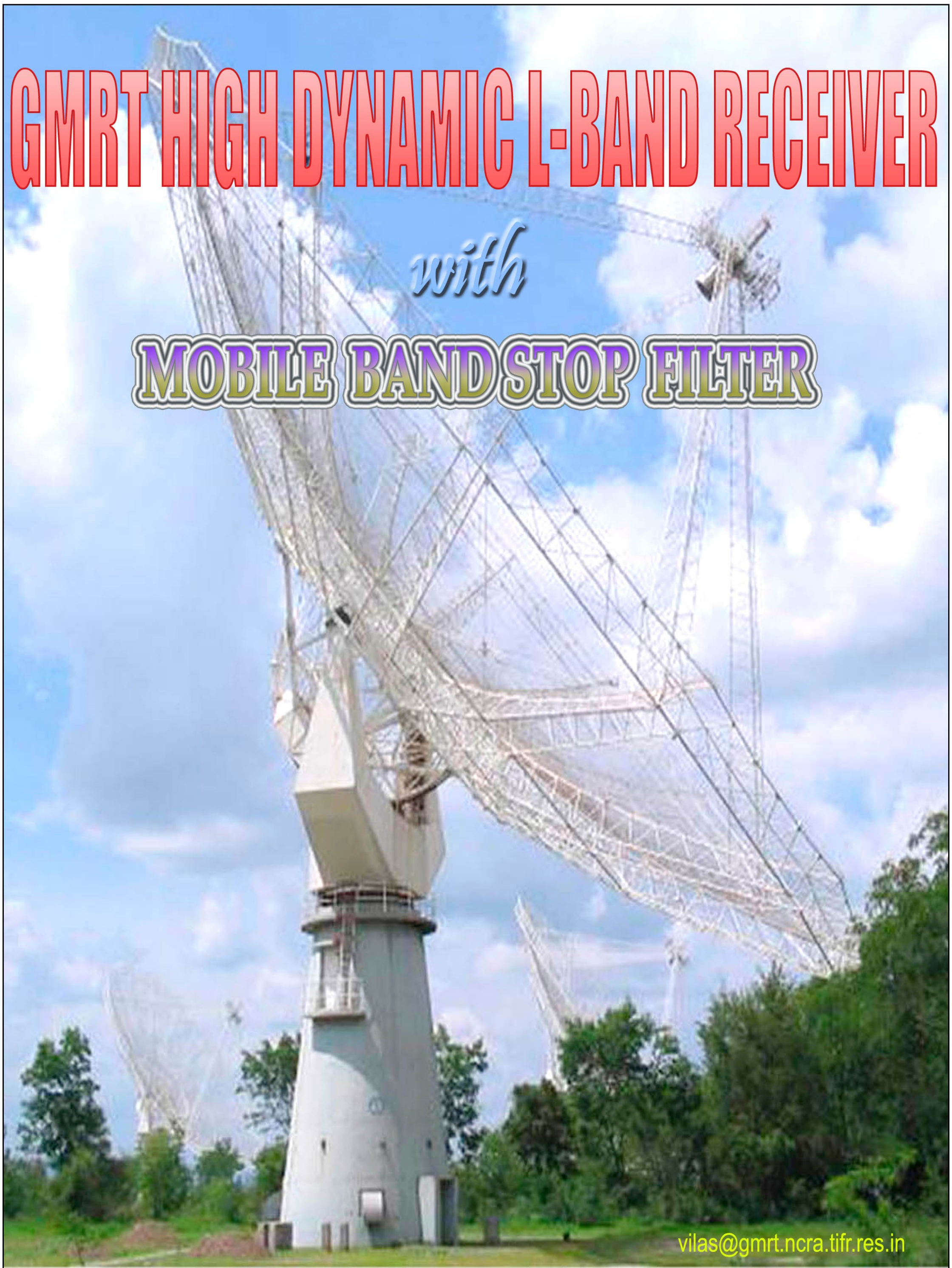
GMRT HIGH DYNAMIC L-BAND RECEIVER

with

MOBILE BAND STOP FILTER



INTERNAL TECHNICAL REPORT

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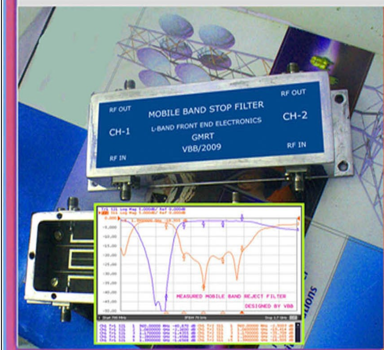
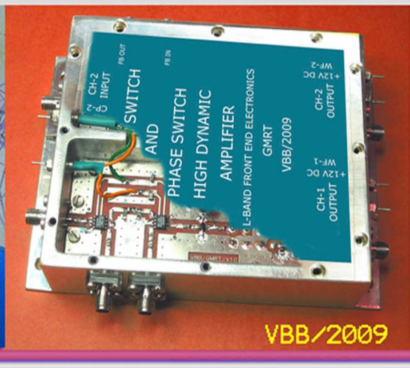
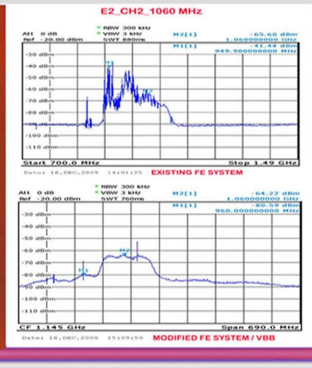
APPROVED BY : Shri. APK

BHALERAO V. B.

GMRT HIGH DYNAMIC L-BAND FRONT END RECEIVER







Giant Metrewave Radio Telescope
TATA INSTITUTE OF FUNDAMENTAL RESEARCH
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PUNE -410504 , MAHARASHTRA , INDIA
NCRA • TIFR

Contents

ACKNOWLEDGEMENT

I would like to express my gratitude to Shri. A. Praveenkumar , my Reporting Officer and Group Coordinator for assigning the task of re-designing the L-Band receiver System with High Dynamic Range and for his guidance and encouragement.

I take this opportunity to thank Santosh S. Bhor , K . T. Thorat and Baban Barkund for their help during production , installation and commissioning.

I also would like to thank the entire Front End Group for all the support and help provided during this work.

Bhalerao V. B.

Introduction

Overview of GMRT Receiver System

Giant Meter-wave Radio Telescope (GMRT) currently operates at five observing bands centered at 150 MHz, 235 MHz, 327 MHz, 610 MHz and an L-band extending from 1000 to 1450 MHz. The L-band is split into four sub bands centered at 1060MHz, 1170 MHz, 1280 MHz and 1390 MHz, each with a bandwidth of 120 MHz.The L-band receiver also has a bypass mode in which the entire RF band can be brought down to the Antenna Base Receiver (ABR).

The 150 MHz, 235 MHz, 327 MHz bands of GMRT have 40 MHz bandwidth and 610 MHz band has about 60 MHz of bandwidth. Lower frequency bands from 150 to 610 MHz have dual circular polarization which are named as CH1 and CH2 for right hand circular polarization and left hand circular polarization respectively. The higher frequency L-band has dual linear polarization (Vertical and Horizontal polarization) named CH1 and CH2 respectively. At the lower frequencies the polarizer placed before the Low Noise Amplifier (LNA) converts the received linear polarization to circular. At L-band, in order to keep the system temperature low, this element is not inserted into the signal path, and the linear polarized signals are fed directly to the LNA. To calibrate the gain of the receiver chain, it is possible to inject an additional noise signal (of known strength) into the input of the LNA. It is possible to inject noise at any one of four levels. These are called Low cal, Medium cal, High cal and Extra high cal and are of monotonically increasing strength.

To minimize crosstalk between different signals a phase switching facility using separate Walsh functions for each signal path is available at the RF section of the receiver.

At the Common Box the signals go through one additional stage of amplification. The common box has a broad band amplifier which covers the entire frequency range of the GMRT (10 – 1800 MHz). The band selector in the common box can be configured to take signals from any one of the six RF Front Ends. The common box (and the entire receiver system) has the flexibility to be configured for receiving either both polarizations at a single frequency band or a single polarization at each of two different frequency bands. It is also possible to swap the polarization channels whenever required. For observing strong radio sources like Sun, solar attenuators of 14 dB, 30 dB or 44 dB are available in the common box. In addition there is a power monitor whose output can be continuously monitored to verify the health of the subsystems upstream of the common box.

The first synthesized local oscillator converts the RF band to an IF band centered at 70 MHz. The synthesized local oscillator has a frequency range of 100 MHz to 1795 MHz. The frequency range 100 MHz to 600 MHz is covered by synthesizer-1 and 605 MHz to 1795 MHz is covered by synthesizer-2.

The local oscillator frequency from 100 MHz to 354 MHz can be set with a step size of 1 MHz and the frequency range from 355 MHz to 1795 MHz can be set with a step size of 5 MHz. At the IF stage, bandwidth of 5.5 MHz, 16 MHz or a full available RF bandwidth can be selected. The IF at 70 MHz is then translated to a second IF at 130 MHz and 175 MHz for CH1 and CH2 respectively.

The maximum bandwidth available at this stage is 32 MHz for each polarization channel This frequency translation is done so that they can be transported to Central Electronics Building (CEB) over a single fiber optic cable. An Automatic Level Control (ALC) facility is provided at the output stage of IF which can be bypassed whenever required.

The IF signal at 130 MHz and 175 MHz along with telemetry and LO round trip phase carriers directly modulate a laser diode operating at 1300 nm wavelength which is coupled to a single mode fiber-optic link between the receiving antennas and the CEB.

At the CEB these signals are recovered with a PIN photo diode detector and suitably amplified. The 130 MHz and 175 MHz signals are then separated out and then sent for base band conversion. There is a monitor port available at the fiber-optic receiver front panel at CEB, where all the received signals can be monitored.

The base band converter section converts 130 MHz and 175 MHz IF signals to 70 MHz using 3rd LO (200 MHz & 105 MHz respectively.)The 70 MHz signals are then converted to base band consisting of upper and lower sidebands for each sidebands for each polarization channel using a tunable LO which can be set from 50 MHz to 90 MHz in steps of 100 Hz. The BB system bandwidths can be set to any one of the bandwidths out of 62.5 KHz, 128 KHz, 256 KHz, 512 KHz, 1 MHz, 2 MHz, 4 MHz, 8 MHz and 16 MHz as per the user requirements. An ALC is incorporated at the output of Base band converter that can be bypassed whenever required.

SCOPE OF WORK

HIGH DYNAMIC L –BAND FRONT END RECEIVER

The concept of HIGH DYNAMIC RANGE receiver implies not only an ability to detect with low distortion but also the desired signal differing in amplitude by large amounts. The response of the entire system must remain linear over a wide range of noise temperature. The entire receiver system should remain linear even in presence of strong interference signals. The receiver must have a higher degree of immunity of spurious responses produced by non linear interaction of multiple high level interfacing signals.

The block diagram of HIGH DYNAMIC L-BAND FRONT END RECEIVER is shown in figure. The L-BAND FRONT END consists of corrugated HORN FEED to collect the radiations reflected from the parabolic dish with a orthomode transducer (OMT) in which the waveguide mode of the signal is converted into coaxial mode. In the OMT two linear components of the incoming signals are picked up in two perpendicular directions which are designated as VERTICAL (V) and HORIZANTAL (H) channels.

The signals are then amplified by a LOW NOISE AMPLIFIER (LNA) . The LNA is designed using three stages of FUJITSU HEMT’s FHX35LG. The gain of the LNA is 35 dB over the frequency range of 1000 MHz to 1500 MHz , with a noise temperature of 35 K.

The signal then pass through MOBILE BAND STOP FILTER where mobile signals (RFI) attenuated by 35 dB. This filter has an insertion loss of 1 dB.

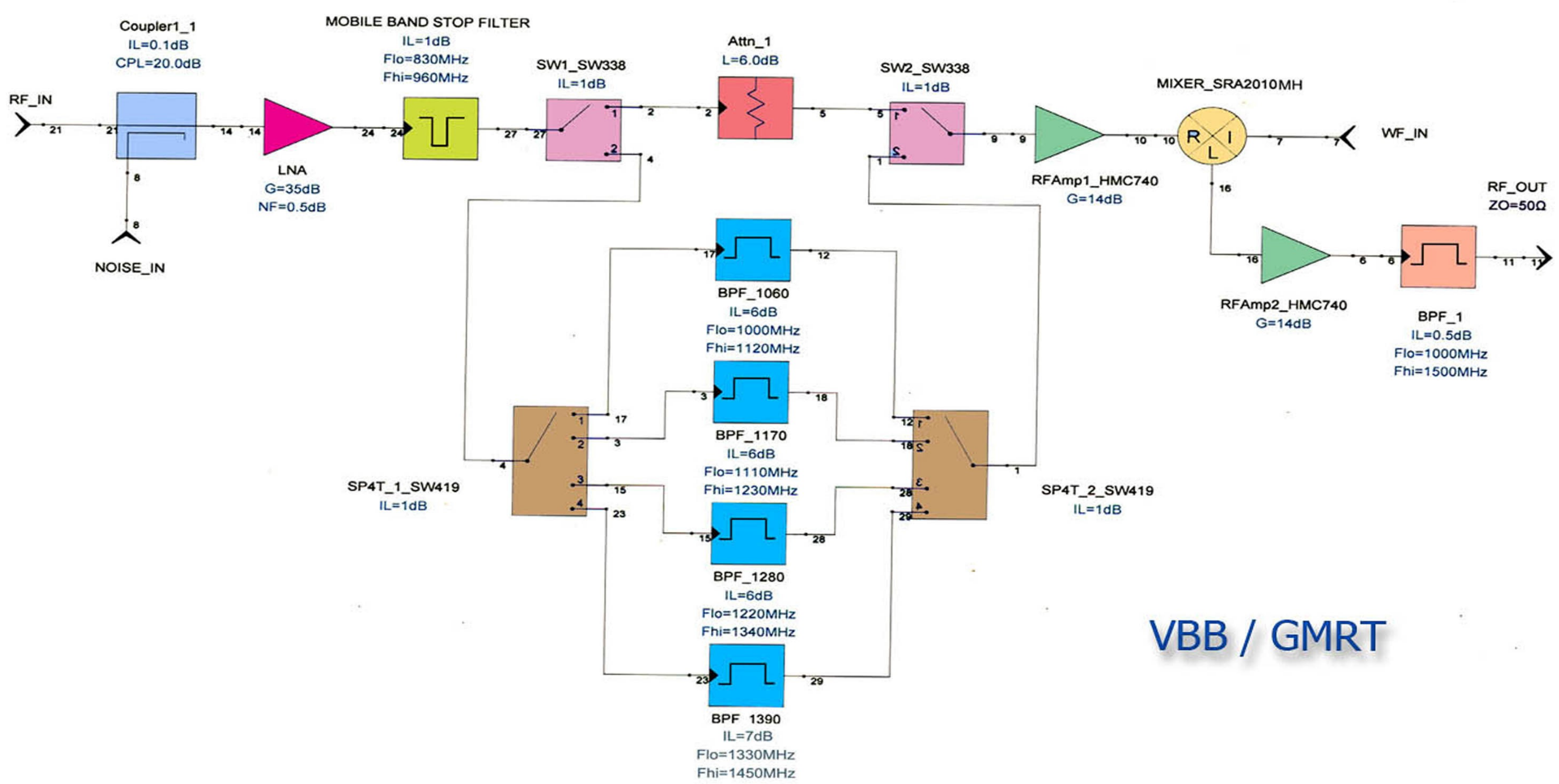
The next stage of the FILTER BY PASS SWITCH and HIGH DYNAMIC PHASE SWITCH AMPLIFIER unit . The signals pass through a set of filter bank or bypass the filter bank to get full band output. The RF switches used are SW338 and SW419 , which has an insertion loss of 1 dB.

In the switched filter mode one of the four sub-bands centered at 1060 MHz , 1170 MHz , 1280 MHz and 1390 MHz , each with a bandwidth of 120 MHz can be selected. The insertion loss of the band pass filter is 6 dB to 7 dB.

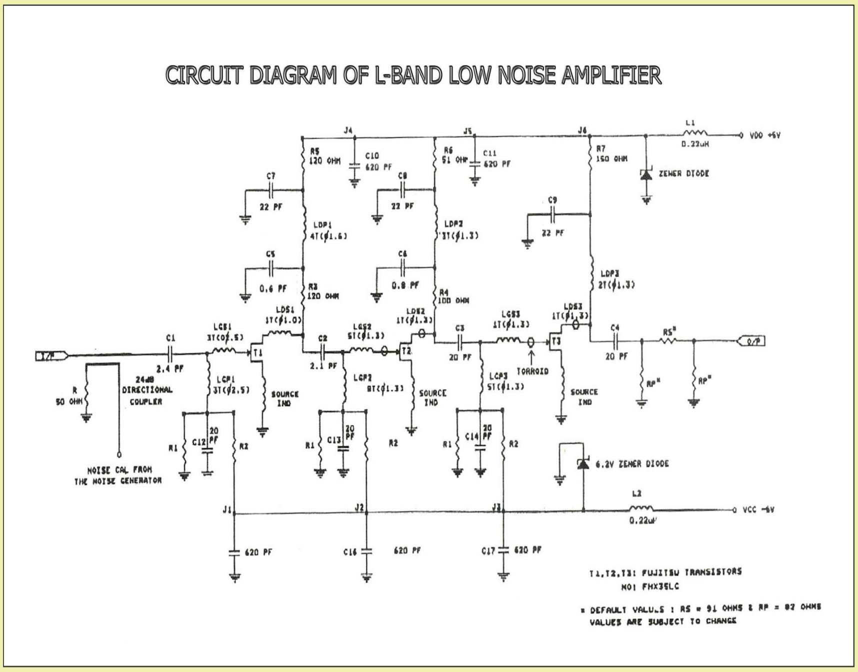
The signals are phase modulated to 180 and 0 degrees with a Walsh Function input , so that the common mode signals can be rejected. It consists of High Dynamic Amplifier HMC740 , Mini-Circuits double balanced mixer SRA-2010MH followed by one more High Dynamic Amplifier HMC740. The Gain of this unit is 18 dB.

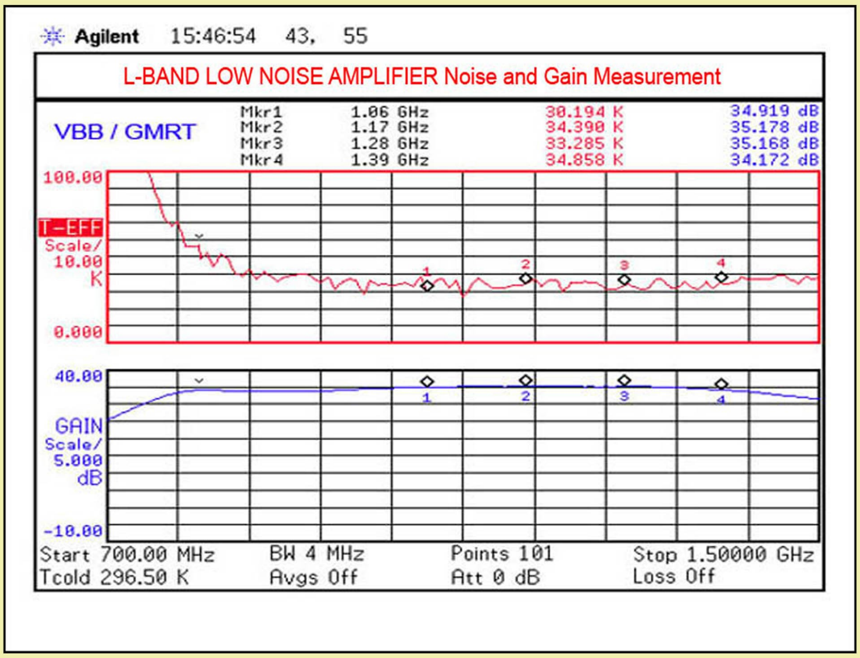
At the final output a 1250 MHz wide band pass filter with bandwidth of 500 MHz is incorporated which has an insertion loss of 0.5 dB.

