

5 V CATV MODEM RF TRANSCEIVER

FEATURES

- **TWO WAY DOCSIS BASED DESIGN:**
91-860 MHz Downstream
5-42 MHz Upstream
- **INTERFACES DIRECTLY WITH QAM DEMOD/MOD ICs**
- **BUILT IN RF TRANSMITTER:**
50 dB AGC Driver
- **LOW PHASE NOISE:**
-83 dBc/Hz @ 10 KHz
- **BUSINESS CARD SIZE:**
3.4" x 2.0" x 0.5"
- **RUGGED DESIGN/NO MICROPHONICS:**
All SMD Components "Coiless"
- **LOW POWER CONSUMPTION:**
Rx: 1.2 Watts, Tx: 0.6 Watts
- **EUROPEAN AND JAPANESE VERSIONS AVAILABLE**

DESCRIPTION AND APPLICATIONS

The ISG2000 is a complete RF transceiver designed for use in cable modem applications. The transceiver integrates a diplex filter, triple conversion receiver and transmit AGC amplifier (see Figure 1). The diplex filter provides over 40 dB of isolation between the Tx band and the Rx band. The receiver section provides channel selectivity and converts QAM carriers to low IF sampling frequency for digital signal processing. The transmitter section provides 50 dB of gain control while maintaining excellent linearity performance.

ELECTRICAL CHARACTERISTICS (V_{CC} = 5 V, V_{CC2} = 24 V, T_A = 25°C)

PART NUMBER			ISG2000		
SYMBOLS	PARAMETERS	UNITS	MIN	TYP	MAX
RF Performance (Rx)					
fOP	Operating Frequency Range	MHz	91		860
	Input Signal Level	dBmV	-20		15
	Gain Range	dB	25		75
VAGC	Automatic Gain Control Voltage RF		0		3.3
VAGC	Automatic Gain Control Voltage IF		0		3.3
NFMAX	Noise Figure (Max Gain)	dB		8	10
	Phase Noise at 10 kHz Offset	dBc/Hz		-83	-80
	LO Radiation at RF Input	dBm		-40	
	Resolution	KHz		62.5	
	Lock Time (end to end channel)	msec.		18	
	Input Impedance (Nominal)	ohms		75	
RLIN	Input Return Loss	dB	5		
	Channel Bandwidth USA	MHz		6	
	Output Frequency ¹	MHz	5.70	5.75	5.80
	Passband Ripple	dB		1	2
	Image Rejection	dB	50		
	Inband Group Delay	ns			100
	CSO ²	dBc			45
	CTB ²	dBc			45
	Frequency Offset	KHz	-50		+50

Notes:

1. Optional Output Frequency of 43.75 MHz Available

2. 110 Channels at +15 dBmV/tone

ELECTRICAL CHARACTERISTICS ($V_{CC} = 5\text{ V}$, $V_{CC2} = 24\text{ V}$, $T_A = 25^\circ\text{C}$)

PART NUMBER			ISG2000		
SYMBOLS	PARAMETERS	UNITS	MIN	TYP	MAX
RF Performance (Tx)					
fOP	Operating Frequency Range	MHz	5		42
	Gain ($V_{AGC} = 0\text{ V}$)	dB		35	
	Gain ($V_{AGC} = 3.3\text{ V}$)	dB		-30	
V_{AGC}	Automatic Gain Control Voltage	V	0		3.3
	2nd Harmonic Level (Single Tone, $P_{OUT} = +58\text{ dBmV}$)	dBc	-53	-56	
	3rd Harmonic Level (Single Tone, $P_{OUT} = +58\text{ dBmV}$)	dBc	-53	-56	
RL _{OUT}	Output Return Loss	dB		10	6
Tx ON	On/Off Setting Time (See Figure 1)	μS		12	
Tx OFF	On/Off Setting Time (See Figure 1)	μS		5	
Power Requirements					
	Supply Voltage V1 Rx (5 V)	V	4.75	5	5.25
	Supply Voltage V2 Rx (30 V)mA	V	22	24	31.5
	Supply Voltage V1 Tx (5 V)	V	4.75	5	9
Supply Current					
I _{CC1} (Rx)	Supply Current 1 (Rx)	mA		240	320
I _{CC2} (Rx)	Supply Current 2 (Rx)	mA		1.5	2
I _{CC1} (Tx)	Supply Current 1 (Tx)	mA		120	160
Physical Interface					
	To the CATV Network			Female F-Connector	
	To the Motherboard			16 Pin Header	
Physical Dimensions					
	L x W x H			3.4 x 2.0 x 0.5"	
Environmental Specs					
T _{OP}	Operating Temperature ¹	$^\circ\text{C}$	-5		60
T _{STG}	Storage Temperature	$^\circ\text{C}$	-40		75

