<u>Additional notes based on Plan meeting discussions ....</u>

In continuation to the discussion on backend LO specs in plan meetings, there are three possibilities for providing LO to both pol channels in antennas.

1. The original Plan (as mentioned in the report in next page) is to have backend for both pols of same antenna in one sub-rack with one LO driving them. This will provide a common LO for both pols in each antenna, allow different LO freq for different antennas.

One can use different bands in pol channels (within 400 Mhz) by using DDC in the digital backend.

2. Another possibility is to have same pol of a pair of antennas in one sub-rack with a common LO. The other pol of these antennas will have a separate LO. This will allow pol channels to have different LO signal, but antennas will be paired and will have a common LO signal (like groups <C00,C01>, <C02,C03>, C04,C05> etc).

The options 1,2 can be implemented at same cost as it mainly depends on the installation of the units, but we need to finalise the scheme before we start the OF to Backend cabling.

3. Third option is to provide separate LO for each pol channel - this involves one additional LO unit in each antenna - about $100 per antenna and also extra mcm bits for controlling this LO unit. (as per current plan one mcm can handle all control and monitor for two pol channels. if we add one more LO this may not be possible - we need one more mcm).

This option can be implemented later also as an add on if we restrict the current implementation to (1) above.

Report on next page .....

Backend System Upgrade

Local Oscillator Generation Scheme

ajith, navnath / 15.03.12

Introduction to GMRT Upgrades

The Backend Receiver of GMRT is being upgraded as part of the eleventh plan jobs. These modifications being implemented in the analog and digital backend receivers will improve the overall specifications of the Backend receiver. The major upgrade in specifications related to the analog section include complete processing of the RF signals at the Central station, seamless frequency coverage upto 1600 Mhz and an instantaneous bandwidth of 400 Mhz (max). A simplified block schematic of the upgraded Backend receiver is shown in the Fig-1. The main function of the analog backend receiver is conversion of the signal at RF frequencies received from antennas through the optical fiber cables to Baseband frequencies in the range 0 to 400 MHz for digitisation in high speed ADCs. This conversion is done for all observational frequencies above 400 Mhz, when observation frequency is less than 400 Mhz, it is passed on to ADC circuits without any frequency conversion. This note describes the generation and distribution of the Local Oscillator frequencies required for this frequency conversion.

Requirements for the Local Oscillator system

The main requirements for the Local Oscillator system can be listed as follows -

1. Capability to set the frequency in the range 600 to 1600 MHz.
2. Output power from the oscillator system to match the requirements of mixer.
3. Remote setting of frequency from control room.
4. All Oscillators to be phase locked to the GMRT Frequency standard.
5. A phase noise better than -90 dBc/Hz @ 1KHz offset for all oscillators.
6. Independent frequencies for each antenna, to facilitate multi-frequency observations.

Local Oscillator : Generation and Distribution

To meet the requirements mentioned above, a Local Oscillator system as shown in the Fig-2 is planned to be developed. The main feature of the system is distribution of the 10MHz reference (from Master Time & Frequency standard) to each antenna backend where the final LO frequency is generated using synthesiser circuits. The same LO frequency will be used in both polarisation channels of the same antenna. This will need a total of 30 synthesisers for the complete GMRT array, all of them located in the NRR. There is also a facility to switch in a common LO signal instead of the antenna specific synthesiser. This synthesiser is described later in this note.

