Integrated Solutions Group

5 V CATV MODEM RF TRANSCEIVER | ISG2000DS

FEATURES

- **TWO WAY MCNS COMPLIANT:**
  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:**
  -85 dBc/Hz @ 10 KHz
- **BUSINESS CARD SIZE:**
  3.4" x 2.0" x 0.5"
- **RUGGED/NO MICROPHONICS:**
  All SMD Components, "Coiless"
- **EUROPEAN AND US VERSIONS AVAILABLE**
- **LOW POWER CONSUMPTION:**
  RX: 1.2 Watts, TX: 0.6 Watts

DESCRIPTION AND APPLICATIONS

The ISG2000DS is a complete RF transceiver designed for use in cable modem applications. The transceiver integrates a diplex filter, double 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 converts QAM signals in the RX band down to the IF sampling frequency and provides the necessary gain control input power to the DSP. The RF transmitter section provides 40 dB gain control under all conditions, while maintaining excellent linearity performance.

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

PART NUMBER			ISG2000DS		
SYMBOLS	**PARAMETERS**	**UNITS**	**MIN**	**TYP**	**MAX**
RF Performance (Rx)					
f_{OP}	Operating Frequency Range	MHz	91		860
	Input Signal Level	dBmV	-20		15
	Gain Range	dB	25		75
V_{AGC}	Automatic Gain Control Voltage RF		0		3.3
V_{AGC}	Automatic Gain Control Voltage IF		0		3.3
NF_{MAX}	Noise Figure (Max Gain)	dB		8	10
	Phase Noise at 10 kHz Offset	dBc/Hz		-85	-83
	LO Radiation at RF Input	dBm		-60	
	Resolution	KHz		62.5	
	Lock Time	µsec.		600	
	Input Impedance (Nominal)	ohms		75	
RL_{IN}	Input Return Loss	dB			6
	Channel Bandwidth USA	MHz		6	
	Output Frequency[1]	MHz	43.70	43.75	43.80
	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 43.75 MHz Available
2. 110 Channels at +15 dBmV/tone

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

PART NUMBER			ISG2000DS		
SYMBOLS	**PARAMETERS**	**UNITS**	**MIN**	**TYP**	**MAX**
RF Performance (Tx)					
f_{OP}	Operating Frequency Range	MHz	5		55
	Gain (V_{AGC} = 0 V)	dB		35	
	Gain (V_{AGC} = 3.3 V)	dB		-30	
V_{AGC}	Automatic Gain Control Voltage	V	0		3.3
	2nd Harmonic Level (Single Tone, P_{OUT} = +58 dBmV)	dBc	-53	-56	
	3rd Harmonic Level (Single Tone, P_{OUT} = +58 dBmV)	dBc	-53	-56	
RL_{OUT}	Output Return Loss	dB		10	6
$T_{X\ ON}$	On/Off Setting Time	µS		12	
$T_{X\ OFF}$	On/Off Setting Time	µS		5	
Power Requirements					
	Supply Voltage V1 Rx	V	4.5	5	5.5
	Supply Voltage V2 Rx	V	22	24	31.5
Supply Current					
	Supply Voltage V1 Tx	V	4.5	5	9
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		80	110
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	°C	-5		60
T_{STG}	Storage Temperature	°C	-40		75

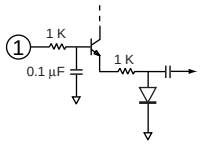
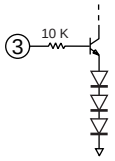
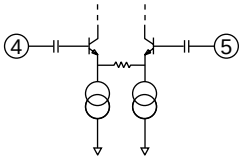
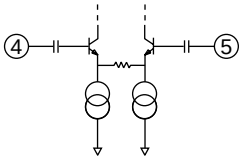
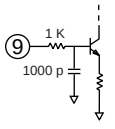
ABSOLUTE MAXIMUM RATINGS

(T_C = 25 °C unless otherwise noted)

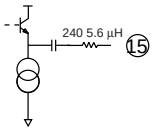
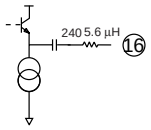
SYMBOLS	PARAMETERS	UNITS	RATINGS
V_{IN}	RF Input Voltage	dBmV	60
V_{CC1} (Rx)	Supply Voltage 1 (Rx)	V	6
V_{CC2} (Rx)	Supply Voltage 2 (Rx)	V	35
V_{CC} (Tx)	Supply Voltage (Tx)	V	10
T_{OP}	Operating Temperature	°C	-10 to 60
T_{STG}	Storage Temperature	°C	-55 to 150
T_{SOL}	Soldering Temperature	°C	260
t_{SOL}	Soldering Time	sec.	4

Note:
1. Operation in excess of any one of these parameters may result in permanent damage.