Note:

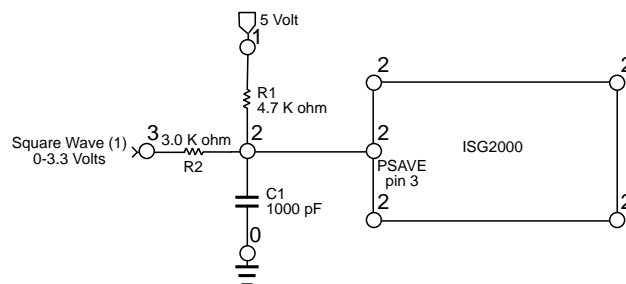
- Temperature performance parameters will vary slightly.

ABSOLUTE MAXIMUM RATINGS(T_C = 25 $^\circ\text{C}$ unless otherwise noted)

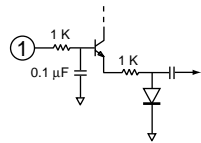
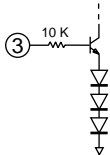
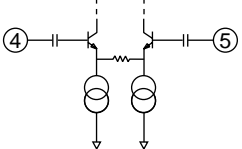
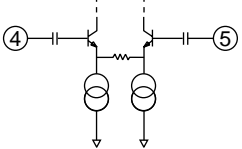
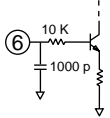
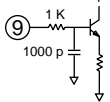
SYMBOLS	PARAMETERS	UNITS	RATINGS
V _{IN}	RF Input Voltage	dBmV	60
V _{CC1} (Rx)	Supply Voltage 1 (Rx)	V	6
V _{CC2} (Rx)	Supply Voltage 2 (Rx)	V	35
V _{CC} (Tx)	Supply Voltage (Tx)	V	6
T _{OP}	Operating Temperature	$^\circ\text{C}$	-10 to 60
T _{STG}	Storage Temperature	$^\circ\text{C}$	-40 to 75
T _{SOL}	Soldering Temperature	$^\circ\text{C}$	260
ts _{SOL}	Soldering Time	sec.	4

Note:

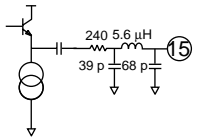
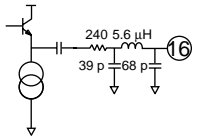
- Operation in excess of any one of these parameters may result in permanent damage.

Tx ENABLE APPLICATION CIRCUIT (Figure 1)

PIN FUNCTIONS

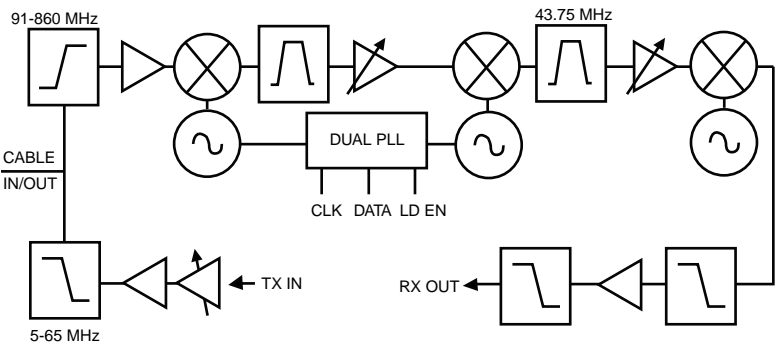
Pin No.	Pin Name	Description	Equivalent Circuit
1	RFAGC	The RFAGC pin is used to adjust gain in the dual conversion tuner. This pin has a positive gain vs. AGC slope. 20 dB of gain control is available by varying the voltage from 0.5 V to 3.3 V.	
2	VCC (Tx)	The VCC (Tx) pin powers the Tx amplifier. A 5 V bias is required and nominal current is 125 mA.	
3	TXEN	The TXEN pin is used to enable/disable the Tx amplifier. When TXEN is set LOW, the Tx amplifier is disabled. In this state, a standby current of 3 mA is required from VCC (Tx). When TXEN is set HIGH, the Tx amplifier is enabled. In this state, a nominal current of 125 mA is required from VCC (Tx).	
4	TXIN-	TXIN- is the inverting input to the Tx amplifier. The input frequency range spans 5-42 MHz.	
5	TXIN+	TXIN+ is the non-inverting input to the Tx amplifier. The input frequency range spans 5-42 MHz.	
6	TXAGC	The TXAGC pin is used to adjust gain in the Tx amplifier. The pin has a positive gain vs. AGC slope. 50 dB of gain control is available by varying the voltage from 0.5 V to 3.0 V.	
7	VCC2 (Rx)	The VCC2 (Rx) pin powers the loop filter for the first LO. A bias of 24 V - 30 V is required and maximum current draw is 2 mA.	
8	VCC1 (Rx)	The VCC1 (Rx) pin powers the entire Rx section. A bias of 5 V is required and nominal current draw is 250 mA.	
9	IFAGC	The IFAGC pin is used to adjust gain in the final downconverter stage of the Rx section. The pin has a positive gain vs. AGC slope. 30 dB of gain control is available by varying the voltage from 0.5 to 2.0 V.	
10	GND	Ground.	