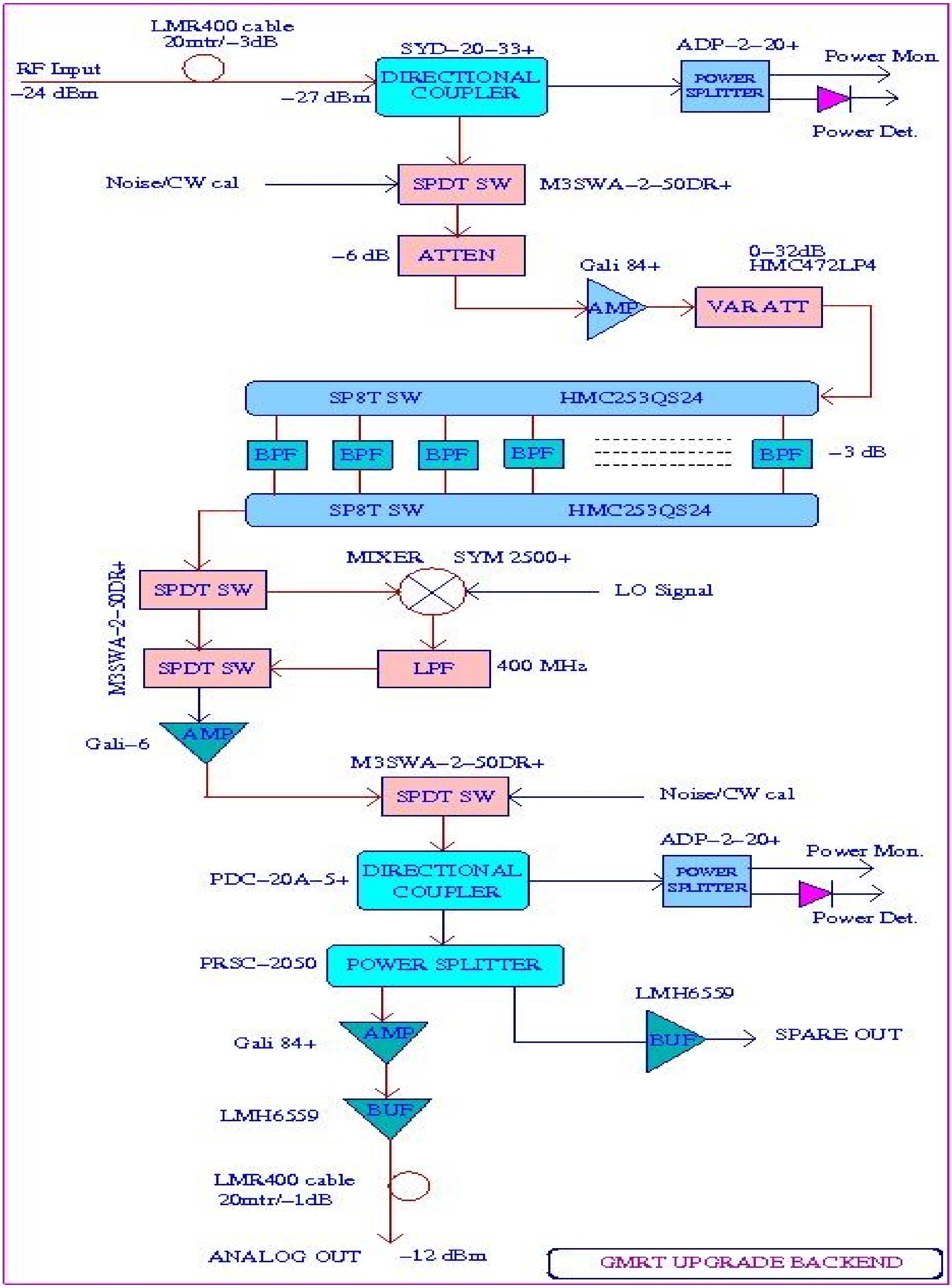


Fig -1 : GMRT Analog Backend Block Schematic

Fig-2a : LO-Ref Distribution Scheme

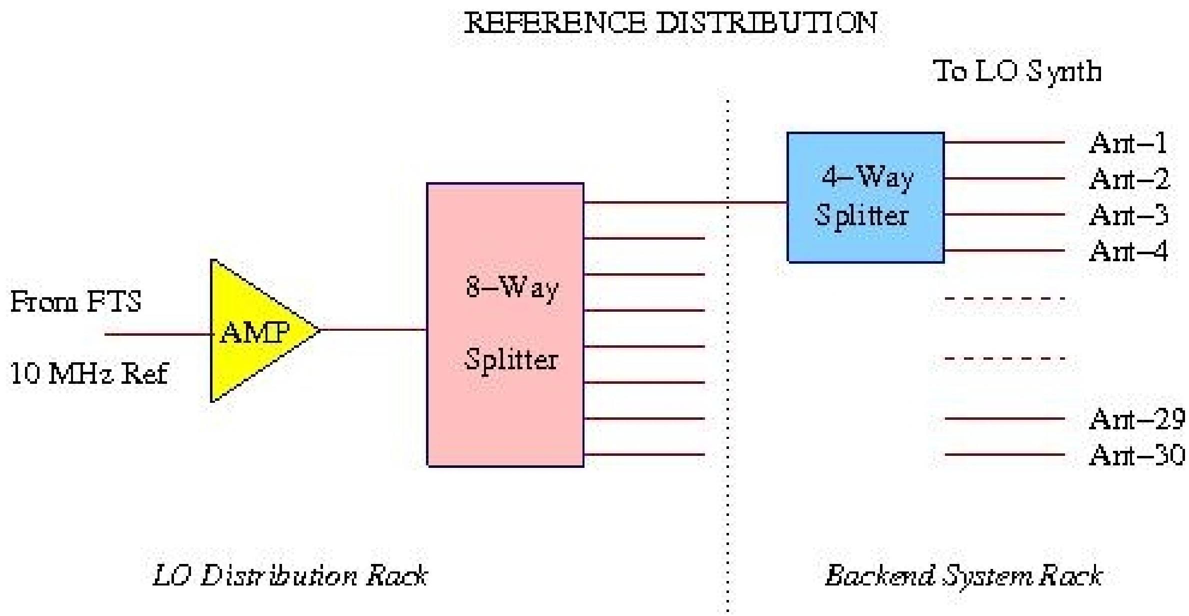
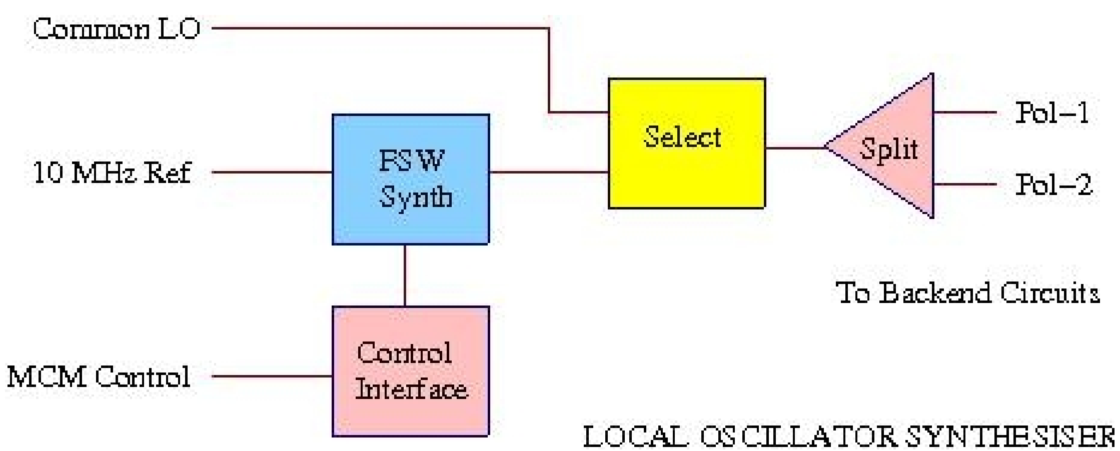


