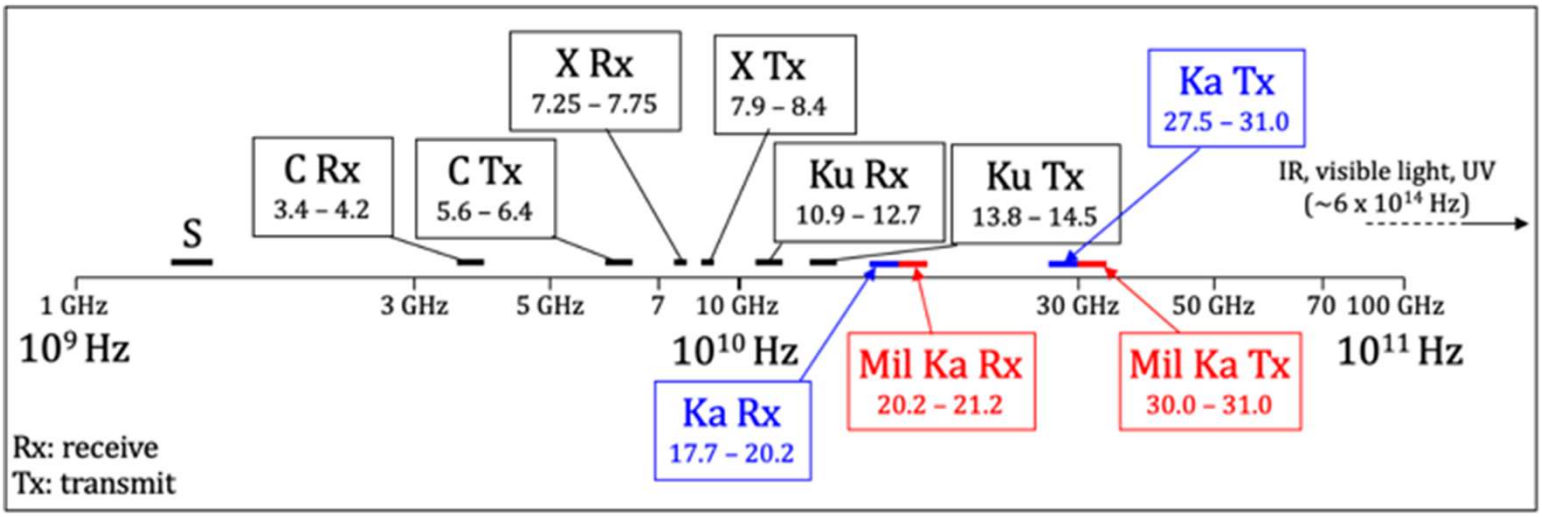
SATCOM Frequencies

R&CS 4-5 SIGL-002B

11 May 2023

B. Graham



SHF sub-band	Uplink		Downlink	
	Freq (GHz)	Bandwidth (MHz)	Freq (GHz)	Bandwidth (MHz)
C	5.85 - 6.65	800	3.4 - 4.2	800
X	7.9 - 8.4	500	7.25 - 7.75	500
Ku	13.75 - 14.5	750	10.95 - 12.75	1800
Commercial Ka	27.5 - 30.0	2500	17.7 - 20.2	2500
Military Ka	30.0 - 31.0	1000	20.2 - 21.2	1000

By convention, the uplink is always higher frequency than the downlink. This is because higher frequencies are attenuated more than lower frequencies so the advantage of transmitting on the lower frequency is given to the power limited satellite.
The X-band spectrum is further divided. In the US mobile terminals are primary users in only 125MHz of uplink (7900-8025MHz). This is further restricted in Canada to 50MHz (7975-8025MHz).

SATCOM MODEMS

SATCOM modems provide IF in the range of 950MHz to 1450/1950/2050/2150 MHz
Some modems may not go as high as 1950 or beyond: these might be extra cost options

There is 500MHz of X-band so when a SATCOM modem is used for X-band it will provide IF in the range 950 to 1450MHz.
Standard up-conversion for X-band is **6950MHz** so 950 to 1450 is up-converted to 7900 to 8500MHz
Standard down-conversion for X-band is 6300MHz so 950 to 1450 is down-converted to 7250 to 7750MHz
X-band Satellite Beacons are down-converted by **6300MHz**. For example WGS beacon is 7600MHz so beacon receivers on Convair/CP-140 is tuned to 1300MHz

Standard up-conversion for MIL Ka-band is found by subtracting the modem lower end (1000Hz for Ka) from the Mil-Ka uplink (30.0GHz) thus Mil Ka up-converters are **29.0 GHz**
Similarly Standard Mil Ka-band down-conversion 20.2GHz - 950MHz = **19.25 GHz**
WGS Ka beacon is 20700 so the IF is 1450MHz.