PIN FUNCTIONS

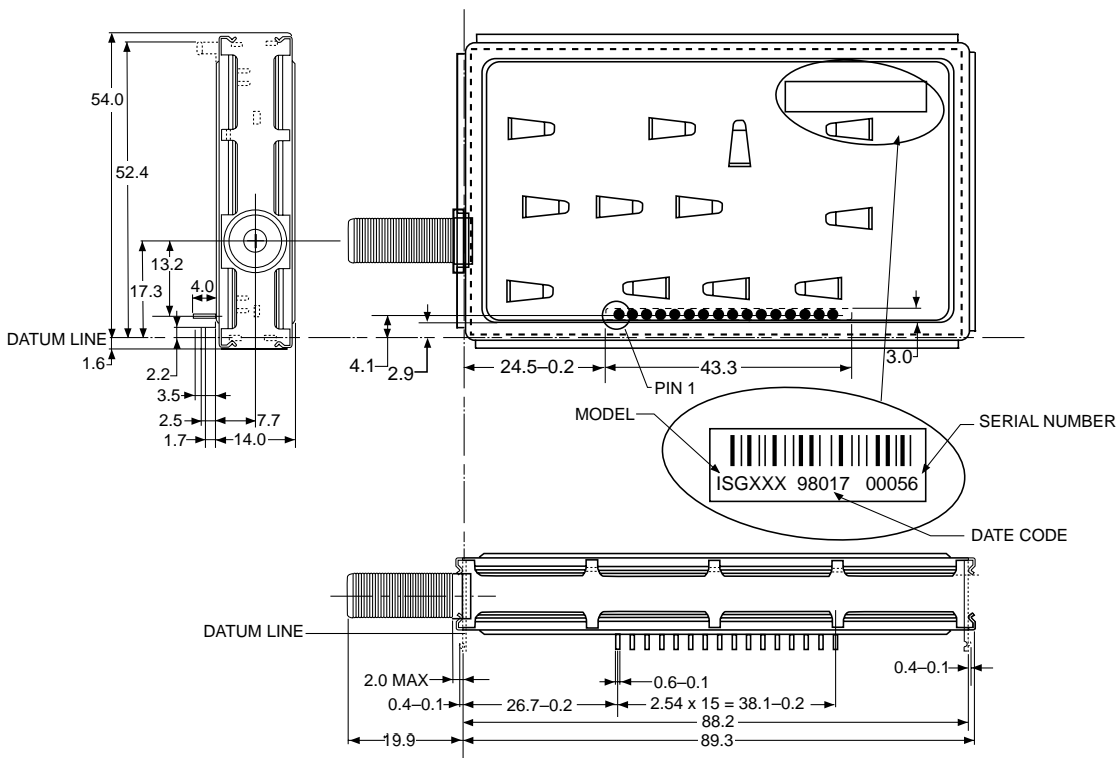
Pin No.	Pin Name	Description	Equivalent Circuit
11	CLK	Clock pin for the dual PLL. High impedance CMOS input. Data for the various latches is clocked in on the rising edge into a 20-bit shift register.	
12	DATA	Serial data pin for the dual PLL. High impedance CMOS input. MSB entered first. The last two bits are the control bits.	
13	LDEN	Latch enable pin for the dual PLL. High impedance CMOS input. When LE goes HIGH, data stored in the shift registers is loaded into one of the 4 latches determined by the 2 control bits.	
14	GND	Ground.	
15	IFOUT+	Non-Inverting final IF output.	
16	IFOUT-	Inverting final IF output.	