Fig-2b : LO Signal generation Scheme



The synthesisers used in the LO generation are Synergy make “Intelligent Interactive Synthesiser” (FSW) models. These surface mount compact synthesisers have wide frequency tuning range, exceptional phase noise, interactive communication, and standard programming interface. They can be locked to an external frequency reference as per our requirement. More details are available in the data sheet of FSW 60170-50 attached. Considering the frequency requirements we are planning to use one FSW60170-50 as LO generator from each antenna backend system. These units can directly lock on to the 10 Mhz reference frequency from Time & Frequency Standard. The LO signal is further distributed to the receivers for two polarisation channels from the antenna through a two way splitter. The frequency setting of the FSW unit is controlled from the control room through the standard MCM cards.

A signal generator of high phase noise in the frequency range 100 to 1600 MHz will be used as a common LO source. This signal will be amplified and distributed to all antenna systems and can be used as an alternate LO source which can be tuned to a step size of 1 Hz. This common source will be useful in line and other observations where a high frequency resolution is needed. But this mode cannot be supported in multi-frequency simultaneous observations, since only one signal source is available.

Features of the proposed scheme

1. The scheme allows setting different LO signal for each antenna using the individual synthesisers in the frequency range 600 to 1600 MHz. LO frequencies lower than 600 MHz (with observation bandwidths less than 400 Mhz) can be set from the common oscillator.

2. Both polarisation channels from one antenna will operate with same LO frequency.

3. Frequency can be set in step size of 500 Khz for multi-frequency observations and 1 Hz in case of single frequency mode.

4. Output power from the oscillator system is amplified and adjusted to match the requirements of conversion circuits.

5. The LO signal has to be set to the edge of the RF band / sub-band from the FE system to avoid aliasing. Fixed 400 MHz filters at the output of the conversion circuits will provide band shaping of the converted signals.

6. Remote setting of LO frequency from control room is possible and all oscillators in the system are phase locked to the GMRT Frequency standard of 10 MHz.

7. A phase noise better than -90 dBc/Hz @ 1KHz offset for all oscillators with good harmonic and in-band spurious performance.

Implementation of LO Scheme

The actual implementation of the LO ref distribution is shown in Fig and LO generation circuits is as shown in Fig. The LO reference of 10Mhz is taken from the Freq & Time Standard (FTS) system amplified using a power amplifier from Minicircuits lab and then distributed to backend system for each antenna using pulsar microwave make 4 way splitter network. The power levels are adjusted using attenuators/amplifiers at every stage. The circuit has facility to select among 10 Mhz signal from one of the two available FTS units. The output reference signal is provided at +3dBm to the LO synth unit.

In the LO synth unit, a 2 way switch is used to select the common signal source or the FSW unit as per requirement. The signal is then amplified and split to two signal for each pol channel in an antenna. A directional coupler with power detector circuits is used for monitoring the signal levels regularly. Currently the prototype units are wired and tested for the individual LO synth units. Final units for mass production is being developed.

A high performance signal source like Agilent make N5161A will be used as the common LO source. The LO signal distribution scheme for the common signal will be similar to the LO-ref distribution circuits. The common source scheme will be wired and tested later.