BLOCK DIAGRAM OF HIGH DYNAMIC L-BAND GMRT RECEIVER



VBB / GMRT


CIRCUIT DIAGRAM OF L-BAND LOW NOISE AMPLIFIER
T1,T2,T3: FUJITSU TRANSISTORS
NO: FHX35LC
* DEFAULT VALUES : RS = 91 OHMS & RP = 82 OHMS
VALUES ARE SUBJECT TO CHANGE


Agilent 15:46:54 43, 55
L-BAND LOW NOISE AMPLIFIER Noise and Gain Measurement
VBB / GMRT
Mkr1 1.06 GHz 30.194 K 34.919 dB
Mkr2 1.17 GHz 34.390 K 35.178 dB
Mkr3 1.28 GHz 33.285 K 35.168 dB
Mkr4 1.39 GHz 34.858 K 34.172 dB
100.00
T-EFF
Scale/
10.00
K
0.000
40.00
GAIN
Scale/
5.000
dB
-10.00
Start 700.00 MHz
Tcold 296.50 K
BW 4 MHz
Avgs Off
Points 101
Att 0 dB
Stop 1.50000 GHz
Loss Off

MOBILE BAND STOP FILTER:

A new miniaturized band stop filter using a microstrip quarter wavelength resonators and open stub inverters for mobile band.

Miniaturized high-performance bandstop filter having low insertion loss and high selectivity in the passband

Figure shows the photograph of the fabricated prototype .

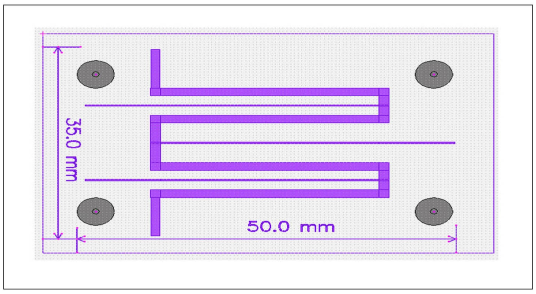
Experimental bandstop filter was designed using AWR and tested.

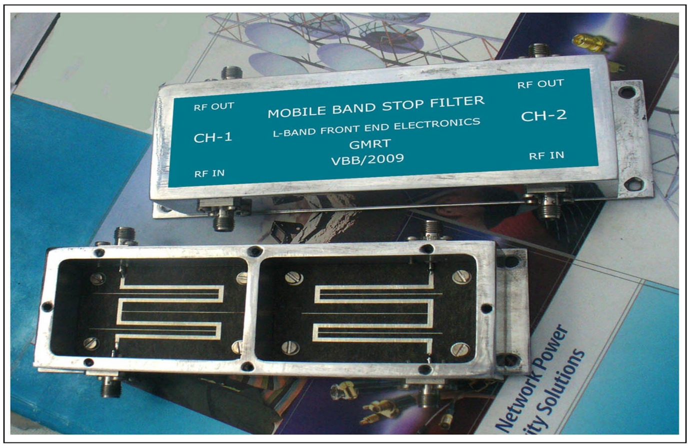
The bandstop filter was fabricated on PTFE substrate (RT / duroid 6010 M) with a relative dielectric constant of 10.2 and a thickness of 1.27 mm

The size of the fabricated filter is 50.00 mm ×35.00 mm.

The measured insertion loss within the pass-band is about 1.5 dB

Within the pass-band, the reflection coefficient is less than -20 dB.





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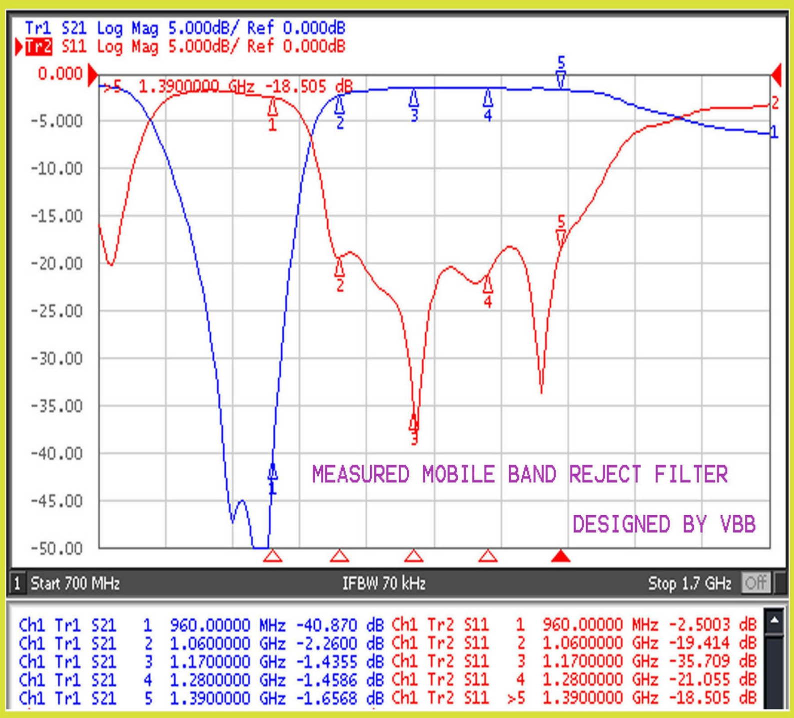
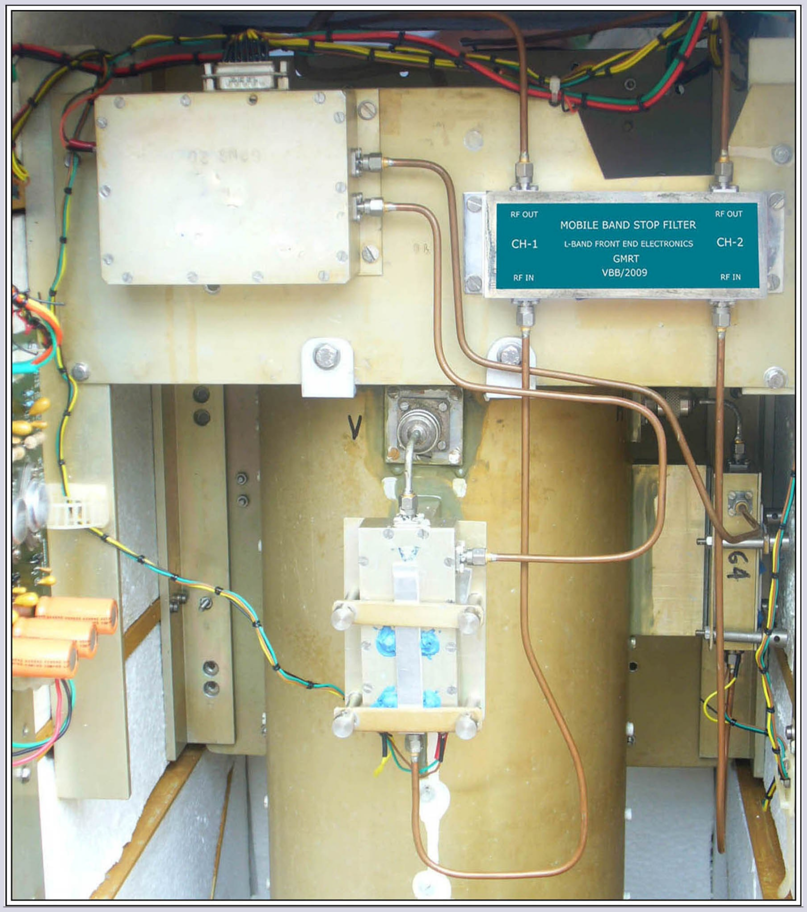
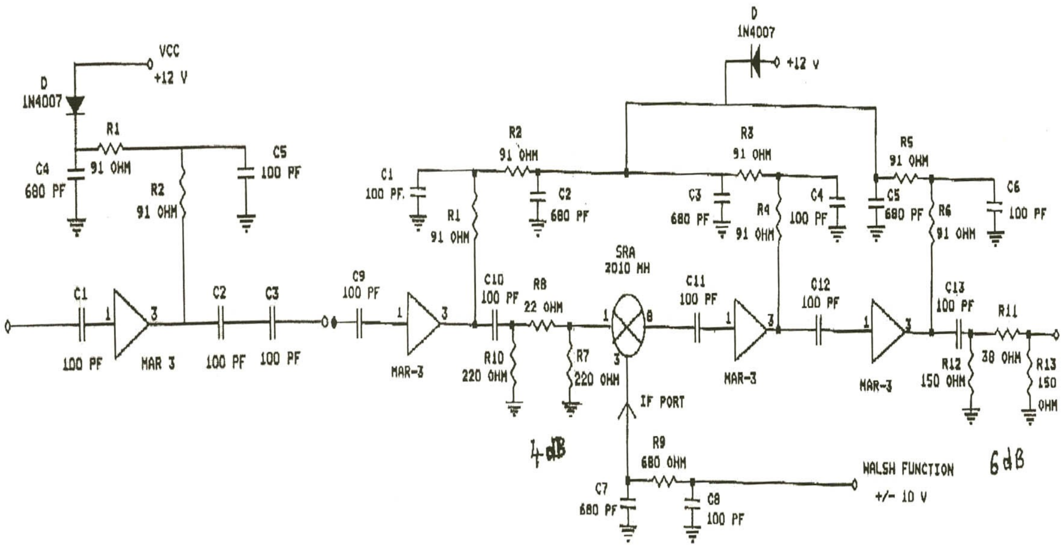
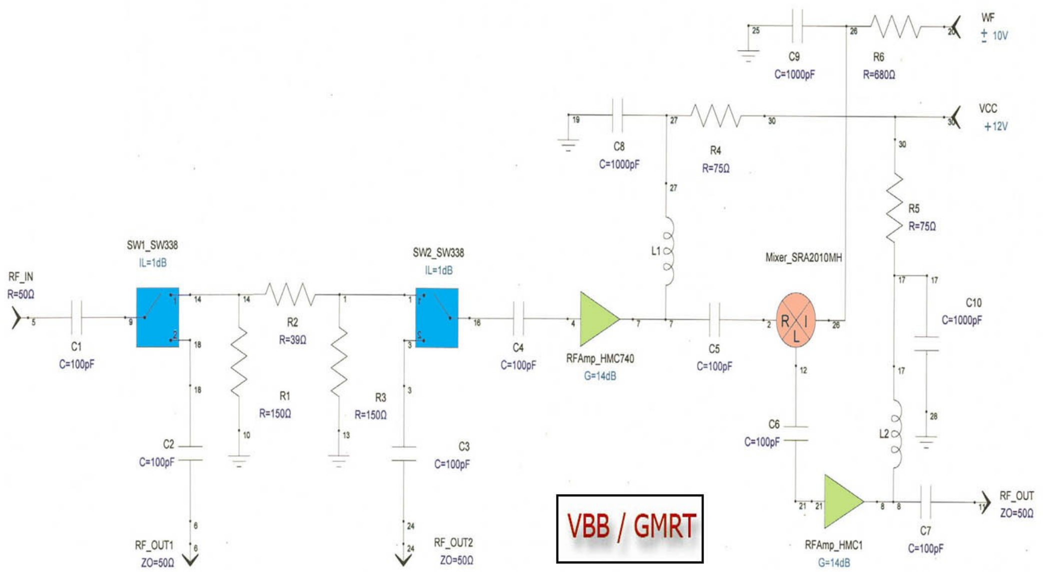

Tr1 S21 Log Mag 5.000dB/ Ref 0.000dB
Tr2 S11 Log Mag 5.000dB/ Ref 0.000dB
>5 1.3900000 GHz -18.505 dB
0.000
-5.000
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
-45.00
-50.00
MEASURED MOBILE BAND REJECT FILTER
DESIGNED BY VBB
1 Start 700 MHz
IFBW 70 kHz
Stop 1.7 GHz
Off
Ch1 Tr1 S21 1 960.00000 MHz -40.870 dB Ch1 Tr2 S11 1 960.00000 MHz -2.5003 dB
Ch1 Tr1 S21 2 1.0600000 GHz -2.2600 dB Ch1 Tr2 S11 2 1.0600000 GHz -19.414 dB
Ch1 Tr1 S21 3 1.1700000 GHz -1.4355 dB Ch1 Tr2 S11 3 1.1700000 GHz -35.709 dB
Ch1 Tr1 S21 4 1.2800000 GHz -1.4586 dB Ch1 Tr2 S11 4 1.2800000 GHz -21.055 dB
Ch1 Tr1 S21 5 1.3900000 GHz -1.6568 dB Ch1 Tr2 S11 >5 1.3900000 GHz -18.505 dB


RF OUT
RF OUT
MOBILE BAND STOP FILTER
CH-1
L-BAND FRONT END ELECTRONICS
CH-2
GMRT
VBB/2009
RF IN
RF IN

CIRCUIT DIAGRAM OF EXISTING PHASE SWITCH AMPLIFIER



Circuit Diagram of High Dynamic Phase Switch Amplifier

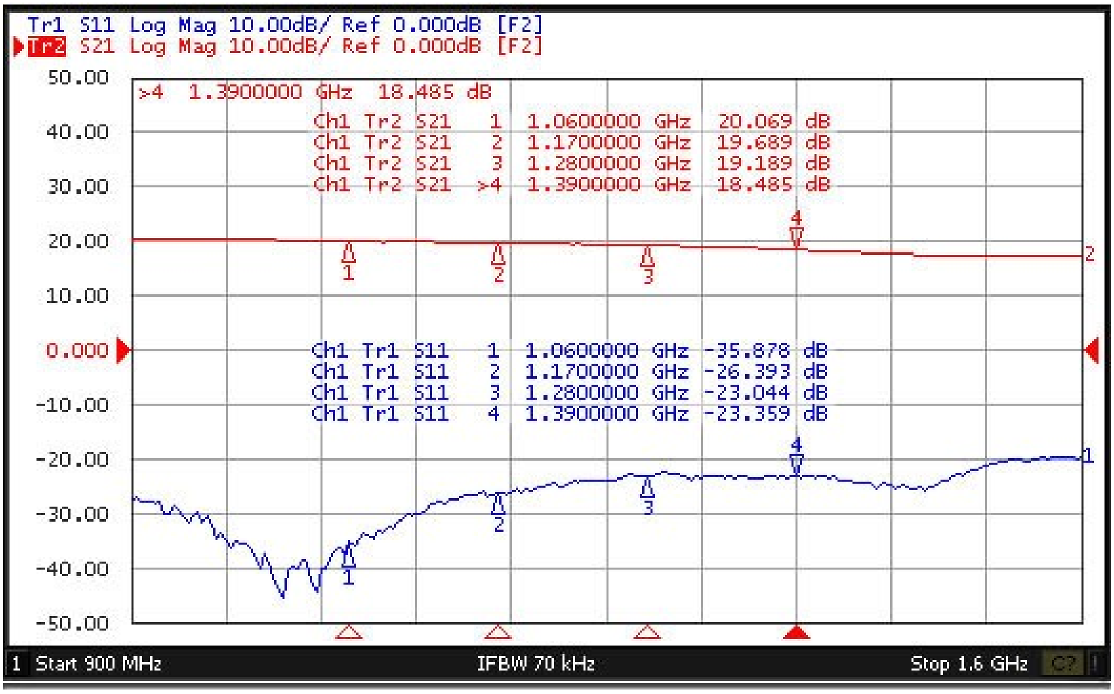


Part List of Filter Bypass and High Dynamic Phase Switch Amplifier :

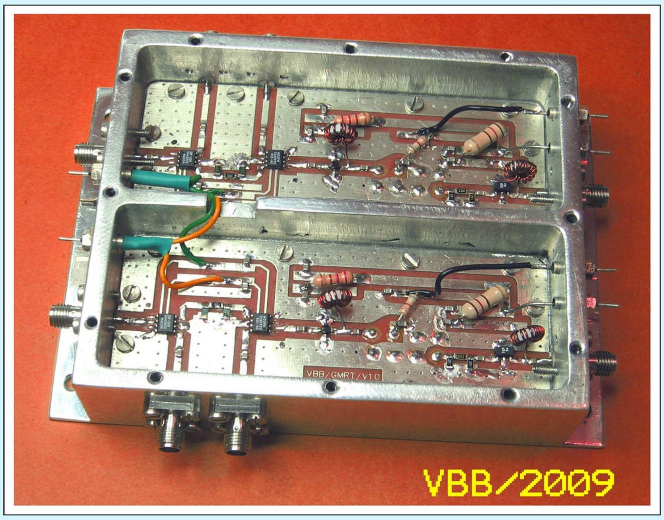
Sr.No.	QTY	ITEM	TYPE	VALUE	RATING/TOL	MAKE	PACKAGE
1	2	R1,R3	CHIP RESISTOR	150 OHMS	1/4 W , +/- 5 %	VISHAY	0805
2	1	R2	CHIP RESISTOR	39 OHMS	1/4 W , +/- 5 %	VISHAY	0805
3	2	R4,R5	CARBON RESISTOR	75 OHMS	2 W , +/- 5 %	VISHAY	AXIAL
4	1	R6	CARBON RESISTOR	680 OHMS	1/4 W , +/- 5 %	VISHAY	AXIAL
5	7	C1,C2,C3,C4	CHIP CAPACITOR	100 pF	CERAMIC +/-1%	ATC	0805
		C5,C6,C7					
6	3	C8,C9,C10	CHIP CAPACITOR	1000 pF	CERAMIC +/-1%	ATC	0805
7	2	L1,L2	TOROIDAL INDUCTOR	# 26 ,13 T	ID 3 mm,OD 6 mm		
8	2	SW1,SW2	SPDT RF SWITCH	SW338	DC-2.5 GHz	M/ACOM	SOIC-8
9	1	RF MIXER	LEVEL 13 RF MIXER	SRA2010MH	10-2000 MHz	MINI-CIRCUITS	A06
10	2	RF A1,RF A2	MMIC AMPLIFIER	15 dB,HMC740	0.05-3 GHZ	HITTITE	SOT-89
11	6	F1,F2,F3	FEEDTHRU CAP	1500 pF	200 V	SPECTUM CTL	8-UNC
		F4,F5,F6					
12	8	J1,J2,J3,J4	SMA FLANGE MOUNT	23 SMA-50-0-53	STAINLESS STEEL	HUBER-SUHNER	FOUR SCREWS
		J5,J6,J7J8	CHASSIS CONNECTOR				
13	1	CHSSIS	AL MILLED	VBB DESIGN	AS PER	DRAWING	