Note:
1. For programming information, refer to National LMX2336 data sheet (<http://www.national.com>)

FIGURE 1



OUTLINE DIMENSIONS (Units in mm)



Note: All tolerances ± 0.15 mm unless otherwise specified.

RECOMMENDED PAD LAYOUT (Units in mm [inches])

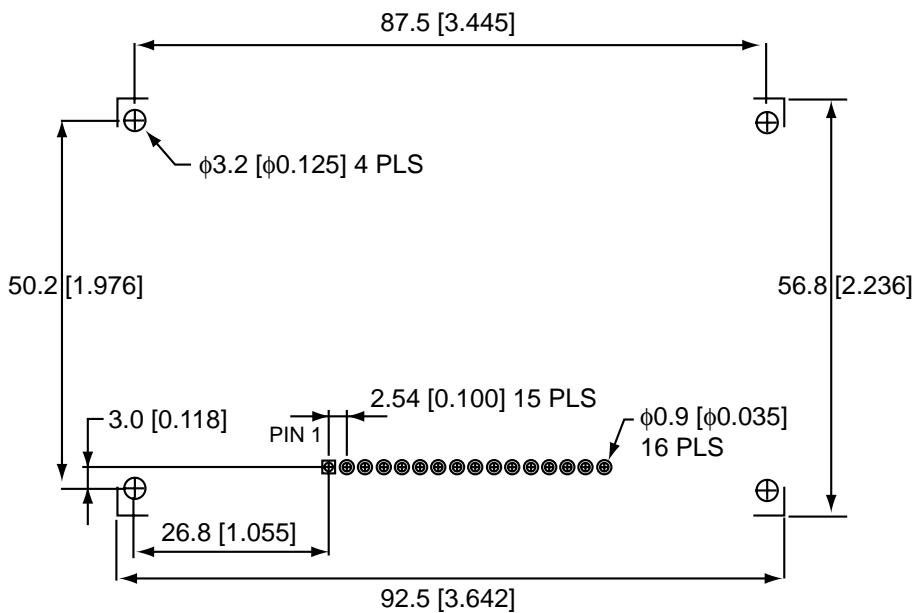


Table 1. Programmable Modes

C1	C2	R16	R17	R18	R19	R20
0	0	RF2 Phase Detector Polarity	RF2 ICP _O	RF2 Do TRI-STATE	RF2 LD	RF2 Fo
0	1	RF1 Phase Detector Polarity	RF1 ICP _O	RF1 Do TRI-STATE	RF1 LD	RF1 Fo
C1	C2	N19		N20		
1	0	RF2 Prescaler		Pwdr RF2		
1	1	RF1 Prescaler		Pwdr RF1		

Table 2. Mode Select Truth Table

	Phase Detector Polarity ³	Do TRI-STATE	ICP _O ¹	RF1 Prescaler	RF2 Prescaler	Pwdrn ²
0	Negative	Normal Operation	LOW	64/65	64/65	pwrdr up
1	Positive	TRI-STATE	HIGH	128/129	128/129	pwrdr dn

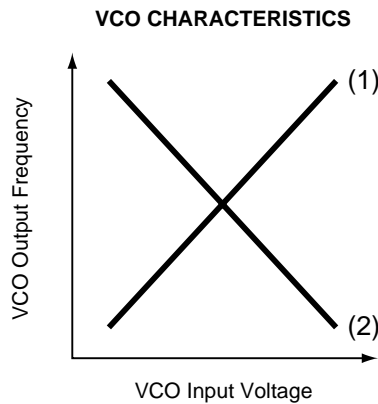


Table 3. The FoLD Output Truth Table

RF1 R (19) (RF1 LD)	RF2 R (19) (RF2 LD)	RF1 R (20) (RF1 Fo)	RF2 R (20) (RF2 Fo)	FoLD Output State
0	0	0	0	Disabled ¹
0	1	0	0	RF2 Lock Detect ²
1	0	0	0	RF1 Lock Detect ²
1	1	0	0	RF1/RF2 Lock Detect ²
X	0	0	1	RF2 Reference Divider Output
X	0	1	0	RF1 Reference Divider Output
X	1	0	1	RF2 Programmable Divider Output
X	1	1	0	RF1 Programmable Divider Output
0	0	1	1	Fastlock ³
0	1	1	1	For internal use only
1	0	1	1	For internal use only
1	1	1	1	Counter Reset ⁴