Fig-3a : LO Ref distribution – Implementation

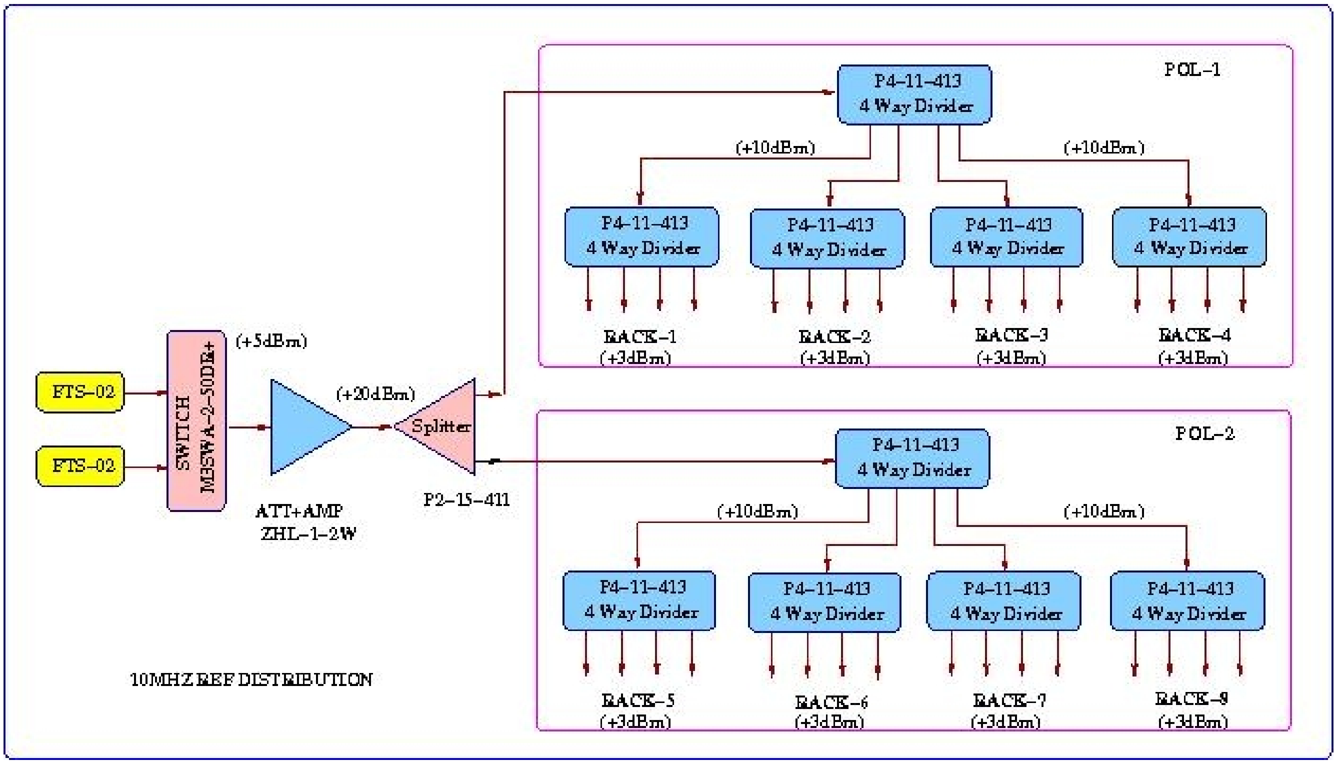
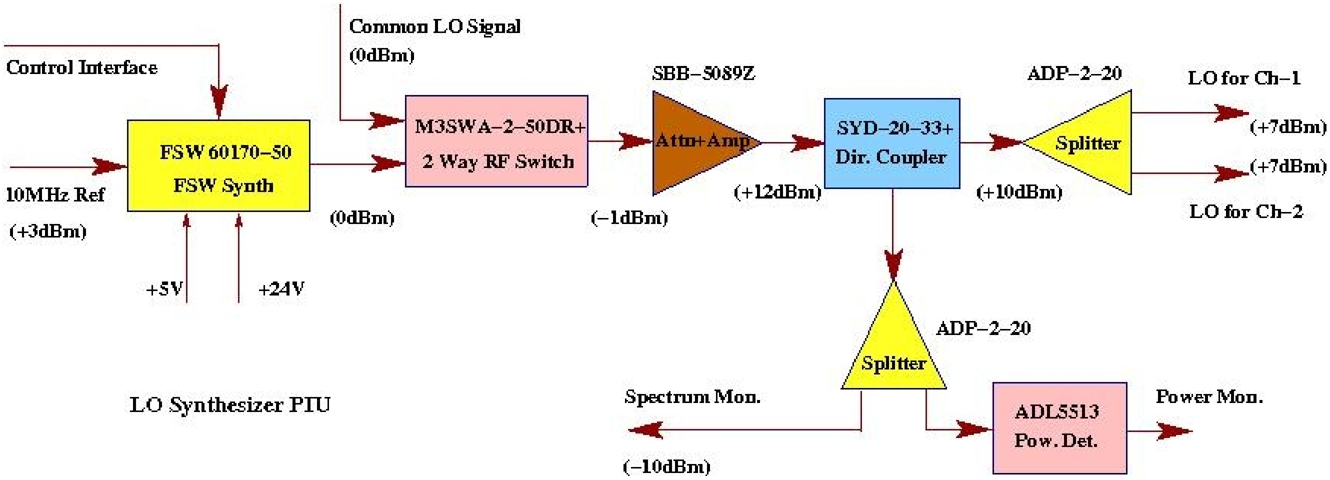