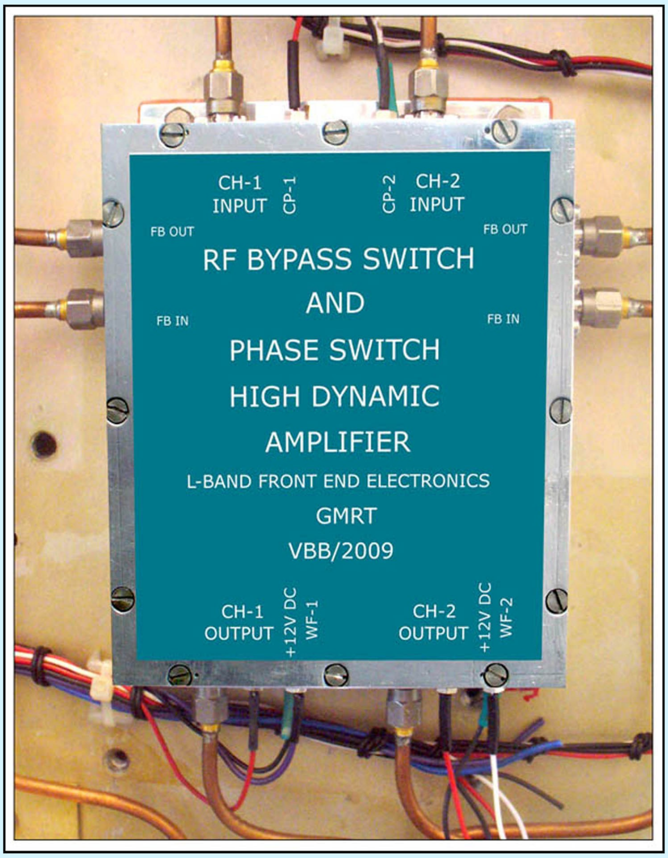
GAIN and INPUT Return Loss Measurement using Network Analyser E5070B

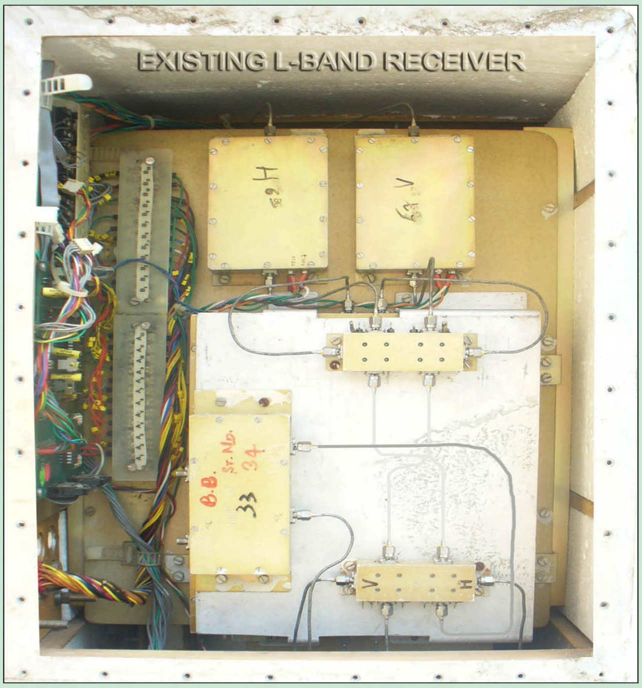
(Filter Bypass and High Dynamic Phase Switch Amplifier)

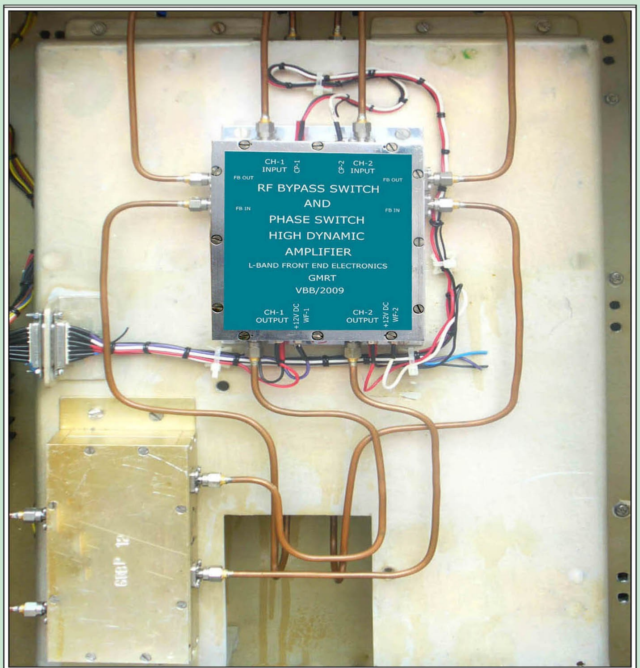


Photograph of Filter Bypass SW and High Dynamic Phase Switch Amplifier





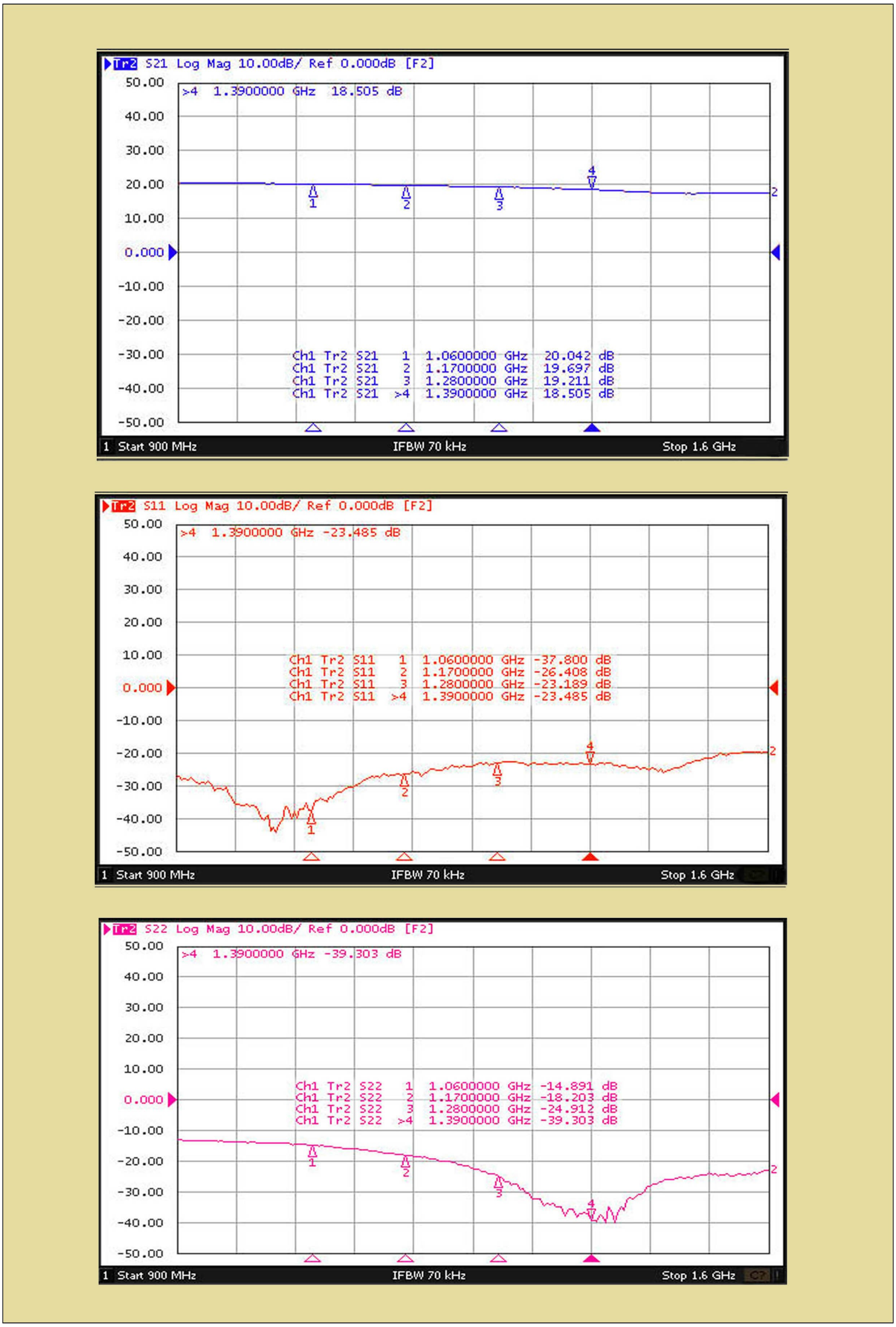




MODIFIED L-BAND RECEIVER

S21, S11 and S22 Measurement using Network Analyser E5070B

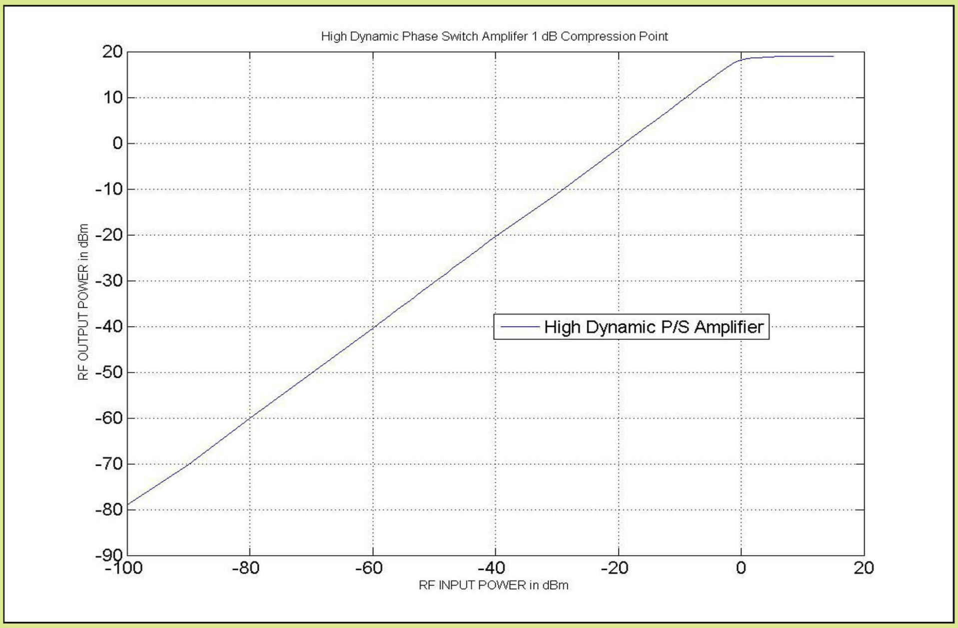
(Filter Bypass SW and High Dynamic Phase Switch Amplifier)



1 dB Compression Point Measurement :

(Filter Bypass SW and High Dynamic Phase Switch Amplifier)

RF INPUT POWER	RF OUTPUT POWER	RF INPUT POWER	RF OUTPUT POWER
dBm	dBm	dBm	dBm
-100	-79	-6	13
-90	-70.2	-5	14
-80	-60.1	-4	14.9
-70	-50.3	-3	15.9
-60	-40.4	-2	16.8
-50	-30.4	-1	17.6
-40	-20.4	0	18.2
-30	-11.1	1	18.5
-20	-1	2	18.6
-19	0	3	18.7
-18	1	4	18.8
-17	2	5	18.8
-16	3	6	18.9
-15	4	7	19
-14	4.9	8	19
-13	5.9	9	19
-12	6.9	10	19
-11	8	11	19
-10	9	12	19
-9	10	13	19
-8	11	14	19
-7	12	15	19



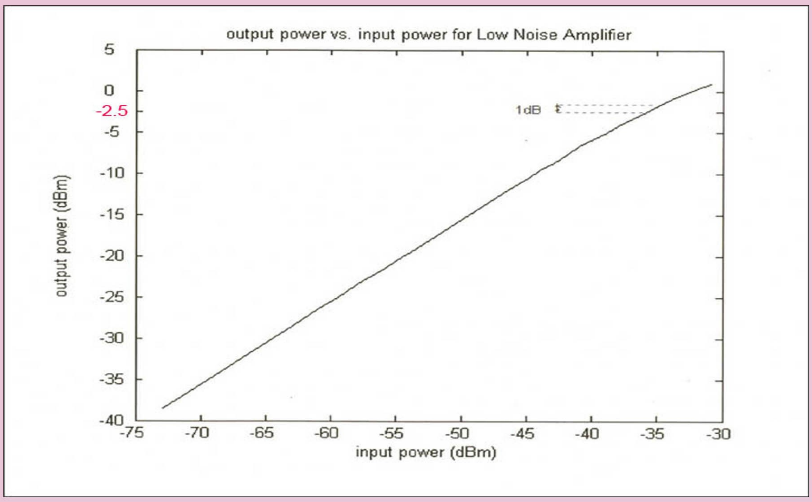
1 dB Compression Point Measurement :

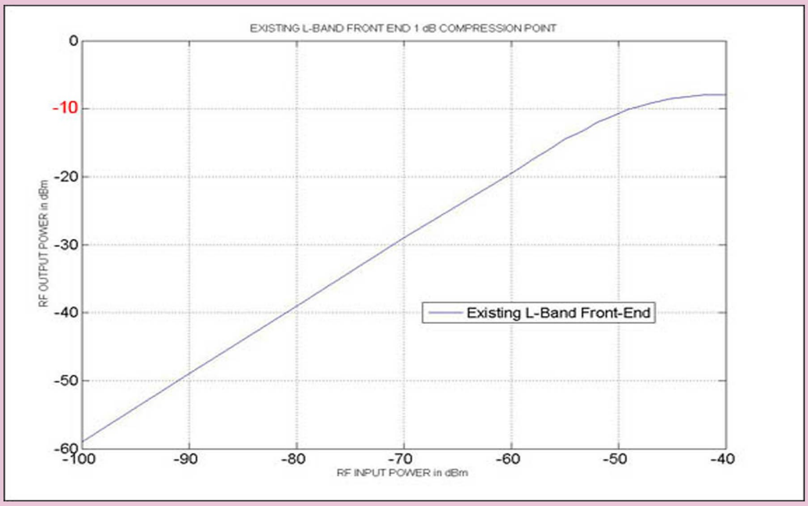
(Complete L- BAND FRONT END with High Dynamic Amplifier)

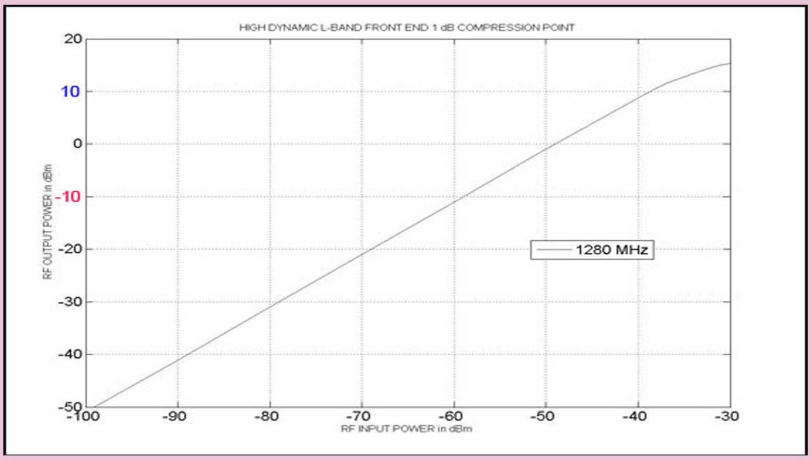
RF IN	ATTN	RF OUT @ 1060	RF OUT @ 1170	RF OUT @ 1280	RF OUT @ 1390
dBm	dB	dBm	dBm	dBm	dBm
-100	30	-80	-80.3	-80.9	-81.93
-90	30	-70	-70.4	-71.1	-72.19
-80	30	-60	-60.4	-61	-62.29
-70	30	-50	-50.4	-51	-52.38
-60	30	-40	-40.4	-41	-42.42
-50	30	-30	-30.4	-31	-32.37
-40	30	-20	-20.4	-21.26	-22.44
-38	30	-18.4	-18.73	-19.42	-20.6
-37	30	-17	-17.9	-18.58	-19.78
-36	30	-17.7	-17.1	-17.85	-19.02
-35	30	-16.5	-16.5	-17.22	-18.35
-34	30	-16.1	-15.9	-16.59	-17.69
-33	30	-15.8	-15.4	-16	-17.07
-32	30	-15.5	-15.04	-15.5	-16.47
-31	30	-15.3	-14.68	-15	-15.94
-30	30	-15	-14.38	-14.71	-15.48

<u>1 dB COMPRESSION POINT</u>

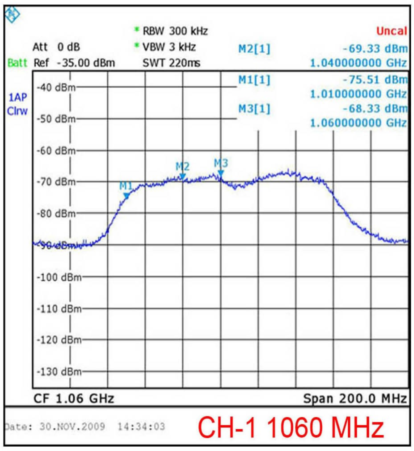
Comparison of LNA , Existing L-BAND and High Dynamic L-BAND FRONT END



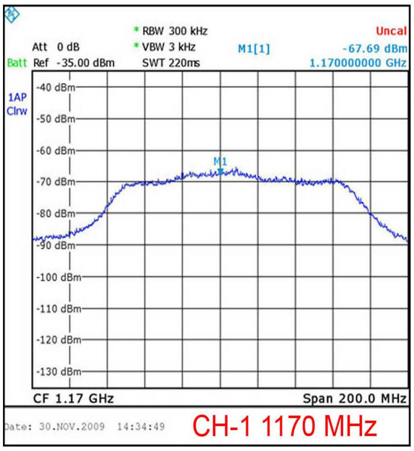




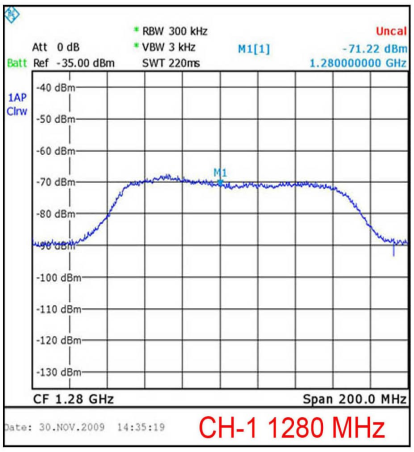
Test Results of L-BAND FRONT END in LAB (CH-1)



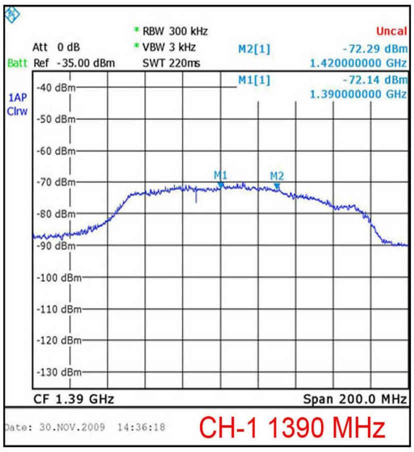
CH-1 1060 MHz



CH-1 1170 MHz



CH-1 1280 MHz



CH-1 1390 MHz

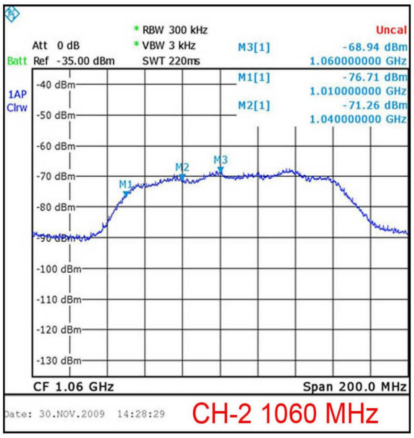
CH-1 FULL BAND

LAB- TESTING PLOTS

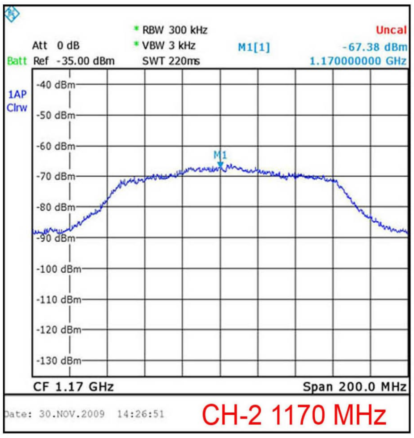
1420 FEED Sr. No.13

VBB / SSB

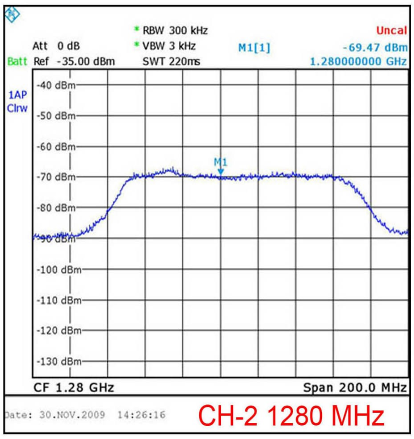
Test Results of L-BAND FRONT END in LAB (CH-2)