X - Don't care condition

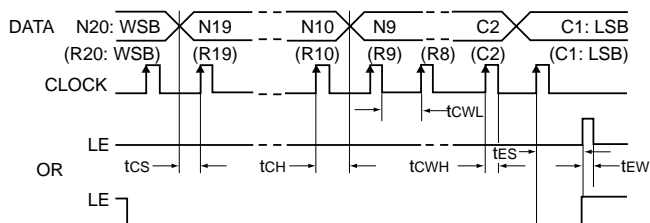
Notes:

1. The ICP_O LOW Current State = 1/4 x ICP_O HIGH Current.
2. Activation of the RF2 PLL or RF1 PLL powerdown modes result in the disabling of the respective N counter divider and debiasing of its respective fin inputs (to a high impedance state). The powerdown function is gated by the charge pump to prevent unwanted frequency jumps. Once the powerdown program mode is loaded, the part will go into powerdown mode when the charge pump reaches a TRI-STATE condition. The R counter and Oscillator functionality does not become disabled until both RF2 and RF1 powerdown bits are activated. The OSCIN is connected to VCC through a 100 kΩ resistor and the OSCOUT goes HIGH when this condition exists. The MICROWAVE™ control register remains active and capable of loading and latching data during all the powerdown modes.
3. Phase Detector Polarity
Depending upon VCO characteristics, the R16 bits should be set accordingly:
When VCO characteristics are positive like (1), R16 should be set HIGH, when VCO characteristics are negative like (2), R16 should be set LOW.

Notes:

1. When the FoLD output is disabled, it is actively pulled to a low logic state.
2. Lock detect output provided to indicate when the VCO frequency is in "lock". When the loop is locked and a lock detect mode is selected, the pin's output is HIGH, with narrow pulses LOW. In the RF1/RF2 lock detect mode a locked condition is indicated when RF2 and RF1 are both locked.
3. The Fastlock mode utilized the FoLD output pin to switch a second loop filter damping resistor to ground during fastlock operation. Activation of Fastlock occurs whenever the RF loop's Icpo magnitude bit #17 is selected HIGH (while the #19 and #20 mode bits are set for Fastlock).
4. The Counter Reset mode bits R19 and R20 when activated reset all counters. Upon removal of the Reset bits the N counter resumes counting in "close" alignment with R counter. (The maximum error is one prescaler cycle). If the Reset bits are activated the R counter is also forced to Reset, allowing smooth acquisition upon powering up.

Serial Data Input Timing



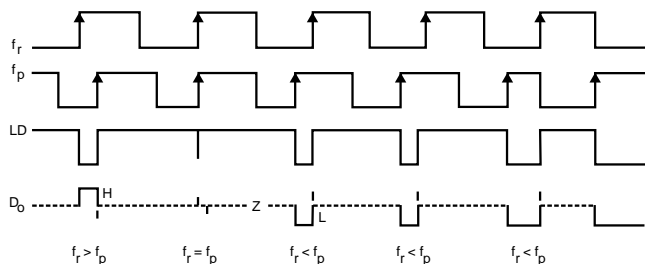
Notes:

1. Parenthesis data indicates programmable reference divider data.
2. Data shifted into register on clock rising edge.
3. Data is shifted in MSB first.

Test Conditions:

The Serial Data Input Timing is tested using a symmetrical waveform around $V_{CC}/2$. The test waveform has an edge rate of 0.6V/ns with amplitudes of 2.2 V @ $V_{CC} = 2.7$ V and 2.6 V @ $V_{CC} = 5.5$ V.

Phase Comparator and Internal Charge Pump Characteristics.



Notes:

1. Phase difference detection range: -2π to $+2\pi$
2. The minimum width pump up and pump down current pulses occur at the Do pin when the loop is locked.