Fig – 3b : LO Signal generation scheme – implementation


Control Interface
Common LO Signal
(0dBm)
SBB-5089Z
ADP-2-20
LO for Ch-1
FSW 60170-50
FSW Synth
M3SWA-2-50DR+
2 Way RF Switch
Attn+Amp
SYD-20-33+
Dir. Coupler
Splitter
(+7dBm)
(+7dBm)
10MHz Ref
(+3dBm)
(0dBm)
(-1dBm)
(+12dBm)
(+10dBm)
LO for Ch-2
+5V
+24V
ADP-2-20
Splitter
LO Synthesizer PIU
Spectrum Mon.
ADL5513
Pow. Det.
Power Mon.
(-10dBm)

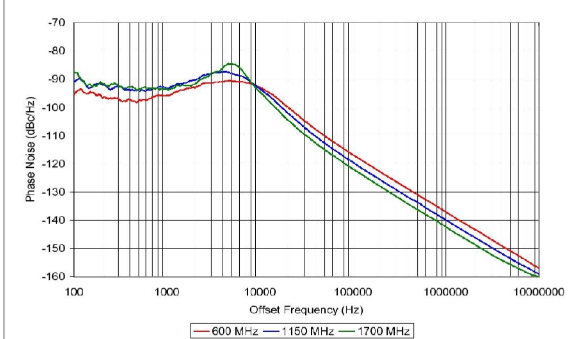
INTELLIGENT INTERACTIVE SYNTHESIZER
SURFACE MOUNT MODEL: FSW60170-50

WIDE BANDWIDTH 600 - 1700 MHz

FEATURES:

- **Exceptionally Low Phase Noise**
- **Interactive Communication**
- **Standard Programming Interface**
- **Ultra Wide Tuning Range**
- **Lead Free - RoHS Compliant**
- **Patented REL-PRO® Technology**
- **Small Size, Surface Mount**

Phase Noise



SPECIFICATIONS (Rev. N 03/24/11)

Frequency	600 - 1700 MHz
Step Size	500 kHz
Reference Input Frequency	10 MHz [1]
Reference Input Voltage	1.0 V p-p to 3.3 V p-p
Bias Voltage	Vcc / V (Vdc) / I (mA Max.): Digital +5 15; VCO +5 40; Tune +25 10
Output Power	0 dBm (Min.)
Spurious Suppression	85 dB (Typ.)
Harmonic Suppression	12 dB (Typ.)
Settling Time	10 mSec (Typ.) [2]
Output Impedance	50 Ohms (Nom.)
Lock Detect Indicator	CMOS 3.3 V
Typical Phase Noise	Offset / Phase Noise: @ 1 kHz -92 dBc/Hz; @ 10 kHz -92 dBc/Hz; @ 100 kHz -120 dBc/Hz
Operating Temperature Range	-40 to +85 °C
Programming	See Application Note: AN7100

Bias Voltage

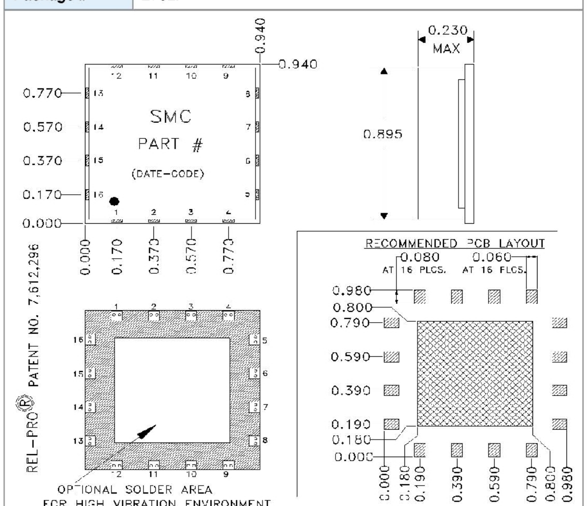
Vcc	V (Vdc)	I (mA Max.)
Digital	+5	15
VCO	+5	40
Tune	+25	10

