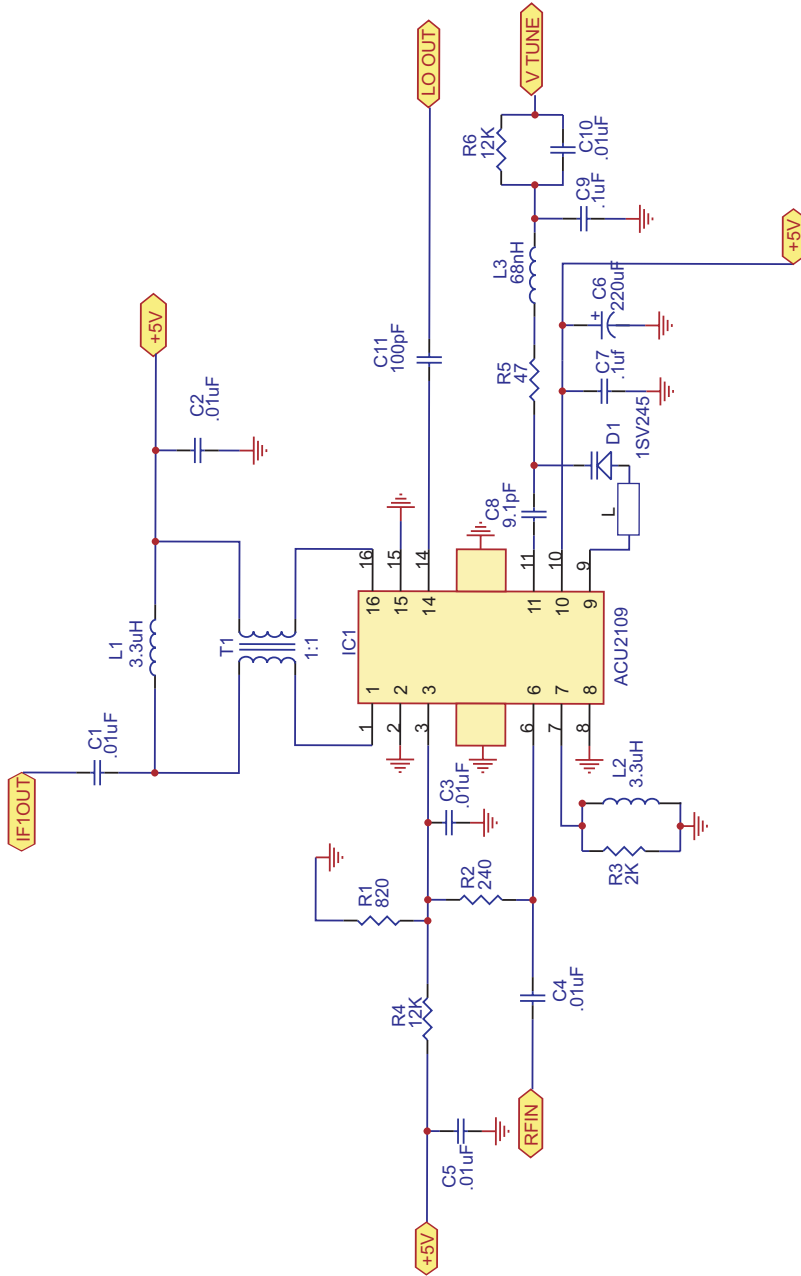
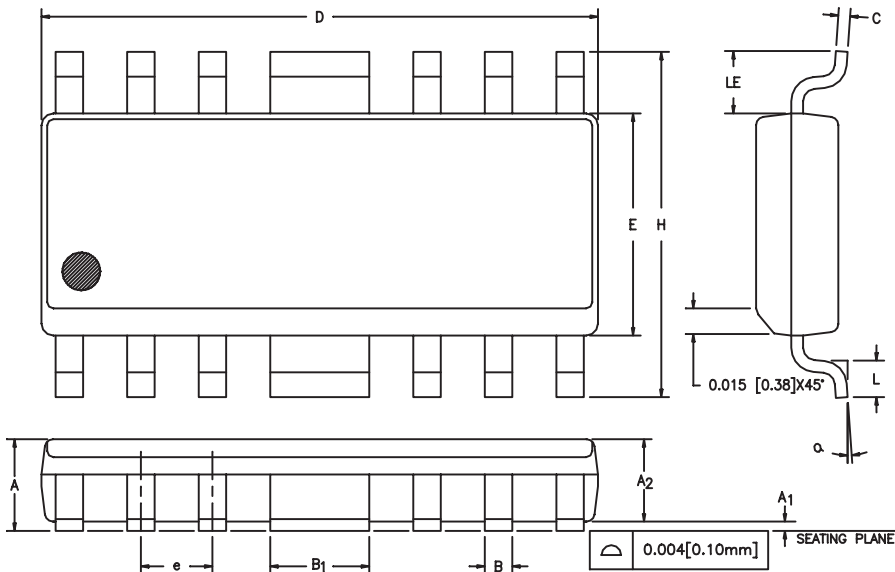


Figure 21: ACU2109 Evaluation Board Schematic

Notes:

1. L = Printed inductor
2. R2 = Gain control/impedance match resistor (240  $\Omega$  for 8 dB gain)
3. C10 not used and R6 = 100  $\Omega$  when V<sub>TUNE</sub> is connected to ACD220X evaluation board.
4. The stated voltage divider R1 and R4 component values provide 0.3 V to pin 3, setting the mixer current to approx. 60 mA. The mixer will be shutdown by applying -2 Vdc.

PACKAGE OUTLINE



	INCHES		MILLIMETERS		NOTE
	MIN.	MAX.	MIN.	MAX.	
A	0.058	0.068	1.47	1.73	
A1	0.004	0.010	0.10	0.25	
A2	0.055	0.065	1.40	1.65	
B	0.013	0.020	0.33	0.50	
B1	0.062	0.070	1.58	1.78	
C	0.008	0.010	0.20	0.25	4
D	0.380	0.400	9.66	10.16	2
E	0.150	0.160	3.81	4.06	3
e	0.050	BSC	1.27	BSC	
H	0.226	0.244	5.74	6.20	
L	0.016	0.040	0.41	1.02	
LE	0.030	—	0.76	—	
α	0°	8°	0°	8°	

NOTES:

1. CONTROLLING DIMENSION: INCHES
2. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED 0.006 [0.15mm] PER SIDE.
3. DIMENSION "E" DOES NOT INCLUDE INTER-LEAD FLASH OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED 0.010 [0.25mm] PER SIDE.
4. MAXIMUM LEAD TWIST/SKEW TO BE  $\pm 0.005$  [0.13mm].
5. LEAD THICKNESS AFTER PLATING TO BE 0.013 [0.33mm] MAXIMUM.

Figure 22: S3 Package Outline - Modified 16 Pin SOIC

## ORDERING INFORMATION

ORDER NUMBER	TEMPERATURE RANGE	PACKAGE DESCRIPTION	COMPONENT PACKAGING
ACU2109S3CTR	-40 to +85 °C	Modified 16 Pin SOIC	3500 Piece Tape and Reel
ACU2109S3C	-40 to +85 °C	Modified 16 Pin SOIC	Plastic Tubes (50 pcs. per tube)
ACU2109S3GP1	-40 to +85 °C	Lead-Free Modified 16 Pin SOIC	3500 Piece Tape and Reel
ACU2109S3GP0	-40 to +85 °C	Lead-Free Modified 16 Pin SOIC	Plastic Tubes (50 pcs. per tube)

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