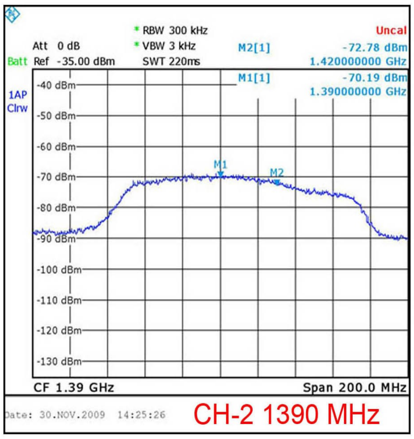
CH-2 1060 MHz



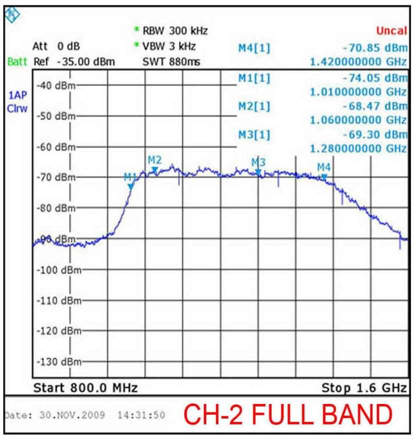
CH-2 1170 MHz



CH-2 1280 MHz



CH-2 1390 MHz



CH-2 FULL BAND

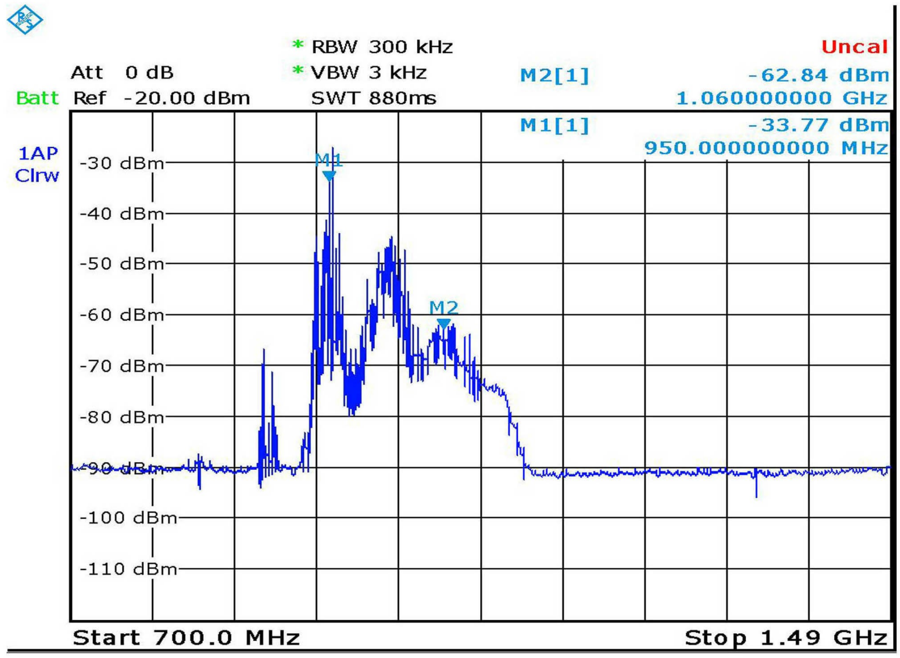
LAB- TESTING PLOTS

1420 FEED Sr. No.13

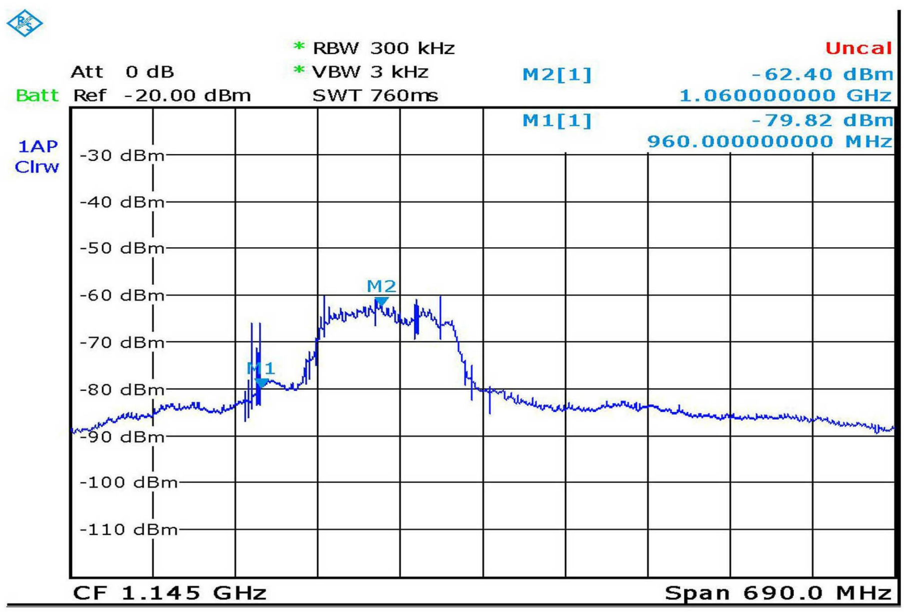
VBB / SSB

Test Results of L-BAND FRONT END at Antenna E-02 (CH-1: 1060 MHz)

E2_CH1_1060 MHz

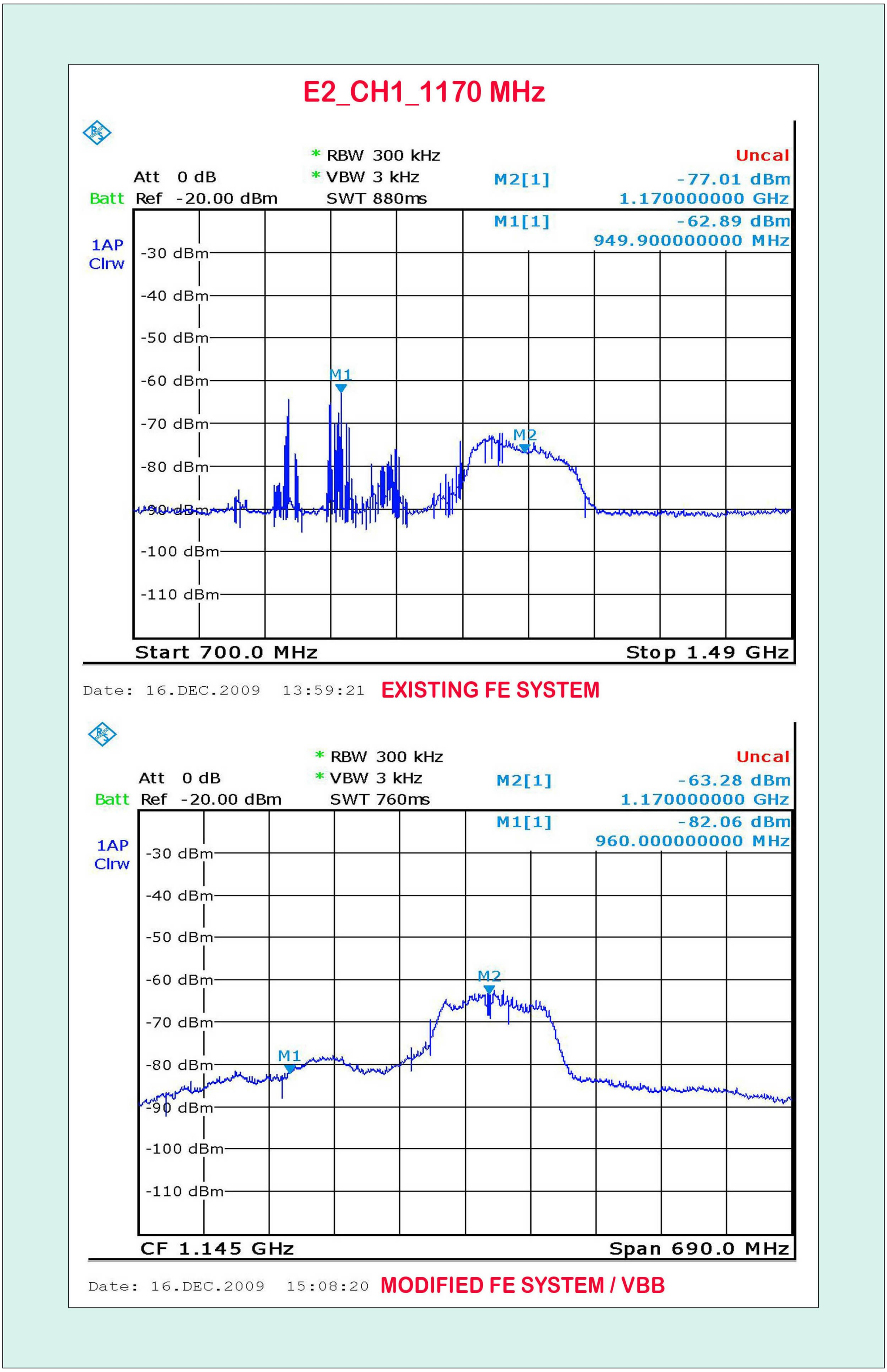


Date: 16.DEC.2009 13:58:25 EXISTING FE SYSTEM

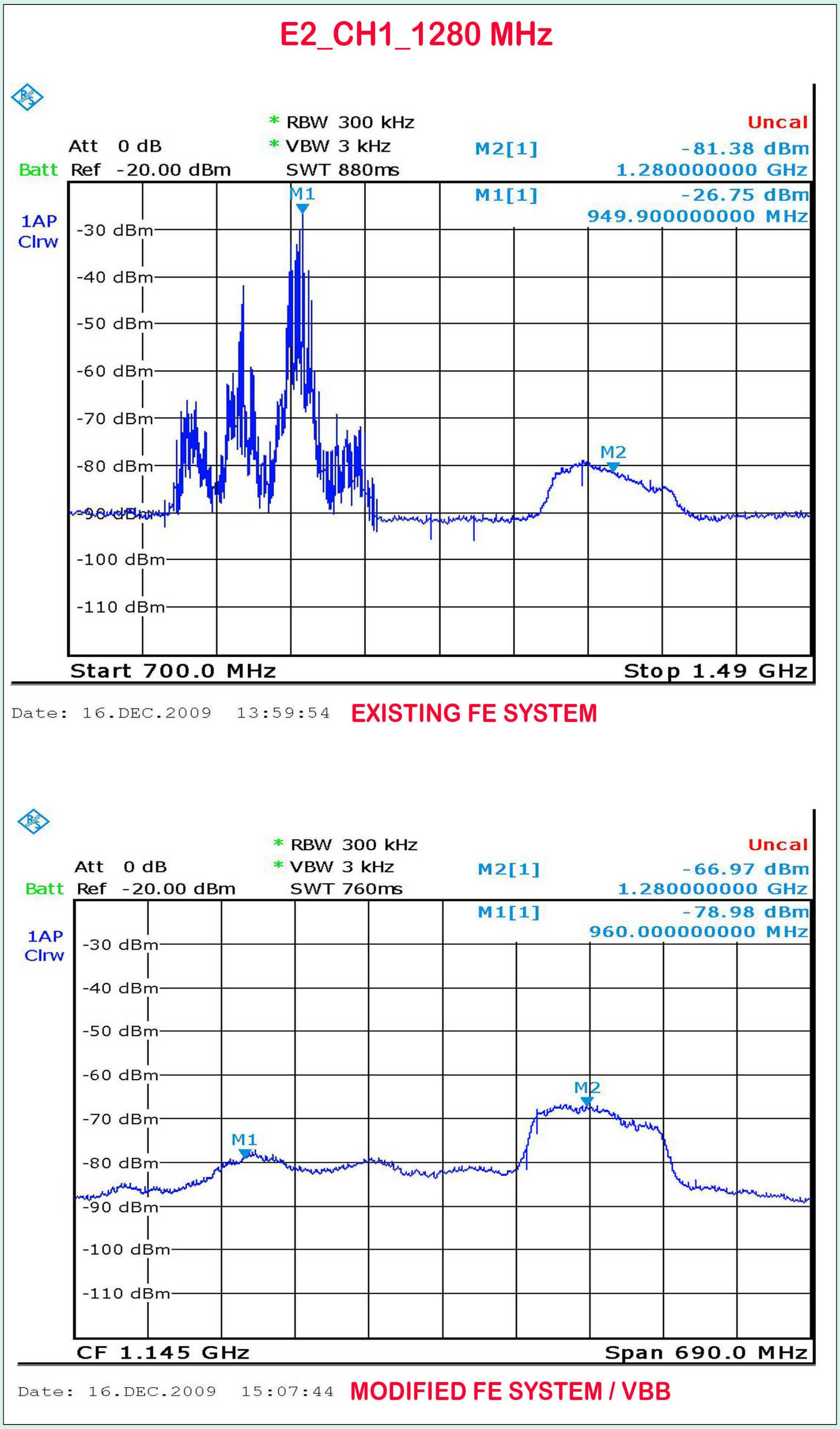


Date: 16.DEC.2009 15:09:06 MODIFIED FE SYSTEM / VBB

Test Results of L-BAND FRONT END at Antenna E-02 (CH-1: 1170 MHz)

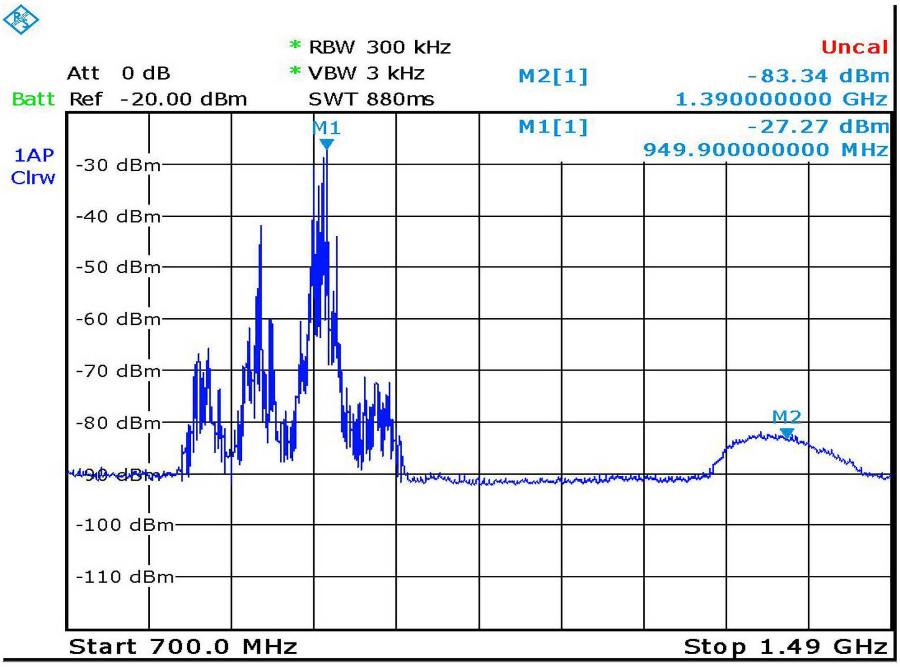


Test Results of L-BAND FRONT END at Antenna E-02 (CH-1: 1280 MHz)

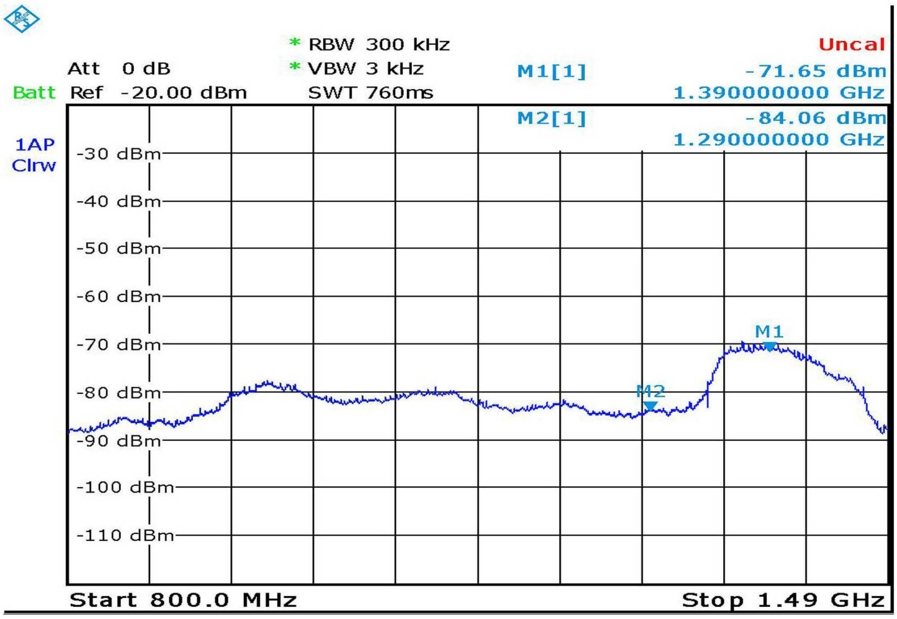


Test Results of L-BAND FRONT END at Antenna E-02 (CH-1: 1390 MHz)