Typical Phase Noise

Offset	Phase Noise
@ 1 kHz	-92 dBc/Hz
@ 10 kHz	-92 dBc/Hz
@ 100 kHz	-120 dBc/Hz

[1] Reference input frequency is programmable (See AN7100) in multiples of the step size, 10 MHz is the factory default setting. 150 MHz (Max.)
[2] From the rising edge of LE to stable lock detect

Package #	273LF



PACKAGE MOUNTING: SEE APPLICATION NOTE AN7200 & AN7300

Absolute Maximum Ratings

Storage Temp. Range	-55 to +125 ºC
Bias Voltage (Digital)	+5.25 V
Bias Voltage (Tune)	+26 V
Bias Voltage (VCO)	+5.5 V
DC Voltage Applied to RF Out	±25 V

Port Configuration

Pin 1,2,3 - NC	Pin 8 - Vcc (Tune)	Pin 16 - Clock In
Pin 4 - Error flag	Pin 9 - Vcc (VCO)	All Others - Ground
Pin 5 - Latch Enable In	Pin 13 - RF Out	NC - No Connection
Pin 6 - Ref. In	Pin 14 - Lock Detect Out *	
Pin 7 - Vcc (Digital)	Pin 15 - Data In	

** High when locked (source/sink 500 uA)*

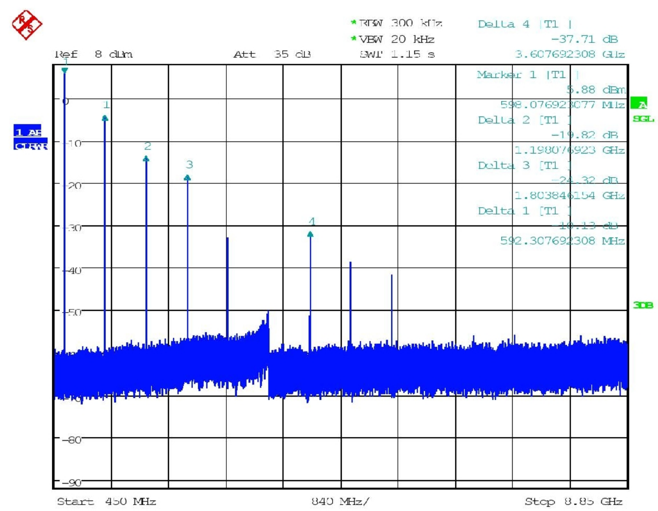
This product is manufactured under one or more of the following patents. Approved: 5,160,810; 5,122,621; 5,390,349; 5,416,449; 5,650,754; 5,805,431; 6,525,623; 6,850,575; 7,088,189; 7,180,381; 7,196,591; 7,262,670; 7,265,642; 7,292,113; 7,365,612; 7,495,525; 2,548,311; 2,548,317; 7,545,229; 7,580,693; 7,586,381; 7,605,670; 7,636,021; 2,533,623 | Pending: 60/493075; 60/501371 & 60/501790; 60/527957 & 60/528670; 60/563481; 60/564173; 60/589090; 60/601823; 60/605791; EV31369834; 11/259766; 60/622485 & 60/710310; 10/937525/60/736901; 60/732787; 7,495,525; 2,548,311; 2,548,317; 7,545,229; 2,563,174; 7,580,693; 7,612,296; 2,524,751

201 McLean Boulevard • Paterson, New Jersey 07504 USA • Tel: (973) 881-8800 • Fax: (973) 881-8361
E-Mail: sales@synergymwave.com • World Wide Web: http://www.synergymwave.com