PIN FUNCTIONS

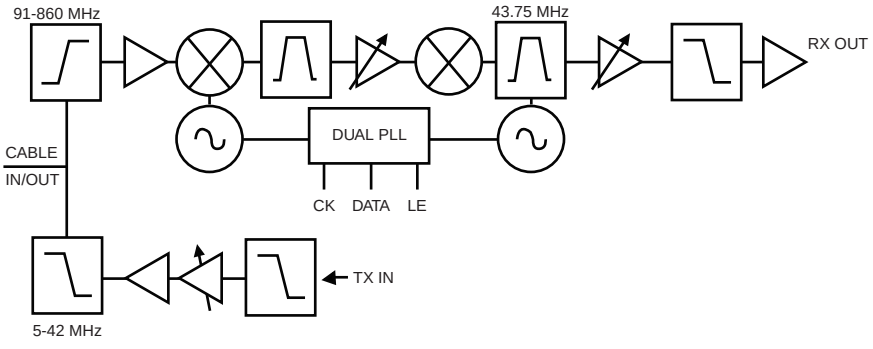
Pin No.	Pin Name	Description	Equivalent Circuit
1	RF_{AGC}	The RF_{AGC} pin is used to adjust gain in the dual conversion tuner. This pin has a positive gain vs. AGC slope. 20 dB of gain control is available by varying the voltage from 0.5 V to 3.3 V.	
2	V_{CC} (T_X)	The V_{CC} (T_X) pin powers the T_X amplifier. A 5 V bias is required and nominal current is 125 mA.	
3	T_{XEN}	The T_{XEN} pin is used to enable/disable the T_X amplifier. When T_{XEN} is set LOW, the T_X amplifier is disabled. In this state, a standby current of 3 mA is required from V_{CC} (T_X). When T_{XEN} is set HIGH, the T_X amplifier is enabled. In this state, a nomimal current of 125 mA is required from V_{CC} (T_X).	
4	T_{XIN-}	T_{XIN-} is the inverting input to the T_X amplifier. The input frequency range spans covers 5-55 MHz.	
5	T_{XIN+}	T_{XIN+} is the non-inverting input to the T_X amplifier. The input frequency range spans covers 5-55 MHz.	
6	T_{XAGC}	The T_{XAGC} pin is used to adjust gain in the T_X 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	V_{CC2} (R_X)	The V_{CC2} (R_X) 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	V_{CC1} (R_X)	The V_{CC1} (R_X) pin powers the entire R_X section. A bias of 5 V is required and nominal current draw is 250 mA.	
9	IF_{AGC}	The IF_{AGC} pin is used to adjust gain in the final downconverter stage of the R_X 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[1]	CK	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[1]	DATA	Serial data pin for the dual PLL. High impedance CMOS input. MSB entered first. The last two bits are the control bits.	
13[1]	LE	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-	Inverting final IF output.	
16	IFOUT+	Non-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 [inches])

