Project ENGN4545

- Project description
- Introduction to the Radiofrequency chips used in the projects.
- Review of Lecture10
The LOW IF can be digitised to avoid the $90^\circ$ phase shifter.

Has an image problem like all superhets.
Transceiver 1

IF Output

Down-con
LM1496

LO
MC145170

IF Input

Up-con
LM1496

LNA
MAX2611

PA
RF2317

CE amp.

Preselector
Transceiver 1

- Worth 40% of mark.
- Mark of 60% of this for the logbook, scrap book and description and dead bug results for the frequency synthesiser.
- 20% for the PCB layout design and description (Eagle files).
- 20% for the working circuit and tests.
- Need eagle PCB designs in by the end of the week.
Mixers

- Mathematically, mixers are multipliers.
- Terminology in the following figure and loosely: \( IF = RF \times LO \).
- Multiplication of sine waves produces sines waves of different frequencies (trig formulae).

\[
\begin{align*}
\text{RF} & \quad \times \quad \text{LO} \\
\downarrow & \\
\text{IF}
\end{align*}
\]
LM1496 Balanced Modulator Demodulator

➤ VHF frequencies only.

Numbers in parentheses show DIP connections.
LM1496 Balanced Modulator Demodulator: How does it work
MAX2611 LNA

DC-to-Microwave, Low-Noise Amplifier

General Description
The MAX2611 is a low-voltage, low-noise amplifier for use from DC to microwave frequencies. Operating from a single +5V supply, it has a 3dB bandwidth of 1100MHz. The MAX2611’s low noise figure and high drive capability make it ideal for a variety of transmit, receive, and buffer applications.

In a typical application, the only external components needed are input and output blocking capacitors and a VCC series resistor. To improve gain and output power, an RF choke can be added in series to the bias resistor.

The MAX2611 comes in a 4-pin SOT143 package, requiring minimal board space.

Features
♦ Single +5V Supply Operation
♦ 3dB Bandwidth: DC to 1100MHz
♦ High Gain: 18dB at 500MHz
♦ Low Noise Figure: 3.5dB at 500MHz
♦ High Drive Capability: +3dBm at 16mA Ip
♦ Ultra-Small SOT143 Package
Evaluation Board Schematic - 50Ω

(Download Bill of Materials from www.rfmd.com.)
PIN diodes

Figure 2. RF Resistance vs. Forward Bias Current.
PIN diodes

```
C81 10mF
D4
L83 Inductor 10mH
L82 3.3uH
R83

Rx

D6
C102 10mF
C103 10mF

D5
C101 10mF
L103 3.3uH
R103
```
Frequency Synthesisers

➤ Phase lock loop (PLL) and voltage controlled oscillator (VCO)

➤ Direct Digital Synthesiser (DDS).
The MC145170

- Operates up to 185 MHz. But no internal VCO.
- R Counter Division Range: 1 and 5 to 32,767
- N Counter Division Range: 40 to 65,535
- Special patented bit grabbing interface to set the PLL parameters such as N and R prescaler values.
The MC145170

MC145170–2
BLOCK DIAGRAM

This device contains 4,800 active transistors.
The Voltage Controlled Oscillator

Back to back varactors
CT = 10 pF

LT = 150 nH

R_{b1} = 33 k\Omega

R_{b2} = 33 k\Omega

C_1 = 47 pF

C_2 = 82 pF

R_c = 2 k\Omega

10 nF

V_{cc} = +15 V

R_L = 50 \Omega

R_1 = 43 \Omega

R_2 = 33 k\Omega
The Demodulator
The Modulator

IF frequency
Input from ADC

RF Output
Transceiver 2
Transceiver 2

➤ Integrated. Plug-n-play.

➤ Need to read the datasheets for the AD9854 and AD9874 carefully.

➤ Also read http://www.arrl.org/tis/info/pdf/030304qex020.pdf

➤ Cheaper and faster in the long run.

➤ Ideal for those who wish to experience state of the art and are good at RF PCB design and soldering.

➤ Cannot do a breadboard dead-bug prototype. Start with a PCB layout. I.E. start EAGLE (or whatever) design immediately.
Transceiver 1

➤ Worth 40% of mark.
➤ 40% For logbook and scrapbook and general description in the report.
➤ 40% for the PCB layout design and description (Eagle files).
➤ 20% for the working circuit and tests.
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AD9854 Direct Digital Synthesiser

**FUNCTIONAL BLOCK DIAGRAM**

- **300MHz DDS**
- **DIGITAL MULTIPLIERS**
- **12-BIT "I" DAC**
- **12-BIT "Q" OR CONTROL DAC**
- **ANALOG OUT**
- **ANALOG OUT**
- **SHAPE ON/OFF KEYING**
- **ANALOG IN**
- **CLOCK OUT**

- **DIFF/SINGLE SELECT**
- **REFERENCE CLOCK IN**
- **FSK/BPSK/HOLD DATA IN**
- **BIDIRECTIONAL I/O UPDATE**
- **READ**
- **WRITE**
- **SERIAL/PARALLEL SELECT**
- **6-BIT ADDRESS OR SERIAL PROGRAMMING LINES**
- **8-BIT PARALLEL LOAD**
- **MASTER RESET**
- **+VeG**
- **GND**

**AD9854**

**PROGRAMMING REGISTERS**

**I/O PORT BUFFERS**

**PROGRAMMABLE RATE AND UPDATE CLOCKS**
AD9854 Circuit
AD9874 IF Digitising Subsystem

- Input impedance about 400 Ω. See p 22 of the data sheet.
- DOUTA/DOUTB are differential outputs. Suggest AD8561 caparator as on the Eval Board schematic.
- Very important to have a ground plane on the lower layer.
- Don't forget about decoupling caps for power supply.
- Separate the AVDD and DVDD.
- Lots of IO = 37 in total.
- Do we need to have IO buffering? If not we need to provide DVDD on the IDC connector pin.
- Power supply for PIN diodes... need 10 mA per diode.
Dual Supply Bus Transceiver

- Control Inputs $V_{IH}/V_{IL}$ Levels Are Referenced to $V_{CCA}$ Voltage
- $V_{CC}$ Isolation Feature – If Either $V_{CC}$ Input Is at GND, All I/O Ports Are in the High-Impedance State
- $I_{off}$ Supports Partial-Power-Down Mode Operation
- Fully Configurable Dual-Rail Design Allows Each Port to Operate Over the Full 1.65-V to 5.5-V Power-Supply Range

SN74LVC8T245
8-BIT DUAL-SUPPLY BUS TRANSCEIVER
WITH CONFIGURABLE VOLTAGE TRANSLATION AND 3-STATE OUTPUTS

SC5594 - JULY 2004
AD9874 IF Digitising Subsystem

FUNCTIONAL BLOCK DIAGRAM

[Block Diagram Image]
The AD9874 based superhet
Figure 26. Example Circuit Showing Recommended Component Values