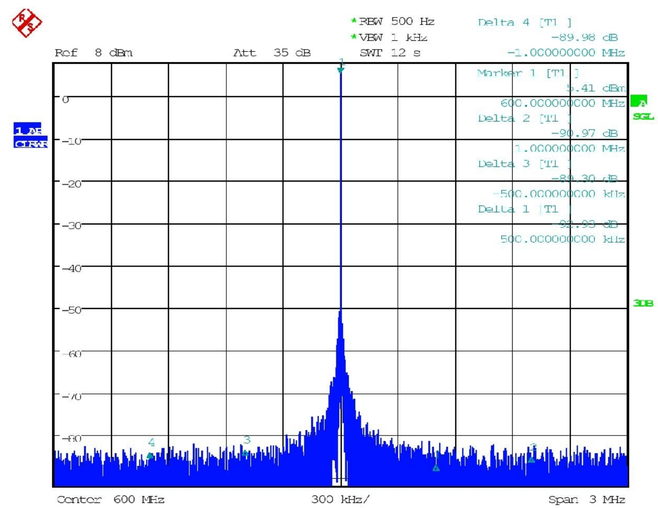
SYNERGY® MICROWAVE CORPORATION

PERFORMANCE PLOTS

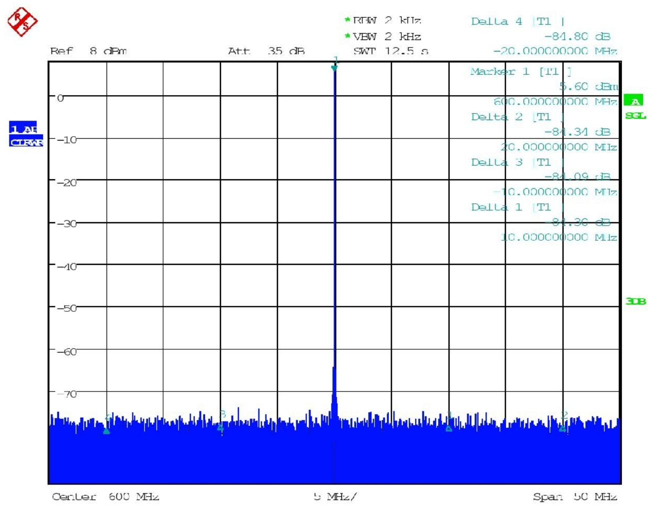
HARMONIC SUPPRESSION



REFERENCE SIDEBAND SUPPRESSION



REFERENCE SIDEBAND SUPPRESSION

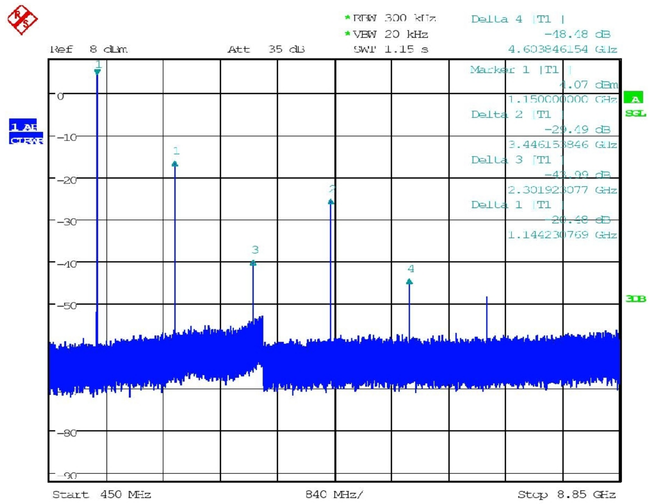


PERFORMANCE PLOTS

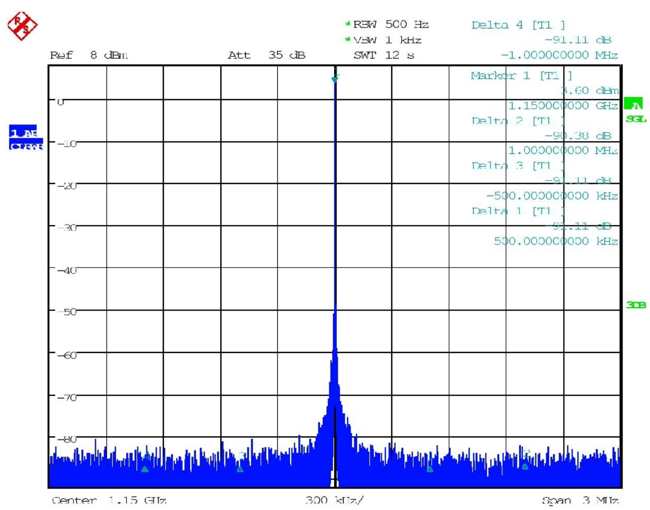
201 McLean Boulevard • Paterson, New Jersey 07504 USA • Tel: (973) 881-8800 • Fax: (973) 881-8361
E-Mail: sales@synergymwave.com • World Wide Web: http://www.synergymwave.com

PERFORMANCE PLOTS

HARMONIC SUPPRESSION



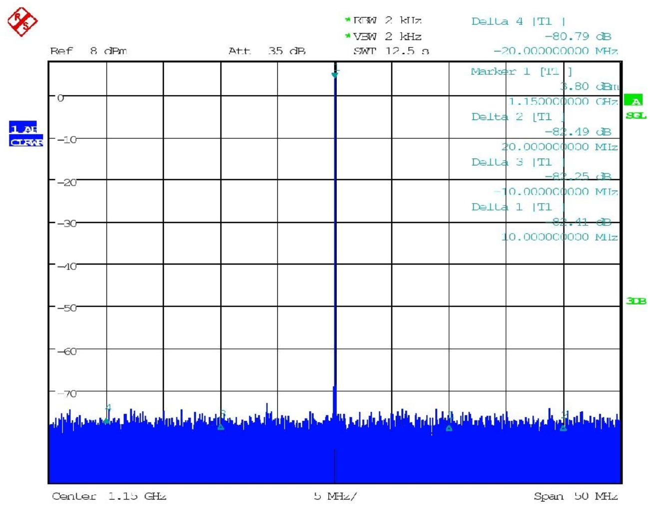
REFERENCE SIDEBAND SUPPRESSION



201 McLean Boulevard • Paterson, New Jersey 07504 USA • Tel: (973) 881-8800 • Fax: (973) 881-8361
E-Mail: sales@synergymwave.com • World Wide Web: http://www.synergymwave.com