E2_CH1_1390 MHz

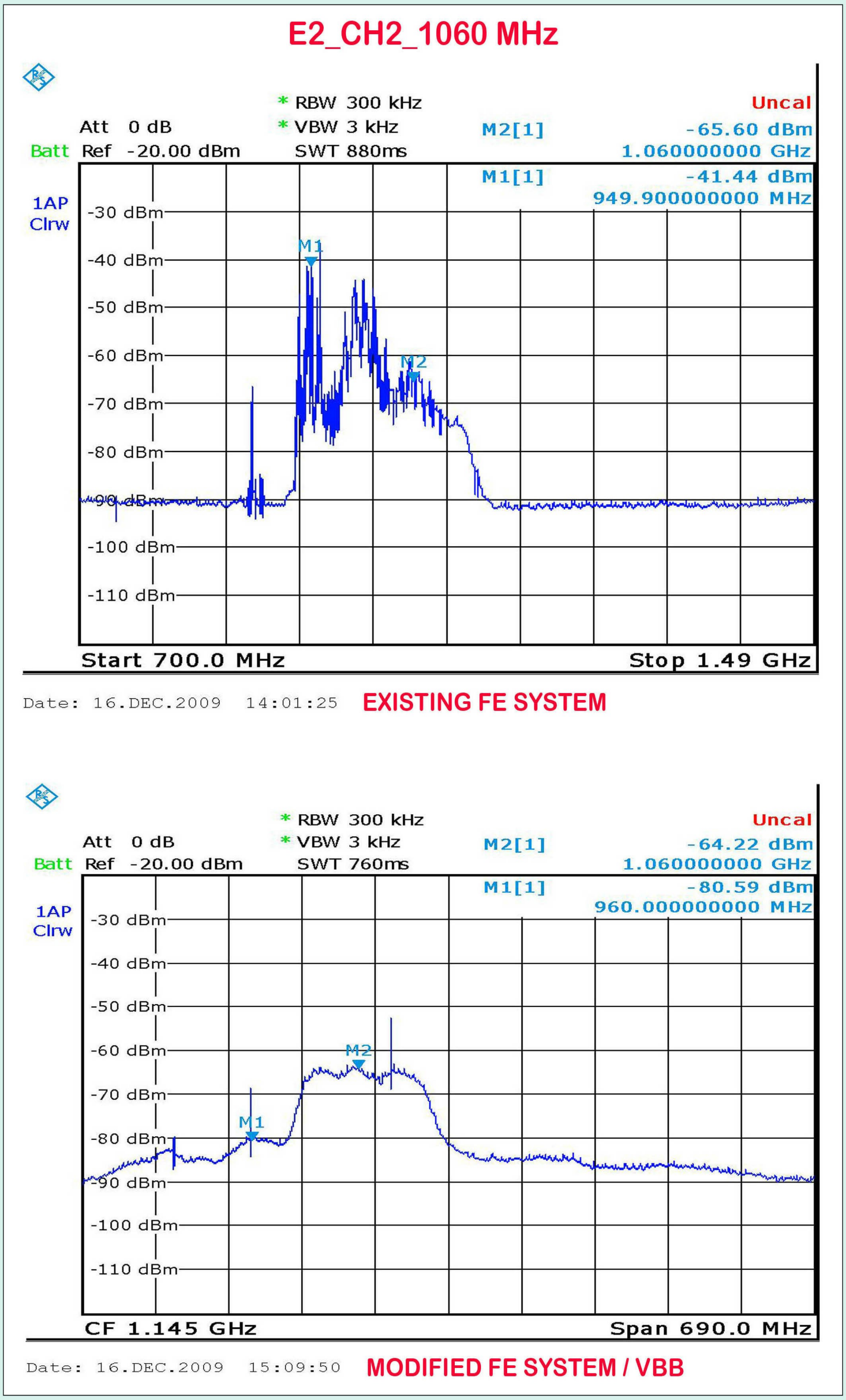


Date: 16.DEC.2009 13:57:34 **EXISTING FE SYSTEM**



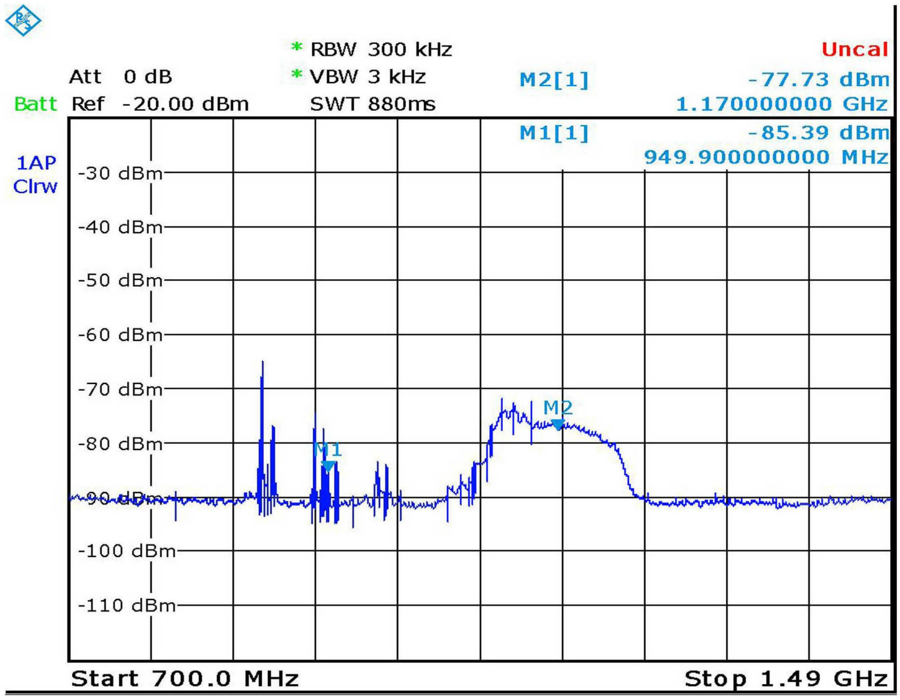
Date: 16.DEC.2009 15:06:57 **MODIFIED FE SYSTEM / VBB**

Test Results of L-BAND FRONT END at Antenna E-02 (CH-2: 1060 MHz)

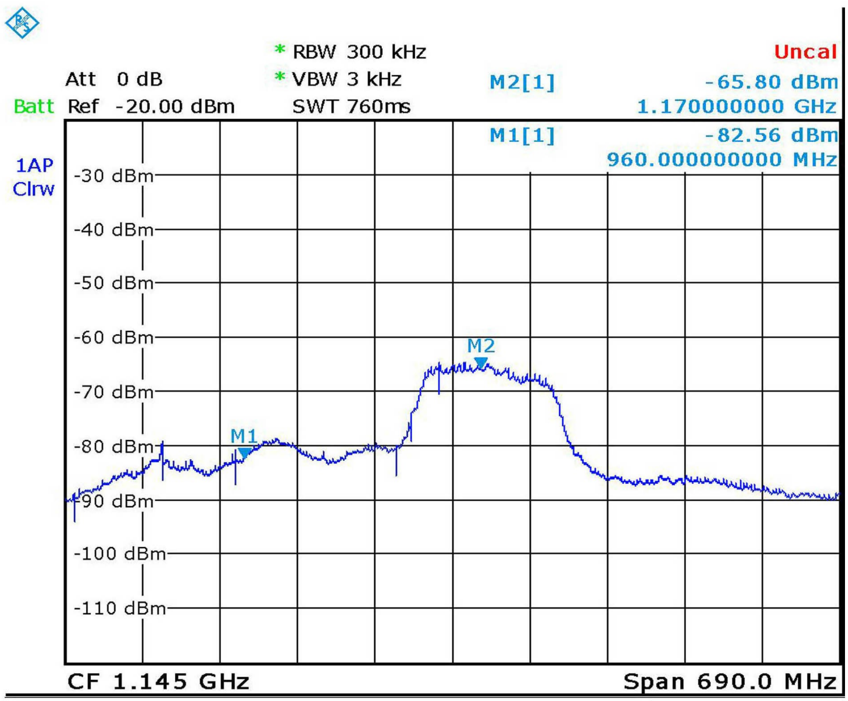


Test Results of L-BAND FRONT END at Antenna E-02 (CH-2: 1170 MHz)

E2_CH2_1170 MHz

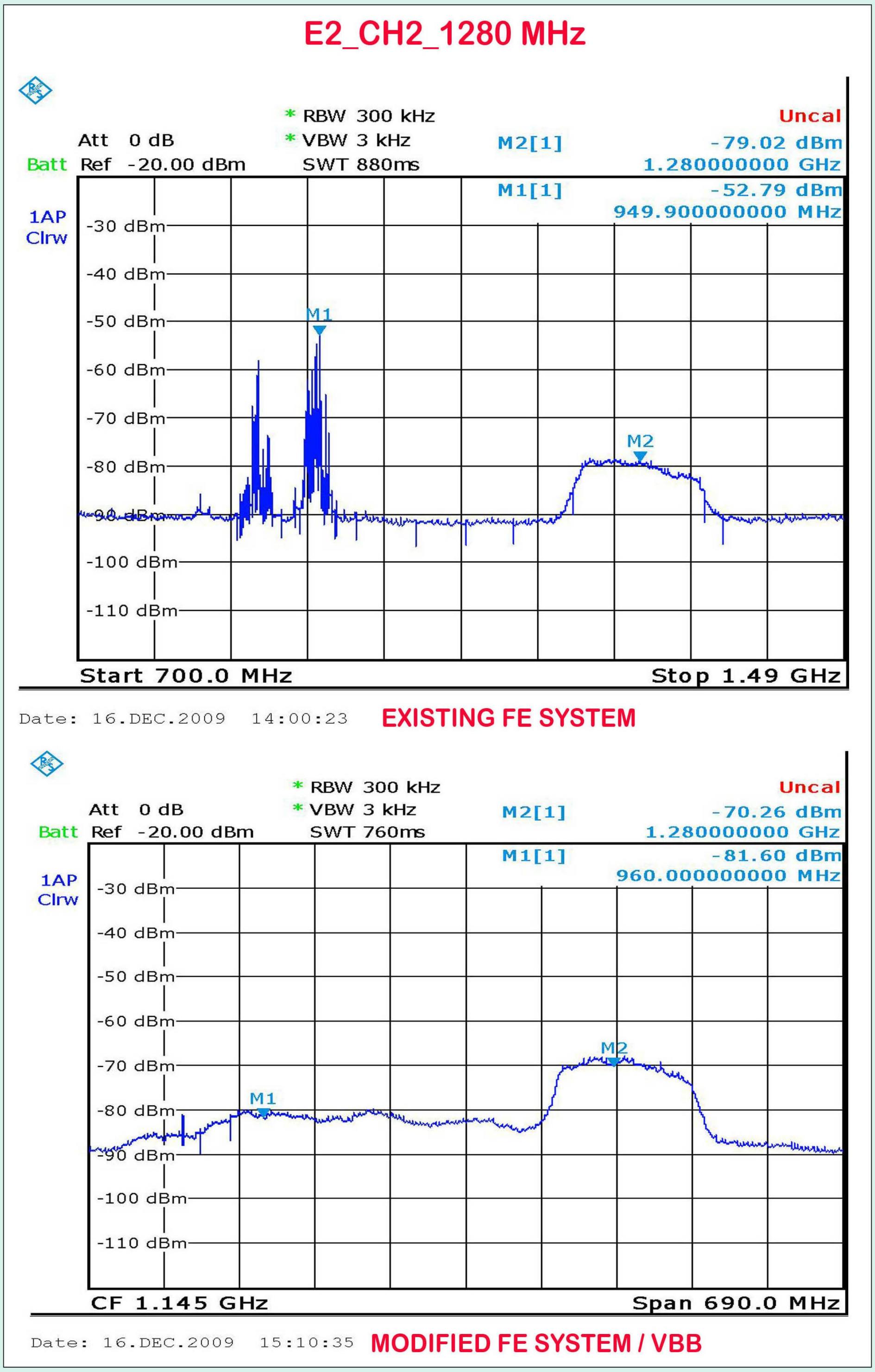


Date: 16.DEC.2009 14:00:55 **EXISTING FE SYSTEM**



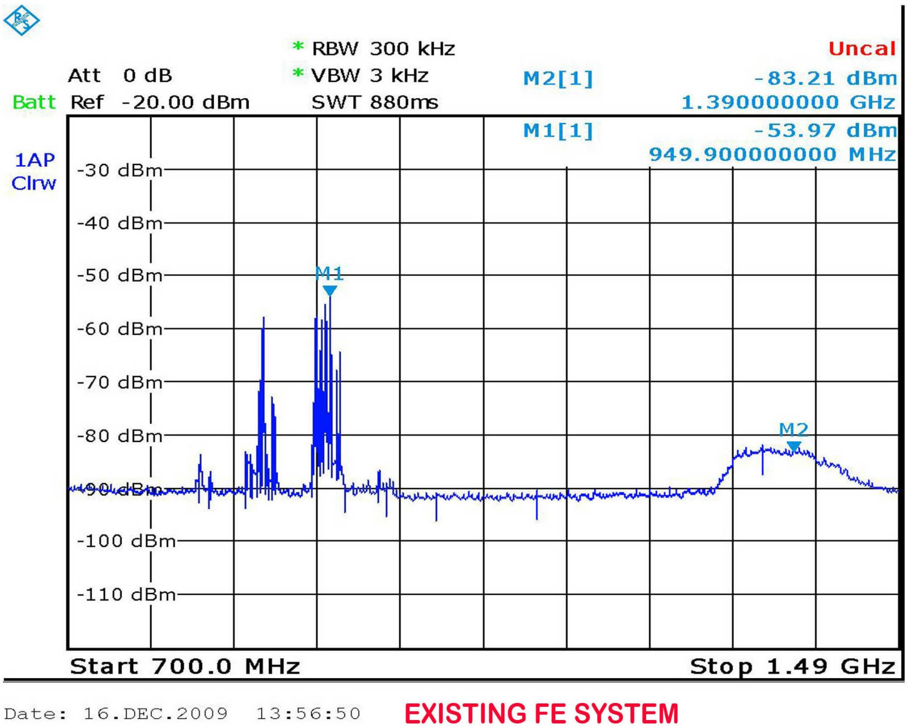
Date: 16.DEC.2009 15:10:12 **MODIFIED FE SYSTEM / VBB**

Test Results of L-BAND FRONT END at Antenna E-02 (CH-2: 1280 MHz)

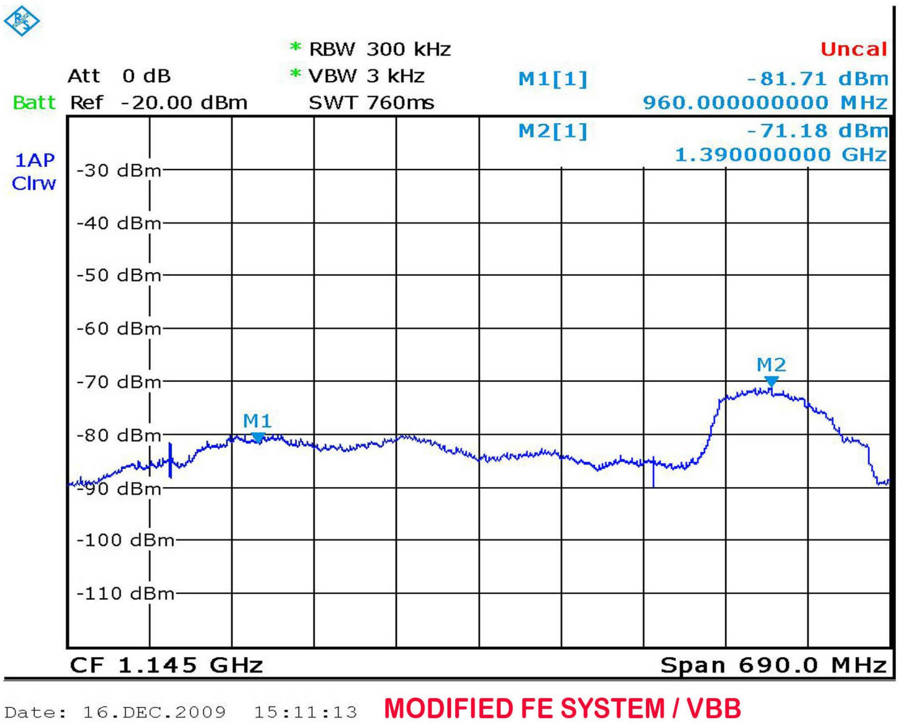


Test Results of L-BAND FRONT END at Antenna E-02 (CH-2: 1390 MHz)

E2_CH2_1390 MHz



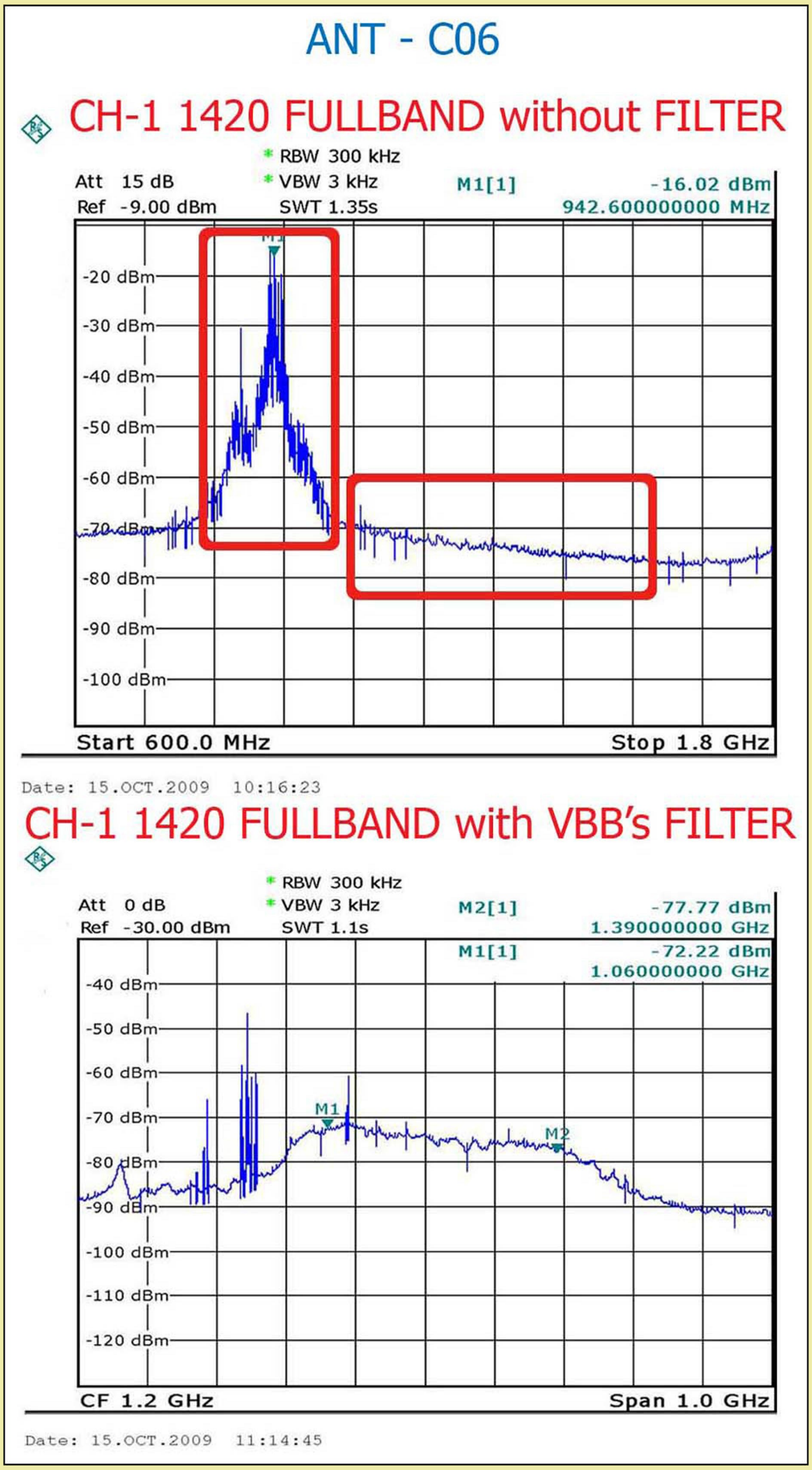
EXISTING FE SYSTEM

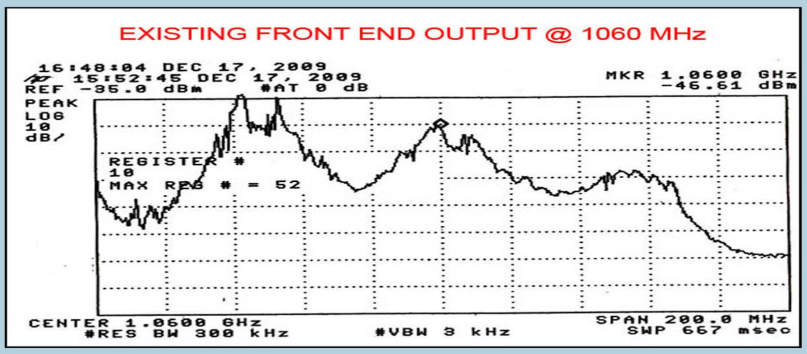


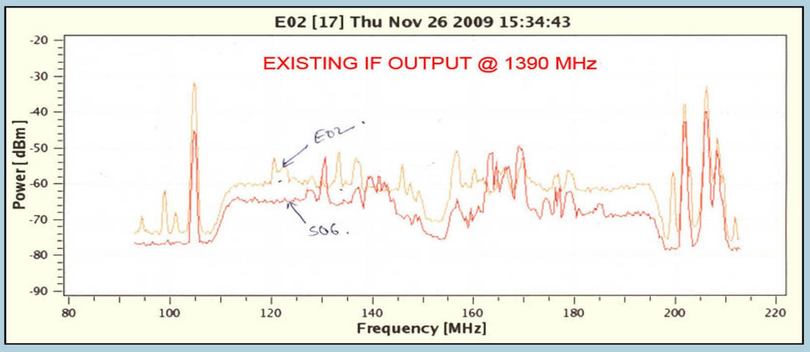
MODIFIED FE SYSTEM / VBB

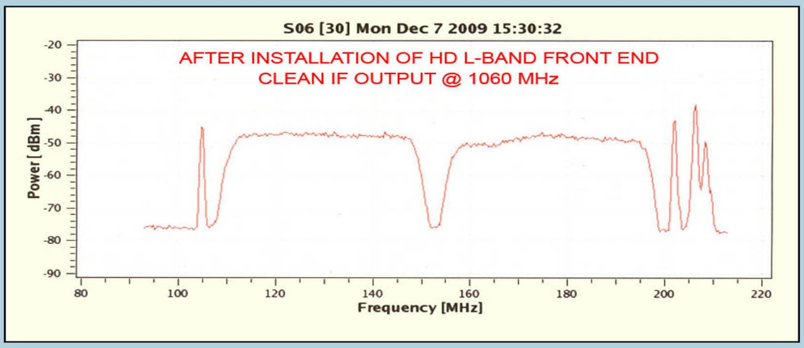
Test Results of L-BAND FRONT END at Antenna C-06