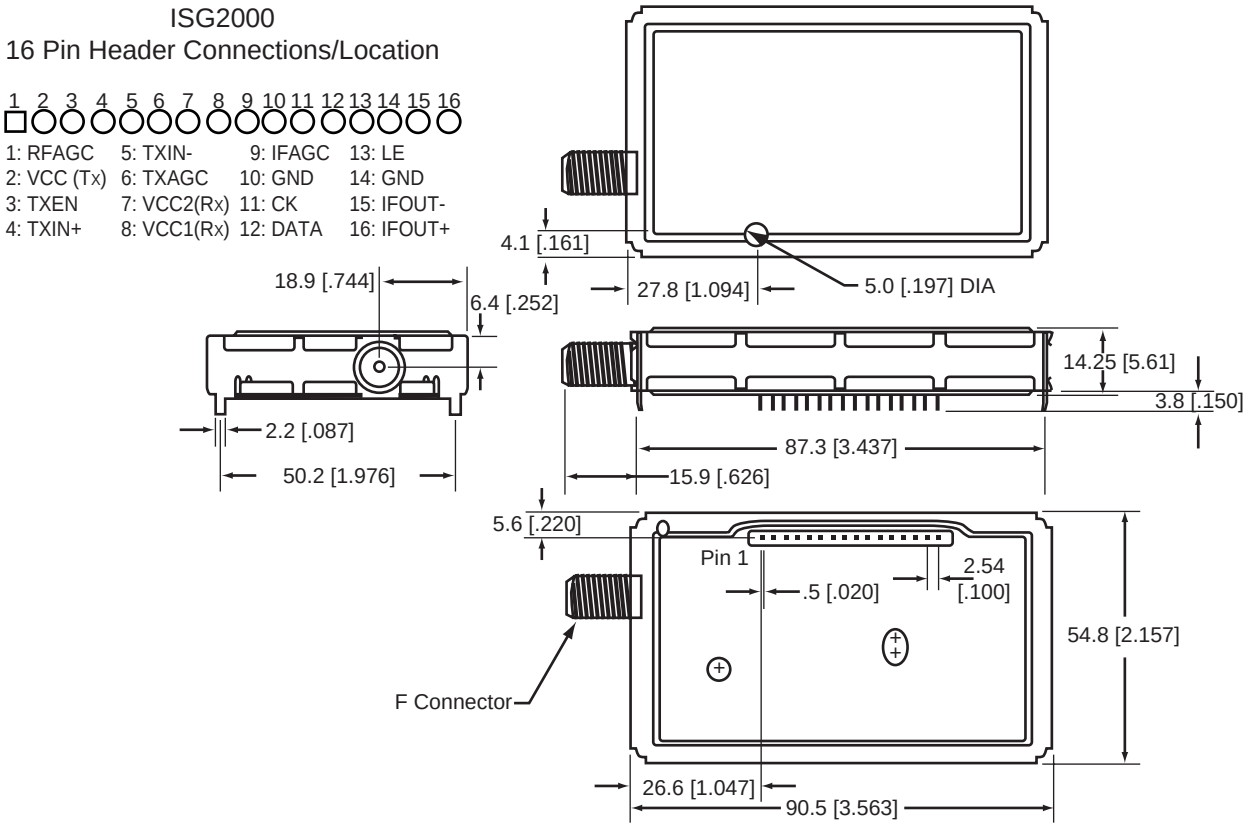


Table 1. Programmable Modes

C1	C2	R16	R17	R18	R19	R20
0	0	RF2 Phase Detector Polarity	RF2 I_{CP_O}	RF2 D_O TRI-STATE	RF2 LD	RF2 F_O
0	1	RF1 Phase Detector Polarity	RF1 I_{CP_O}	RF1D_O TRI-STATE	RF1 LD	RF1 F_O

C1	C2	N19	N20
1	0	RF2 Prescaler	Pwdn RF2
1	1	RF1 Prescaler	Pwdn RF1

Table 2. Mode Select Truth Table

	Phase Detector Polarity[3]	D_O TRI-STATE	I_{CP_O}[1]	RF1 Prescaler	RF2 Prescaler	Pwdn[2]
0	Negative	Normal Operation	LOW	64/65	64/65	pwrd up
1	Positive	TRI-STATE	HIGH	128/129	128/129	pwrd dn

Notes:

1. The I_{CP_O} LOW Current State = 1/4 x I_{CP_O} HIGH Current.
2. Activitation of the RF2 PLL or RF1 PLL powerdown modes result in the disabling of the respective N counter divider and debiasing of its respective f_{IN} 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 OSC_{IN} is connected to V_{CC} through a 100 kΩ resistor and the OSC_{OUT} 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.

VCO CHARACTERISTICS

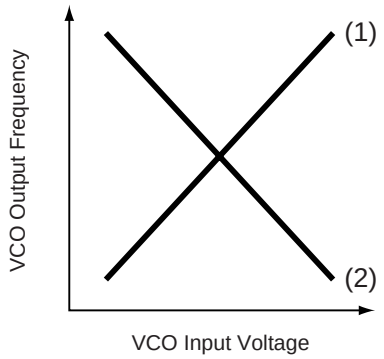


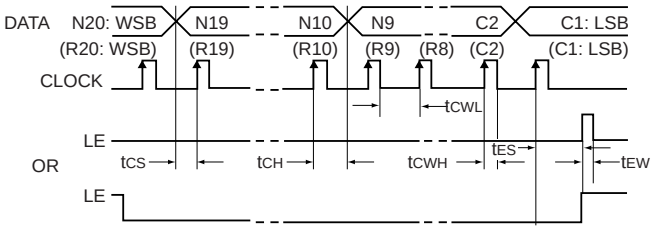
Table 3. The FoLD Output Truth Table

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. 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.

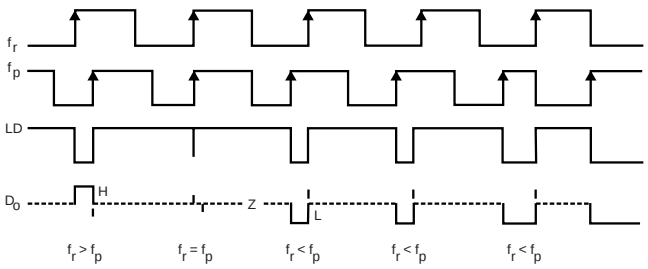
Serial Data Input Timing



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 VCC/2. The test waveform has an edge rate of 0.6V/ns with amplitudes of 2.2 V @ VCC = 2.7 V and 2.6 V @ VCC = 5.5 V.

Phase Comparator and Internal Charge Pump Characteristics.



Notes:
1. Phase difference detection range: -2π to +2π

2. The minimum width pump up and pump down current pulses occur at the Do pin when the loop is locked.