SYNERGY® MICROWAVE CORPORATION

REFERENCE SIDEBAND SUPPRESSION



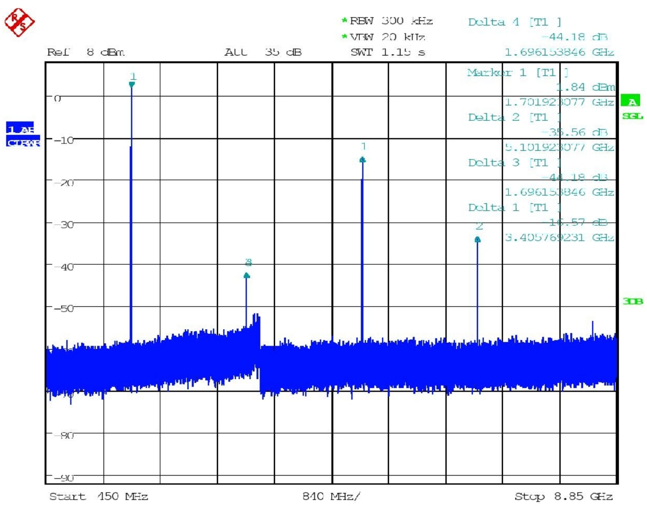
PERFORMANCE PLOTS

201 McLean Boulevard • Paterson, New Jersey 07504 USA • Tel: (973) 881-8800 • Fax: (973) 881-8361
E-Mail: sales@synergymwave.com • World Wide Web: http://www.synergymwave.com

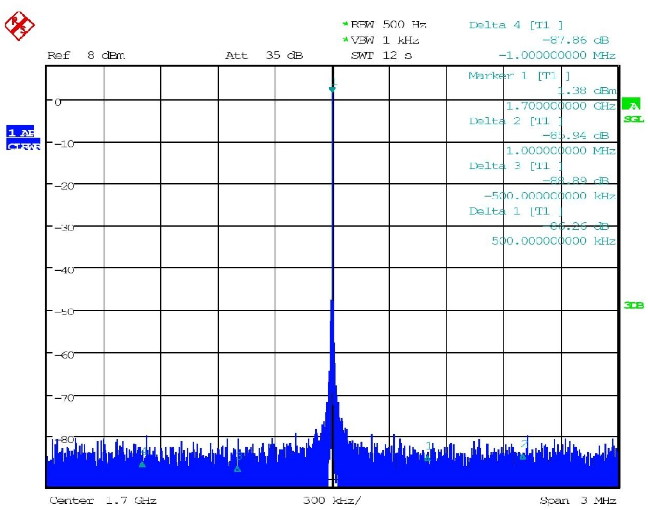
MICROWAVE CORPORATION

PERFORMANCE PLOTS

HARMONIC SUPPRESSION



REFERENCE SIDEBAND SUPPRESSION

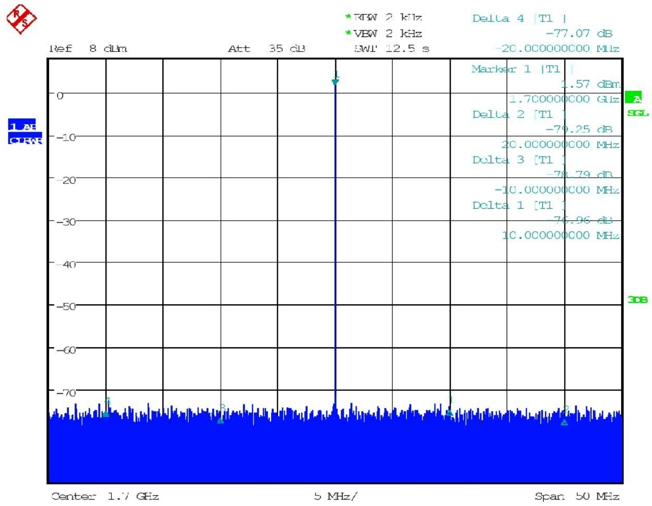


201 McLean Boulevard • Paterson, New Jersey 07504 USA • Tel: (973) 881-8800 • Fax: (973) 881-8361
E-Mail: sales@synergymwave.com • World Wide Web: http://www.synergymwave.com

SYNERGY® MICROWAVE CORPORATION

PERFORMANCE PLOTS

REFERENCE SIDEBAND SUPPRESSION



201 McLean Boulevard • Paterson, New Jersey 07504 USA • Tel: (973) 881-8800 • Fax: (973) 881-8361
E-Mail: sales@synergymwave.com • World Wide Web: http://www.synergymwave.com

SYNERGY® MICROWAVE CORPORATION