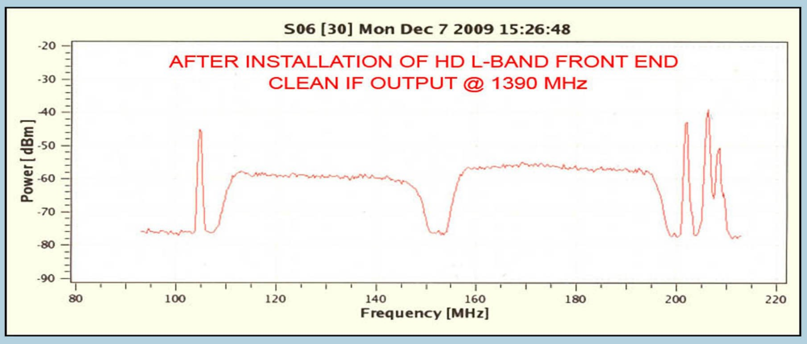
(CH-1: FULLBAND MHz)




EXISTING FRONT END OUTPUT @ 1060 MHz
16:48:04 DEC 17, 2009
15:52:45 DEC 17, 2009
REF -35.0 dBm #AT 0 dB
MKR 1.0600 GHz
-46.61 dBm
PEAK
LOG
10
dB/
REGISTER #
10
MAX REG # = 52
CENTER 1.0600 GHz
#RES BW 300 kHz
#VBW 3 kHz
SPAN 200.0 MHz
SWP 667 msec


E02 [17] Thu Nov 26 2009 15:34:43
EXISTING IF OUTPUT @ 1390 MHz
E02.
S06.
Power [dBm]
Frequency [MHz]


S06 [30] Mon Dec 7 2009 15:30:32
AFTER INSTALLATION OF HD L-BAND FRONT END
CLEAN IF OUTPUT @ 1060 MHz
Power [dBm]
Frequency [MHz]


S06 [30] Mon Dec 7 2009 15:26:48
AFTER INSTALLATION OF HD L-BAND FRONT END
CLEAN IF OUTPUT @ 1390 MHz
Power [dBm]
Frequency [MHz]

RESULT:

[1] MAR 3 is incorporated in the existing L-band front-end design in the post amplifier and the phase switch network with one stage of MAR 3 in post amplifier and 3 stages of MAR 3 in post amplifier.

	Gain	NF	P1	OIP3
MAR-3	10 dB	6.0 dB	+1.5 dBm	+23 dBm
HMC740	14 dB	3.5 dB	+18 dBm	+40 dBm

To compare the characteristics of MAR 3 (mini-circuits) and HMC740 (Hittite) amplifiers we have designed an amplifier with HMC740 while keeping L-BAND FRONT END gain of 50 dB.

[2] Only two HMC740 devices are used.

[3] Existing L-band front end is having total 5 nos. of aluminum chassis for RF Bypass Switch (2 Nos.) , Post amplifier (1 No.) and Phase Switch Amplifier (2 Nos.).

[4] High Dynamic L-Band Front End has only ONE aluminum chassis for the same. So number of inter-connection and RF connectors are reduced.

[5] Existing L-band front end has 1 dB compression point of -15 dBm.

[6] High Dynamic L-Band Front End has 1 dB compression point of +13 dBm.

[7] Mobile signal level is down by 35 dB after using Mobile band stop filter.

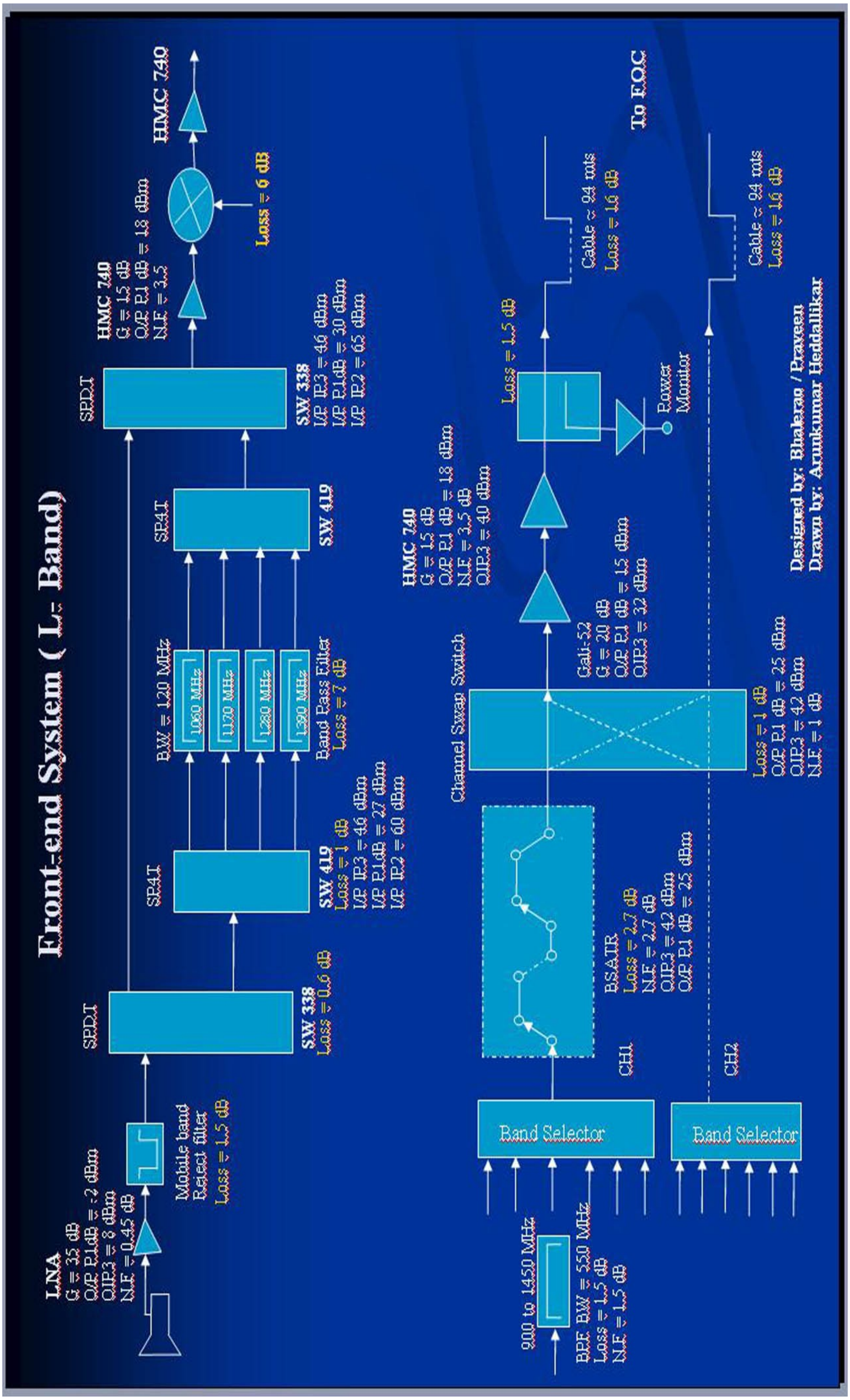
[8] Full Band and all sub-band are seen clearly.

[9] Signal to Noise Ratio is increase by 10 dB at 1390 MHz.

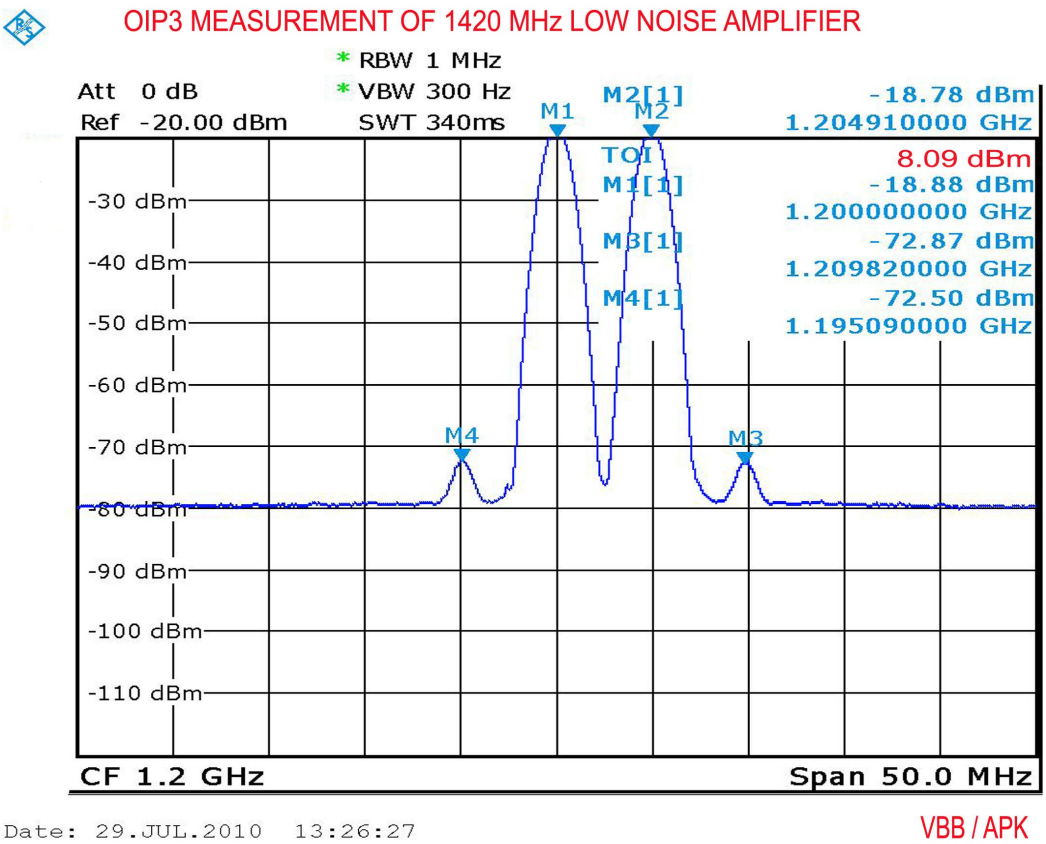
[10] Problem like Bad band shape at 1390 MHz and Huge RFI at 1060 MHz are totally vanished.

[11] We had installed the High Dynamic L-Band Front End to the following Antennas:

C06, S06, E06, E02, C04, W04, C03, C14, E03, C11, E05, W06, W05 and C13.


Front-end System (L- Band)
LNA
G = 35 dB
O/P P1dB = -2 dBm
OIP3 = 8 dBm
N.F = 0.45 dB
Mobile band
Reject filter
Loss = 1.5 dB
SPDT
SW 338
Loss = 0.6 dB
SP4T
SW 419
Loss = 1 dB
I/P IP3 = 46 dBm
I/P P1dB = 27 dBm
I/P IP2 = 60 dBm
B.W = 120 MHz
1060 MHz
1170 MHz
1280 MHz
1390 MHz
Band Pass Filter
Loss = 7 dB
SP4T
SW 419
SPDT
SW 338
I/P IP3 = 46 dBm
I/P P1dB = 30 dBm
I/P IP2 = 65 dBm
HMC 740
G = 15 dB
O/P P1 dB = 18 dBm
N.F = 3.5
Loss = 6 dB
HMC 740
900 to 1450 MHz
BPF BW = 550 MHz
Loss = 1.5 dB
N.F = 1.5 dB
Band Selector
CH1
BSATR
Loss = 2.7 dB
N.F = 2.7 dB
OIP3 = 42 dBm
O/P P1 dB = 25 dBm
Channel Swap Switch
Loss = 1 dB
O/P P1 dB = 25 dBm
OIP3 = 42 dBm
N.F = 1 dB
Gali-52
G = 20 dB
O/P P1 dB = 15 dBm
OIP3 = 32 dBm
HMC 740
G = 15 dB
O/P P1 dB = 18 dBm
N.F = 3.5 dB
OIP3 = 40 dBm
Loss = 1.5 dB
Power Monitor
Cable ≈ 94 mts
Loss = 16 dB
To FOC
Band Selector
CH2
Cable ≈ 94 mts
Loss = 16 dB
Designed by: Bhalerao / Praveen
Drawn by: Arunkumar Heddallikar


1420 MHz LOW NOISE AMPLIFIER


OIP3 MEASUREMENT OF 1420 MHz LOW NOISE AMPLIFIER
* RBW 1 MHz
Att 0 dB
* VBW 300 Hz
Ref -20.00 dBm
SWT 340ms
M1
M2
M2[1] -18.78 dBm
1.204910000 GHz
TOI 8.09 dBm
M1[1] -18.88 dBm
1.200000000 GHz
M3[1] -72.87 dBm
1.209820000 GHz
M4[1] -72.50 dBm
1.195090000 GHz
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
-100 dBm
-110 dBm
M4
M3
CF 1.2 GHz
Span 50.0 MHz
Date: 29.JUL.2010 13:26:27
VBB / APK

Summary of L-Band Front-End Cascaded Signal Flow Analysis

Date : 10 Aug 2010

UNIT Description	DEVICE Part	Freq (MHz)	Zin/Zout (ohms)	Gain (dB)	Noise Figure (dB)	Output P1 dB (dBm)	Output IP3 (dBm)	Pow @ Device O/P	Cum. Gain (dB)	Cum. NF (dB)	Head room for the I/P	I/P for Device Sat
LNA	FHX35LG	1200	50	35.00	0.45	-2	8	-59.00	35.00	0.45	57	-37
GSM-CDMA Filter		1200	50	-1.5	1.5	40	1000.00	-60.50	33.50	0.45	100.5	6.5
SPDT RF Switch	SW-338	1200	50	-0.6	0.6	30	46.00	-61.10	32.90	0.45	91.1	-2.9
Filter-bank		1200	50	-7	7	35	1000.00	-68.10	25.90	0.46	103.1	9.1
SPDT RF Switch	SW-338	1200	50	-0.6	0.6	30	46.00	-68.70	25.30	0.46	98.7	4.7
Hittite Amplifier	HMC740	1200	50	14	3.5	18	40.00	-54.70	39.30	0.47	72.7	-21.3
Phase Switch	SRA-2010MH	1200	50	-5	5	10	25.00	-59.70	34.30	0.48	69.7	-24.3
Hittite Amplifier	HMC740	1200	50	14	3.5	18	40.00	-45.70	48.30	0.48	63.7	-30.3
WBPF		1200	50	-0.5	0.5	35	1000.00	-46.20	47.80	0.48	81.2	-12.8
BSATR	SW-338,SW-239	1200	50	-2.7	2.7	30	46.00	-48.90	45.10	0.48	78.9	-15.1
SWAPSW	SW-239	1200	50	-1	1	30	46.00	-49.90	44.10	0.48	79.9	-14.1
Mini-circuit Amp.	Gali-52	1200	50	20	2.5	15	32.00	-29.90	64.10	0.48	44.9	-49.1
Hittite Amplifier	HMC740	1200	50	14	3.5	18	40.00	-15.90	78.10	0.48	33.9	-60.1
Directinal Coupler	TDC-9-1W	1200	50	-1.50	1.50	20	40	-17.40	76.60	0.48	37.4	-56.6

CASCADED ANALYSIS

Instantanious BW	100	200	400	MHz
Input Power	-100.00	-97.00	-94.00	dBm
Output Power	-23.40	-20.40	-17.40	dBm
Power Gain	76.60	76.60	76.60	dB
Noise Figure	0.48	0.48	0.48	dB
1 dB Compression point Output P1 dB	16.50	16.50	16.50	dBm
O/P Third order Intercept Point OIP3	35.40	35.40	35.40	dBm
Compression Dynamic range (CDR)	39.90	36.90	33.90	dB
Spurious Free Dynamic Range (SFDR)	39.20	37.20	35.20	dB

$T_{sys} = 70^{o}K$ Gain = 76.6 dB

$kT_{sys}B = k.T_{sys}.B = 1.38 \times 10^{-23} \times 70 \times 1$

$= -210$ dBW/Hz $= -180$ dBm/Hz

Cascaded Analysis Tool :

Designed By : AKB / Sweta Gupta

Entry By : APK / VBB / APS

REFERENCES:

[1] A. Raghunathan, *Building of 21cm front-end Receiver for the Giant Meterwave Radio Telescope*, Thesis submitted to Bangalore University for M.Sc.(Engg.), Jan 2000

[2] A. Praveen Kumar, Anil Raut and Vilas Bhalerao, *Dynamic Range of the L-Band front -end Receiver*, GMRT Internal Technical Report, Sept. 2005.

[3] A. Praveen Kumar and Anil Raut, *Improvement of GMRT Receiver for better Dynamic Range*, GMRT Internal Technical Report, Nov. 2003.

[4] Reduced-size Microstrip Four-Pole Bandpass Filter Using Two-layer Structure with Quarter-Wavelength Resonators and Open Stub Inverters
Azzeddine Djaiz and Tayeb A. Denidni and Halim Boutayeb
INRS-EMT, University of Québec, 800 rue de la Gauchetiere, Montréal Québec H5A 1K6, Canada.

[5] New Compact Bandpass Filter Using Microstrip _1/4 Resonators with Open Stub Inverter
Jae-Ryong Lee, Jeong-Hoon Cho, and Sang-Won Yun
IEEE DEC 2000

APPENDIX –A   DATASHEETS

Hittite MICROWAVE CORPORATION v00.0209

HMC740ST89E

InGaP HBT ACTIVE BIAS MMIC AMPLIFIER, 0.05 – 3 GHz

Typical Applications

The HMC740ST89E is ideal for:

- Cellular/3G & WiMAX/4G
- Fixed Wireless & WLAN
- CATV, Cable Modem & DBS
- Microwave Radio & Test Equipment
- IF & RF Applications

Features

P1dB Output Power: +18 dBm

Gain: 15 dB

Output IP3: +40 dBm

Cascadable 50 Ohm I/Os

Single Supply: +5V

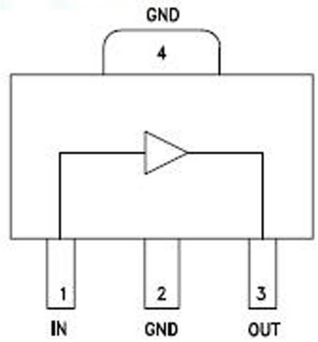
Industry Standard SOT89 Package

Robust 1000V ESD, Class 1C

Stable Current Over Temperature

Active Bias Network

Functional Diagram



General Description

The HMC740ST89E is an InGaP Heterojunction Bipolar Transistor (HBT) Gain Block MMIC SMT amplifier covering 0.05 to 3 GHz. Packaged in an industry standard SOT89, the amplifier can be used as a cascadable 50 Ohm RF or IF gain stage as well as a PA or LO driver with up to +18 dBm output power. The HMC740ST89E offers 15 dB of gain with a +40 dBm output IP3 at 100 MHz, and can operate directly from a +5V supply. The HMC740ST89E exhibits excellent gain and output power stability over temperature, while requiring a minimal number of external bias components.

Electrical Specifications, Vcc = 5V, T_A = +25° C

Parameter	Min.	Typ.	Max.	Min.	Typ.	Max.	Units
Frequency Range		0.05 - 1			0.05 - 3		GHz
Gain	12	15		11	15		dB
Gain Flatness		±0.1			±0.7		dB
Gain Variation over Temperature		0.003	0.006		0.003	0.006	dB/ °C
Input Return Loss		18			15		dB
Output Return Loss		18			18		dB
Reverse Isolation		20			21		dB
Output Power for 1 dB Compression (P1dB)	15.5	18		14.5	17		dBm
Output Third Order Intercept (IP3) (Pout= 0 dBm per tone, 1 MHz spacing)		38			32		dBm
Noise Figure		3.5			3.5		dB
Supply Current (Icq)		88			88		mA

For price, delivery, and to place orders, please contact Hittite Microwave Corporation:
20 Alpha Road, Chelmsford, MA 01824 Phone: 978-250-3343 Fax: 978-250-3373
Order On-line at www.hittite.com

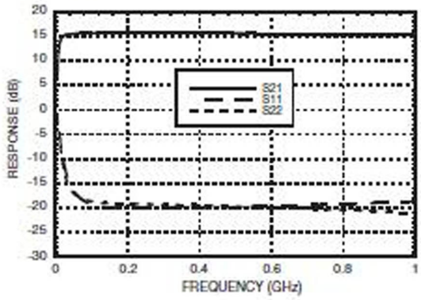
Hittite MICROWAVE CORPORATION v00.0209

HMC740ST89E

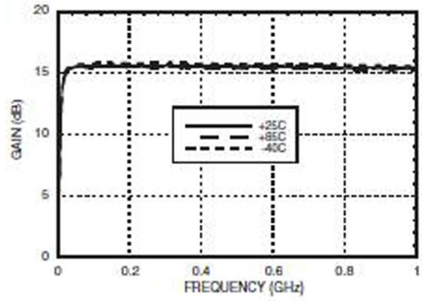
InGaP HBT ACTIVE BIAS MMIC AMPLIFIER, 0.05 – 3 GHz

IF Band Performance

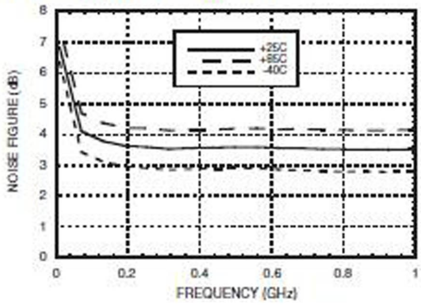
Gain & Return Loss



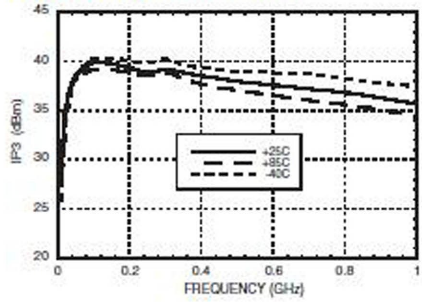
Gain vs. Temperature



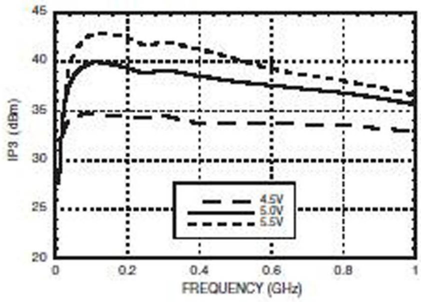
Noise Figure vs. Temperature



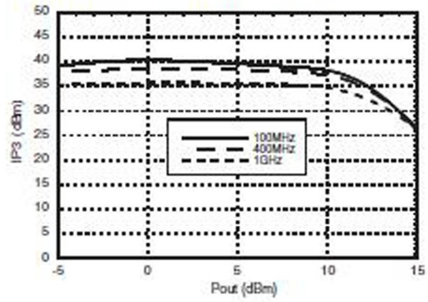
Output IP3 vs. Temperature



Output IP3 vs. Vcc



Output IP3 vs. Output Power

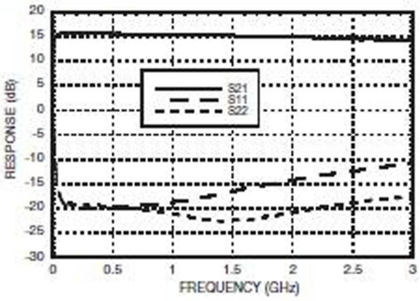


RoHS ✓

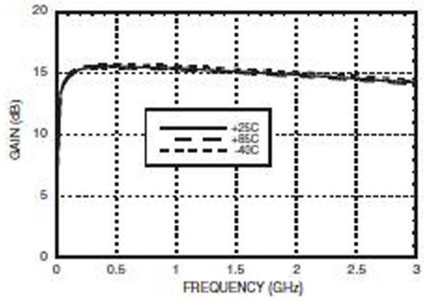
InGaP HBT ACTIVE BIAS MMIC AMPLIFIER, 0.05 – 3 GHz

Broadband Performance

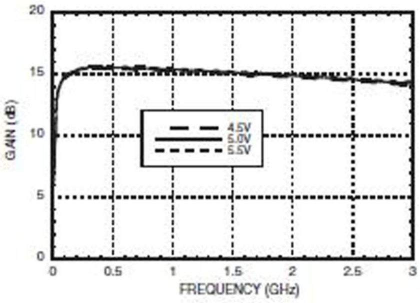
Gain & Return Loss



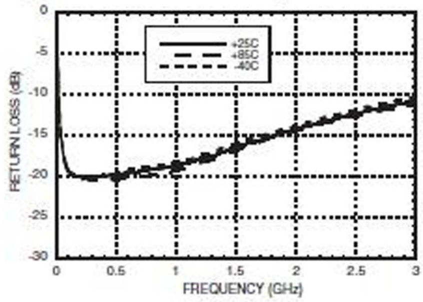
Gain vs. Temperature



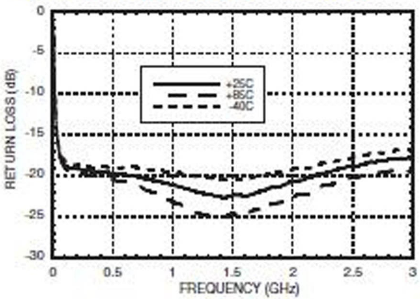
Gain vs. Vcc



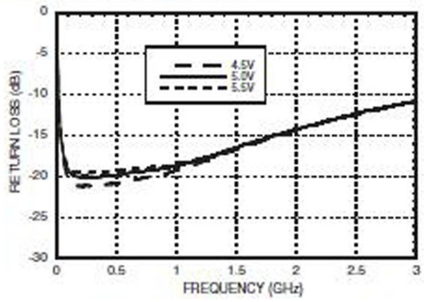
Input Return Loss vs. Temperature



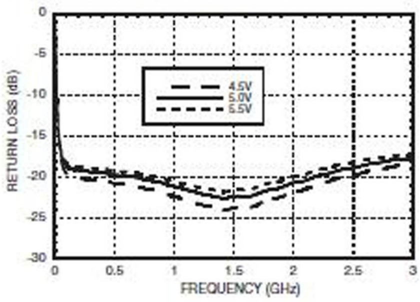
Output Return Loss vs. Temperature



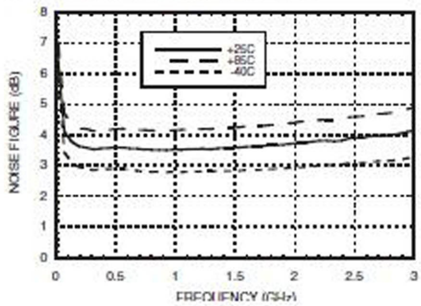
Input Return Loss vs. Vcc



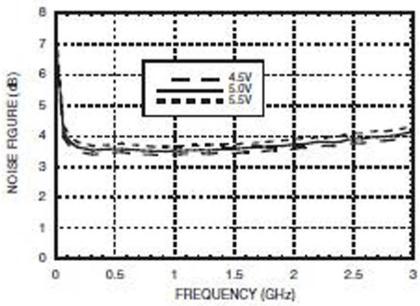
Output Return Loss vs. Vcc



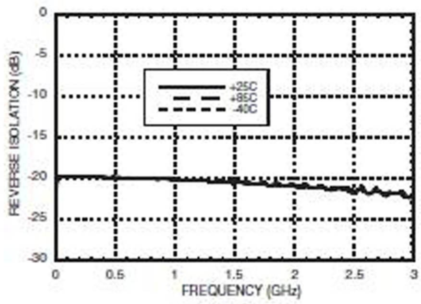
Noise Figure vs. Temperature



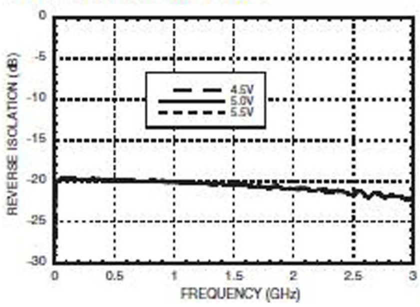
Noise Figure vs. Vcc



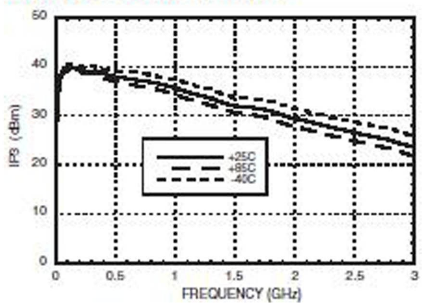
Reverse Isolation vs. Temperature



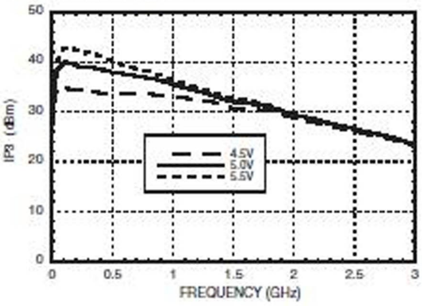
Reverse Isolation vs. Vcc



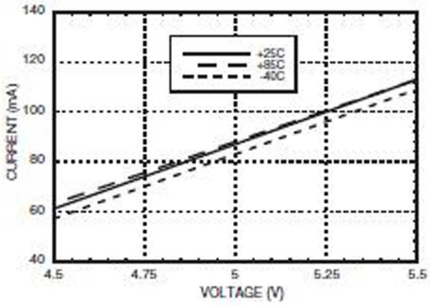
Output IP3 vs. Temperature



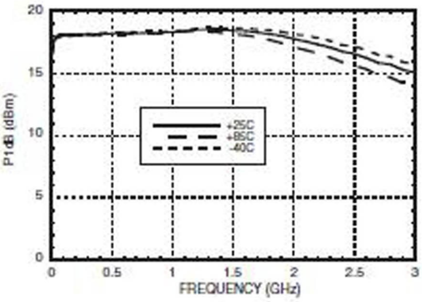
Output IP3 vs. Vcc



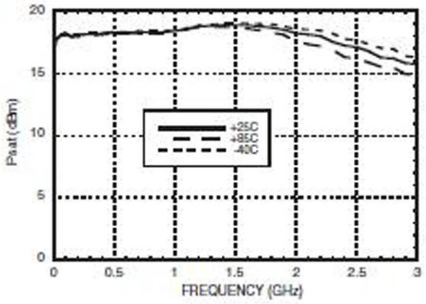
Current vs. Temperature



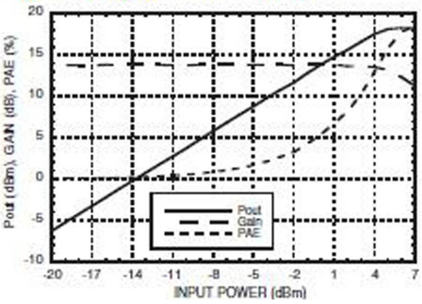
P1dB vs. Temperature



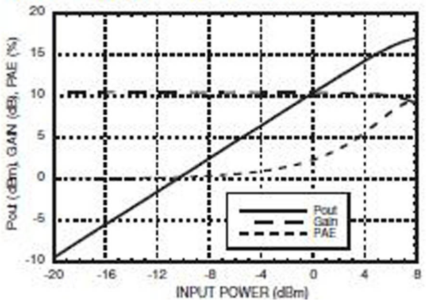
Psat vs. Temperature



Power Compression @ 500 MHz



Power Compression @ 2 GHz



GaAs SPDT Terminated Switch DC - 2.5 GHz

SW-338 V6

Features

- Very Low Power Consumption
- High Isolation: 30 dB up to 2 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40°C to +85°C
- Low Cost SOIC-8 Plastic Package
- Tape and Reel Packaging Available

Description

M/A-COM's SW-338 is a GaAs MMIC SPDT terminated switch in a low cost SOIC 8-lead surface mount plastic package. The SW-338 is ideally suited for use where very low power consumption is required.

Typical applications include transmit/receive switching, switch matrices, and filter banks in systems such as radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

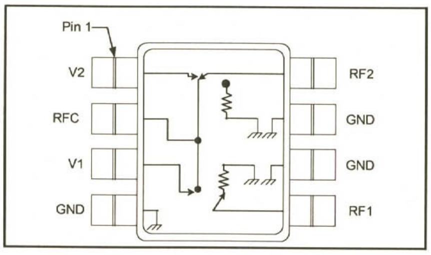
The SW-338 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

Ordering Information

Part Number	Package
SW-338	Bulk Packaging
SW-338TR	1000 piece reel
SW-338SMB	Sample Test Board

Note: Reference Application Note M513 for reel size information.

Functional Schematic



Pin Configuration

Pin No.	Function	Pin No.	Function
1	V2	5	RF Port 1
2	RF Common	6	Ground
3	V1	7	Ground
4	Ground	8	RF Port 2

Absolute Maximum Ratings [1,2]

Parameter	Absolute Maximum
Input Power 0.05 GHz 0.5 - 2.0 GHz	 +27 dBm +34 dBm
Control Voltage	-8.5 V ≤ Vc ≤ + 5 V
Operating Temperature	-40°C to +85°C
Storage Temperature	-65°C to +150°C

1. Exceeding any one or combination of these limits may cause permanent damage to this device.
2. M/A-COM does not recommend sustained operation near these survivability limits.

- **North America** Tel: 800.366.2266 / Fax: 978.366.2266
- **Europe** Tel: 44.1908.574.200 / Fax: 44.1908.574.300
- **Asia/Pacific** Tel: 81.44.844.8296 / Fax: 81.44.844.8298

Visit www.macom.com for additional data sheets and product information.

Electrical Specifications: T_A = 25°C, Vc = 0 V / -2.9 V, Z_0 = 50 Ω

Parameter	Test Conditions	Units	Min.	Typ. [3]	Max.
Insertion Loss	DC - 0.5 GHz 0.5 - 1.0 GHz 1.0 - 2.0 GHz	dB dB dB	— — —	0.55 0.60 0.65	— 0.7 —
Isolation	DC - 0.5 GHz 0.5 - 1.0 GHz 1.0 - 2.0 GHz	dB dB dB	— 36 —	50 43 35	— — —
VSWR On/Off	DC - 2.0 GHz	Ratio	—	1.1:1	—
Trise, Tfall	10% to 90% RF, 90% to 10 % RF	nS	—	10	—
Ton, Toff	50% Control to 90% RF, 50% Control to 10% RF	nS	—	20	—
Transients	In-Band	mV	—	25	—
1 dB Compression Point	Input Power 0.05 GHz 0.5 - 2.0 GHz	dBm dBm	— —	25 30	— —
2nd Order Intercept	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5 - 2.0 GHz	dBm dBm	— —	60 65	— —
3rd Order Intercept	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5 - 2.0 GHz	dBm dBm	— —	40 46	— —
Control Current	|Vc| = 2.9 V	µA	—	15	35

3. Typical values represent performance at middle of frequency range noted.

Truth Table [4]

Control Inputs		Condition of Switch RF Common to Each RF Port	
V1	V2	RFC-RF1	RFC-RF2
1	0	ON	OFF
0	1	OFF	ON

4. 0 = 0 V ± 0.2 V, 1 = -2.9 V to -5.0 V

• **North America** Tel: 800.366.2266 / Fax: 978.366.2266
• **Europe** Tel: 44.1908.574.200 / Fax: 44.1908.574.300
• **Asia/Pacific** Tel: 81.44.844.8296 / Fax: 81.44.844.8298

Visit www.macom.com for additional data sheets and product information.

M/A-COM
an AMP company

GaAs SP4T Terminated Switch
DC - 2 GHz

SW-419

Features

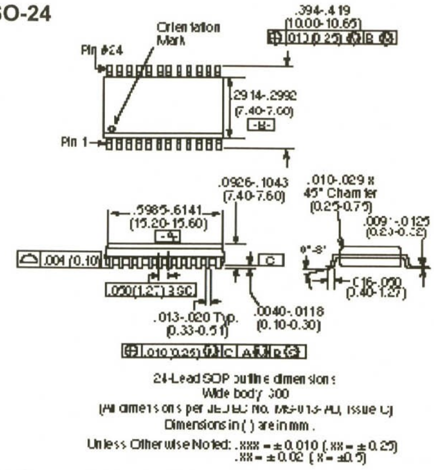
- Very Low Power Consumption: 100 µW
- Low Insertion Loss: 1 dB
- High Isolation: 25 dB up to 2 GHz
- Very High Intercept Point: 46 dBm IP_3
- Nanosecond Switching Speed
- Temperature Range: -40˚C to +85˚C
- Low Cost SOIC24 Plastic Package
- Tape and Reel Packaging Available[1]

Description

M/A-COM's SW-419 is a GaAs MMIC SP4T terminated switch in a low cost SOIC 24-lead wide body surface mount plastic package. The SW-419 is ideally suited for use where very low power consumption is required. Typical applications include switch matrices, and filter banks in systems such as: radio and cellular equipment, PCM, GPS, fiber optic modules, and other battery powered radio equipment.

The SW-419 is fabricated with a monolithic GaAs MMIC using a mature 1-micron process. The process features full chip passivation for increased performance and reliability.

SO-24



Ordering Information

Part No.	Package
SW-419 PIN	SOIC 24-Lead Plastic Package
SW-419 TR	Forward Tape & Reel
SW-419 RTR	Reverse Tape & Reel

Electrical Specifications, T_A = +25°C

Parameter	Test Conditions[2]	Unit	Min.	Typ.	Max
Insertion Loss	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB		0.8 0.8 0.9 1.2	1.0 1.1 1.2 1.4
Isolation	DC – 0.1 GHz DC – 0.5 GHz DC – 1.0 GHz DC – 2.0 GHz	dB dB dB dB	54 46 36 20	60 51 39 24	
VSWR	On Off			1.3:1 1.3:1	
Trise, Tfall Ton, Toff Transients	10% to 90% RF, 90% to 10% RF 50% Control to 90% RF, 50% Control to 10% RF In Band	nS nS mV		8 16 15	
One dB Compression	Input Power 0.05 GHz Input Power 0.5 – 2.0 GHz	dBm dBm		21 27	
IP_2	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		45 60	
IP_3	Measured Relative to Input Power (for two-tone input power up to +5 dBm) 0.05 GHz 0.5 – 2.0 GHz	dBm dBm		35 46	

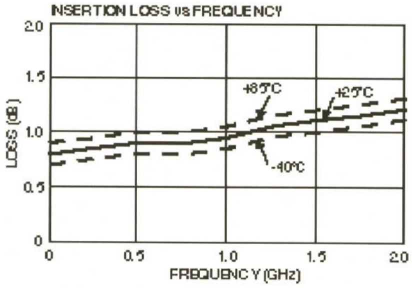
1. Refer to "Tape and Reel Packaging" Section, or contact factory.
2. All measurements with 0, -5 V control voltages at 1 GHz in a 50Ω system, unless otherwise specified.

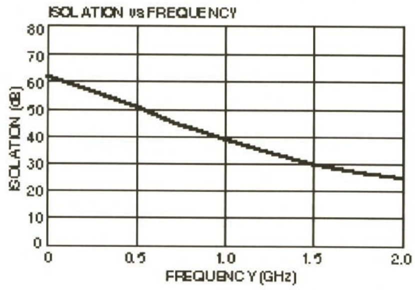
Absolute Maximum Ratings[1]

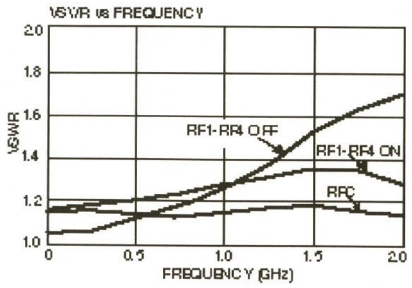
Parameter	Absolute Maximum
Max. Input Power	
Below 500 MHz	+27 dBm
Above 500 MHz	+30 dBm
Control Voltage	+5 V, – 8.5 V
Storage Temperature	-65° to +150°C

1.Operation of this device above any one of these parameters may cause permanent damage.

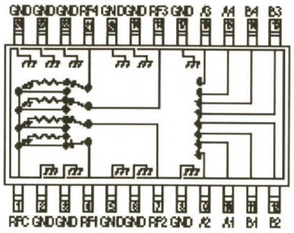
Typical Performance







Functional Schematic



Pin Configuration

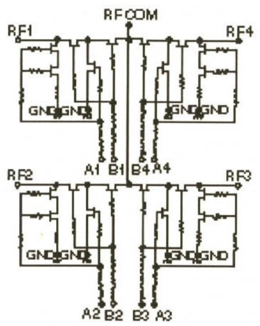
Pin No.	Description	Pin No.	Description
1	RF Common	13	B3
2	GND	14	B4
3	GND	15	A4
4	RF1	16	A3
5	GND	17	GND
6	GND	18	RF3
7	RF2	19	GND
8	GND	20	GND
9	A2	21	RF4
10	A1	22	GND
11	B1	23	GND
12	B2	24	GND

Truth Table

Control Input								Condition Of Switch RF Common to Each RF Port			
A1	B1	A2	B2	A3	B3	A4	B4	RF1	RF2	RF3	RF4
1	0	0	1	0	1	0	1	On	Off	Off	Off
0	1	1	0	0	1	0	1	Off	On	Off	Off
0	1	0	1	1	0	0	1	Off	Off	On	Off
0	1	0	1	0	1	1	0	Off	Off	Off	On

"0" – 0 – -0.2 V @ 20 µA max
"1" – -5 V @ 20 µA Typ to -8 V @ 300 µA max.

Electrical Schematic



Non-Catalog Model

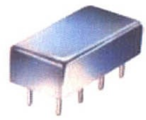
Frequency Mixer SRA-2010MH

Level 13 (LO Power +13 dBm)

Important Note

This is a non-catalog model and can be manufactured on specific request.
Pricing and delivery information can be supplied upon request.

Please click "Back", and then click "Contact Us" for Applications support.



CASE STYLE : A06

ELECTRICAL SPECIFICATIONS 50Ω @ +25°C					
Parameter		**Min.**	**Typ.**	**Max.**	**Units**
Frequency	**LO** (fL to fU)	10		2000	MHz
	RF (fL to fU)	10		2000	MHz
	IF	0		600	MHz
Conversion Loss	**mid band**		7.5	8.5	dB
	Total Range			9.8	dB
LO-RF Isolation	**Low Range**	45	50		dB
	Mid Range	30	45		dB
	Upper Range	25	40		dB
LO-IF Isolation	**Low Range**	40	45		dB
	Mid Range	30	35		dB
	Upper Range	20	35		dB
1 dB Comp. Input Power			+9		dBm

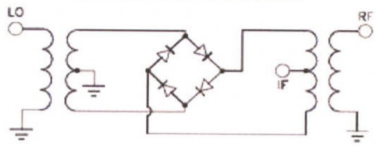
Notes: Low Range = [fL to 10fL] Mid Range = [10fL to fU/2] Upper Range = [fU/2 to fU]
mid band = [2fL to fU/2]

Hermetically sealed

MAXIMUM RATINGS	
Operating Temperature	-55°C to 100°C
Storage Temperature	-55°C to 100°C
RF Power	200mW
IF Current	40mA

PIN CONNECTIONS	
LO	8
RF	1
IF	3
GROUND	2, 5, 6, 7

Electrical Schematics



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ROGERS CORPORATION

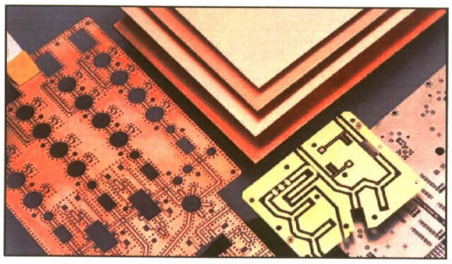
Advanced Circuit Materials

Advanced Circuit Materials Division
100 S. Roosevelt Avenue
Chandler, AZ 85226
Tel: 480-961-1382, Fax: 480-961-4533
www.rogerscorp.com

Data Sheet
1.6000

RT/duroid® 6006/6010LM High Frequency Laminates

Features	
•	High dielectric constant for circuit size reduction.
•	Low loss. Ideal for operating at X-band or below.
•	Low Z-axis expansion for RT/duroid 6010LM. Provides reliable plated through holes in multilayer boards.
•	Low moisture absorption for RT/duroid 6010LM. Reduces effects of moisture on electrical loss.
•	Tight ε_r and thickness control for repeatable circuit performance.
Some Typical Applications	
•	Space Saving Circuitry
•	Patch Antennas
•	Satellite Communications Systems
•	Power Amplifiers
•	Aircraft Collision Avoidance Systems
•	Ground Radar Warning Systems



RT/duroid® 6006/6010LM microwave laminates are ceramic-PTFE composites designed for electronic and microwave circuit applications requiring a high dielectric constant. RT/duroid 6006 laminate is available with a dielectric constant value of 6.15 and RT/duroid 6010LM laminate has a dielectric constant of 10.2.

RT/duroid 6006/6010LM microwave laminates feature ease of fabrication and stability in use. They have tight dielectric constant and thickness control, low moisture absorption, and good thermal mechanical stability.

RT/duroid 6006 laminates are supplied clad both sides with ¼ oz. to 2 oz./ft² (9 to 70 μm) electrodeposited copper foil. RT/duroid 6010 laminates are supplied clad both sides with 5 micron (0.025" (0.625mm) dielectric thickness only) to 2 oz./ft.² (5 to 70 μm) electrodeposited (ED) copper foil. Cladding with rolled copper foil is also available. Thick aluminum, brass, or copper plate on one side may be specified.

Standard tolerance dielectric thicknesses of 0.010", 0.025", 0.050", 0.075", and 0.100" (0.254, 0.635, 1.270, 1.905, 2.54 mm) are available. When ordering RT/duroid 6006 and RT/duroid 6010LM laminates, it is important to specify dielectric thickness, electrodeposited or rolled, and weight of copper foil required.

Typical Values

RT/duroid 6006, RT/duroid 6010LM Laminates

Property	Typical Value [2] RT/duroid 6006	Typical Value [2] RT/duroid 6010.2LM	Direction	Units [1]	Condition	Test Method
[3]Dielectric Constant ε_r	6.15± 0.15	10.2 ± 0.25	Z		10 GHz/A	IPC-TM-650 2.5.5.5
Dissipation Factor, tan δ	0.0027	0.0023	Z		10 GHz/A	IPC-TM-650 2.5.5.5
Thermal Coefficient of ε_r	-410	-425	Z	ppm/°C	-50 to 170°C	IPC-TM-650 2.5.5.5
Surface Resistivity	$7X10^7$	$5X10^6$		Mohm	A	IPC 2.5.17.1
Volume Resistivity	$2X10^7$	$5X10^5$		Mohm•cm	A	IPC 2.5.17.1
Youngs' Modulus						ASTM D638 (0.1/min. strain rate)
under tension	627 (91) 517 (75)	931 (135) 559 (81)	X Y	MPa (kpsi)	A	
ultimate stress	20 (2.8) 17 (2.5)	17 (2.4) 13 (1.9)	X Y	MPa (kpsi)	A	
ultimate strain	12 to 13 4 to 6	9 to 15 7 to 14	X Y	%	A	
Youngs' Modulus						ASTM D695 (0.05/min. strain rate)
under compression	1069 (155)	2144 (311)	Z	MPa (kpsi)	A	
ultimate stress	54 (7.9)	47 (6.9)	Z	MPa (kpsi)	A	
ultimate strain	33	25	Z	%		
Flexural Modulus	2634 (382) 1951 (283)	4364 (633) 3751 (544)	X	MPa (kpsi)	A	ASTM D790
ultimate stress	38 (5.5)	36 (5.2) 32 (4.4)	X Y	MPa (kpsi)	A	
Deformation under load	0.33 2.10	0.26 1.37	Z Z	%	24 hr/ 50°C/7MPa 24 hr/150°C/7MPa	ASTM D621
Moisture Absorption	0.05	0.05		%	24 hr/23°C, 0.050"(1.27mm) thick	IPC-TM-650, 2.6.2.1
Density	2.7	3.1				ASTM D792
Thermal Conductivity	0.49	0.78		W/m/K	23 to 100°C	ASTM C518
Thermal Expansion	47 34, 117	24 24,47	X Y,Z	ppm/°C	0 to 100°C	ASTM 3386 (5K/min)
Td	500	500		°C TGA		ASTM D3850
Specific Heat	0.97 (0.231)	1.00 (0.239)		J/g/K (BTU/lb/°F)		Calculated
Copper Peel	14.3 (2.5)	12.3 (2.1)		pli (N/mm)	after solder float	IPC-TM-650 2.4.8
Flammability Rating	94V-0	94V-0				UL
Lead-Free Process Compatible	Yes	Yes				

[1] SI unit given first with other frequently used units in parentheses.
[2] References: APR4022.33 DJS 4019.27-32, Internal TR 2610. Tests were at 23°C unless otherwise noted. Typical values should not be used for specification limits.
[3] Dielectric constant is based on .025 dielectric thickness, one ounce electrodeposited copper on two sides.
Typical values are a representation of an average value for the population of the property. For specification values contact Rogers Corporation.

STANDARD THICKNESS:	STANDARD PANEL SIZE:	STANDARD COPPER CLADDING:
0.005" (0.127mm) 0.010" (0.254mm) 0.025" (0.635mm) 0.050" (1.27mm) 0.075" (1.90mm) 0.100" (2.50mm)	10" X 10" (254 X 254mm) 10" X 20" (254 X 508mm) 20" X 20" (508 X 508mm)	5 µm (RT/duroid 6010 0.025" (0.635mm) dielectric thickness only). ¼ oz. (9 µm) electrodeposited copper foil. ½ oz. (17 µm), 1 oz. (35µm), 2 oz. (70µm) electrodeposited and rolled copper foil. Heavy metal claddings are available. Contact Rogers Customer Service.

CONTACT INFORMATION:

USA:	Rogers Advanced Circuit Materials	Tel: 480-961-1382	Fax: 480-961-4533
Belgium:	Rogers BVBA - Gent	Tel: 32-9-2353611	Fax: 32-9-2353658
Japan:	Rogers Japan Inc.	Tel: 81-3-5200-2700	Fax: 81-3-5200-0571
Taiwan:	Rogers Taiwan Inc.	Tel: 886-2-86609056	Fax: 886-2-86609057
Korea:	Rogers Korea Inc.	Tel: 82-31-716-6112	Fax: 82-31-716-6208
Singapore:	Rogers Technologies Singapore Inc.	Tel: 65-747-3521	Fax: 65-747-7425
China:	Rogers (Shanghai) International Trading Co., Ltd	Tel: 86 21 62175599	Fax: 86 21 62677913

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Revised 12/2009 0890-1209-.5CC **Publication: #92-105**

FEATURES

- Low Noise Figure: 1.2B (Typ.)@f=12GHz
- High Associated Gain: 10.0dB (Typ.)@f=12GHz
- Lg ≤ 0.25μm, Wg = 280μm
- Gold Gate Metallization for High Reliability
- Cost Effective Ceramic Microstrip (SMT) Package
- Tape and Reel Packaging Available

DESCRIPTION

The FHX35LG is a High Electron Mobility Transistor(HEMT) intended for general purpose, low noise and high gain amplifiers in the 2-18GHz frequency range. This device is packaged in cost effective, low parasitic, hermetically sealed(LG) or epoxy-sealed(LP) metal-ceramic packages for high volume telecommunication, DBS, TVRO, VSAT or other low noise applications.

Fujitsu's stringent Quality Assurance Program assures the highest reliability and consistent performance.

ABSOLUTE MAXIMUM RATING (Ambient Temperature Ta=25°C)

Item	Symbol	Rating	Unit
Drain-Source Voltage	V_{DS}	4.0	V
Gate-Source Voltage	V_{GS}	-3.0	V
Total Power Dissipation	P_t*	290	mW
Storage Temperature	T_{stg}	-65 to +175	°C
Channel Temperature	T_{ch}	175	°C

***Note:** Mounted on Al_2O_3 board (30 x 30 x 0.65mm)

Fujitsu recommends the following conditions for the reliable operation of GaAs FETs:

1. The drain-source operating voltage (V_{DS}) should not exceed 3 volts.
2. The forward and reverse gate currents should not exceed 0.2 and -0.075 mA respectively with gate resistance of 4000Ω.
3. The operating channel temperature (T_{ch}) should not exceed 80°C.

ELECTRICAL CHARACTERISTICS (Ambient Temperature Ta=25°C)

Item	Symbol	Test Conditions	Limit			Unit
			Min.	Typ.	Max.	
Saturated Drain Current	I_{DSS}	V_{DS} = 2V, V_{GS} = 0V	15	40	85	mA
Transconductance	g_m	V_{DS} = 2V, I_{DS} = 10mA	40	60	-	mS
Pinch-off Voltage	V_p	V_{DS} = 2V, I_{DS} = 1mA	-0.2	-1.0	-2.0	V
Gate Source Breakdown Voltage	V_{GSO}	I_{GS} = -10μA	-3.0	-	-	V
Noise Figure	NF	V_{DS} = 3V, I_{DS} = 10mA f = 12GHz	-	1.2	1.6	dB
Associated Gain	G_{as}		8.5	10.0	-	dB
Thermal Resistance	R_{th}	Channel to Case	-	220	300	°C/W

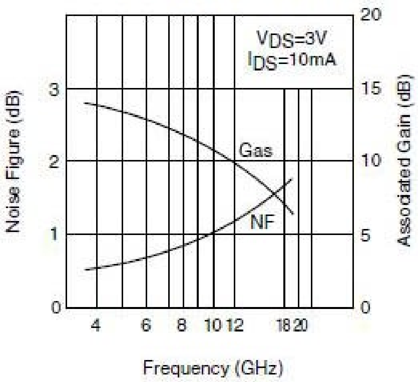
AVAILABLE CASE STYLES: LG

Note: RF parameters are measured on a sample basis as follows:

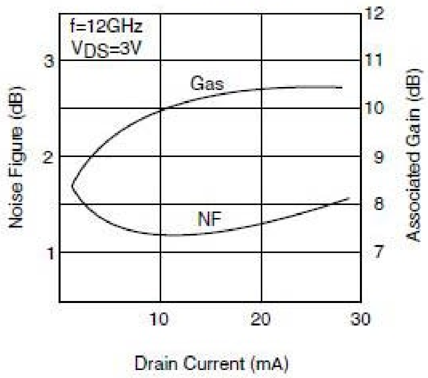
Lot qty.			Sample qty.	Accept/Reject
1200	or	less	125	(0,1)
1201	to	3200	200	(0,1)
3201	to	10000	315	(1,2)
10001	or	over	500	(1,2)

FUJITSU

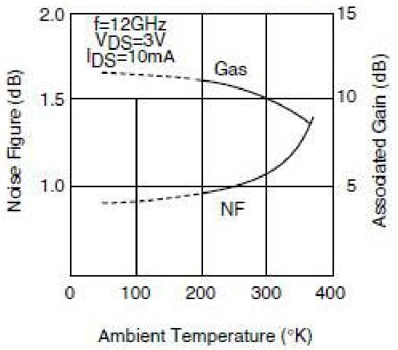
NF & Gas vs. FREQUENCY



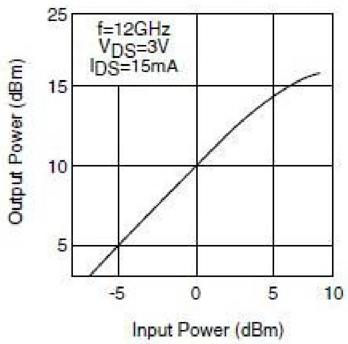
NF & Gas vs. IDS



NF & Gas vs. TEMPERATURE

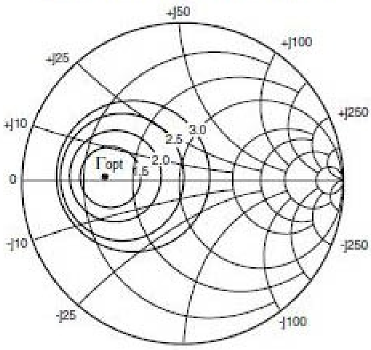


OUTPUT POWER vs. INPUT POWER



FUJITSU

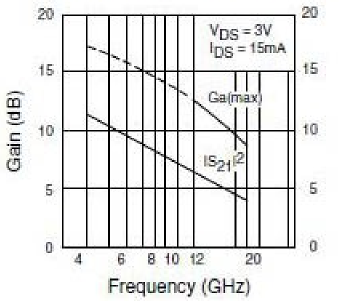
TYPICAL NOISE FIGURE CIRCLE



f = 12 GHz
V_{DS} = 3V
I_{DS} = 10mA

Γopt = 0.56∠175°
Rn/50 = 0.08
NFmin = 1.2dB

Ga(max) AND $|S_{21}|^2$ vs. FREQUENCY



NOISE PARAMETERS
V_{DS} = 3V, I_{DS} = 10mA

Freq. (GHz)	Γopt (MAG)	(ANG)	NFmin (dB)	Rn/50
2	0.81	32	0.40	0.58
4	0.74	63	0.50	0.42
6	0.69	93	0.68	0.30
8	0.64	127	0.86	0.20
10	0.60	148	1.03	0.12
12	0.56	175	1.20	0.08
14	0.53	-162	1.38	0.08
16	0.50	-139	1.54	0.10
18	0.48	-117	1.70	0.14