Note that the uplink Classic Bent pipe transponders translate uplink to downlink by a fixed frequency. For example SkyNet 5C X-band bent-pipe transponder translates the uplink by -650MHz before re-transmitting it on the downlink. This is the difference between the uplink and downlink frequencies on the charts above.

WGS satellites are channelized bent pipe transponders that can translate the uplink to downlink by a variable amount. WGS can also do cross banding in which the uplink can be X-band and the downlink Mil Ka and vice versa

SATCOM IF/RF for X-Band

SATCOM Modem Frequencies
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X-band
7.25 GHz to 7.75 GHz (Space to Earth)
7.9 GHz to 8.4 GHz (Earth to Space)

Traditional Bent Pipe transponders translate the X-Band frequency by 650MHz.

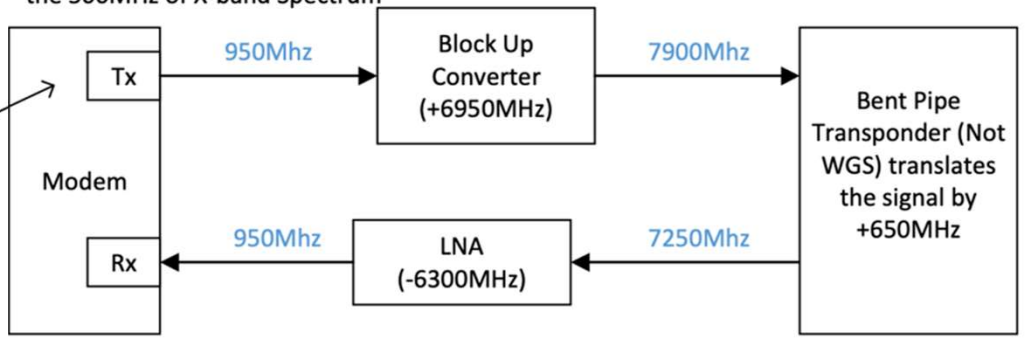
This has driven the requirements for X-band SATCOM modems to provide an IF of 950-1450MHz.

Wider IF ranges are required for Ka band which has 1GHz of spectrum.

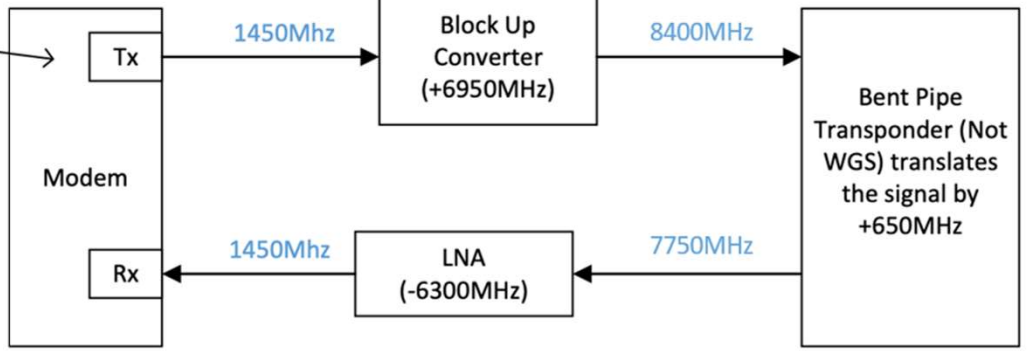
The Astrium Loopback is based on running the output of the modem through the Tx of the antenna and then into the Rx of the antenna without the benefit of the 650MHz translation that occurs on traditional satellites.

The MDM9000 has IF range of 950 – 2150. This should support an Astrium style loopback.

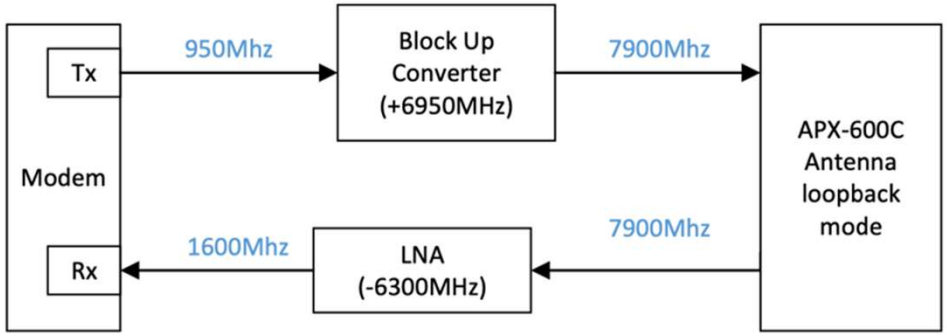
Example with Tx at low end (7250MHz) of the 500MHz of X-band Spectrum



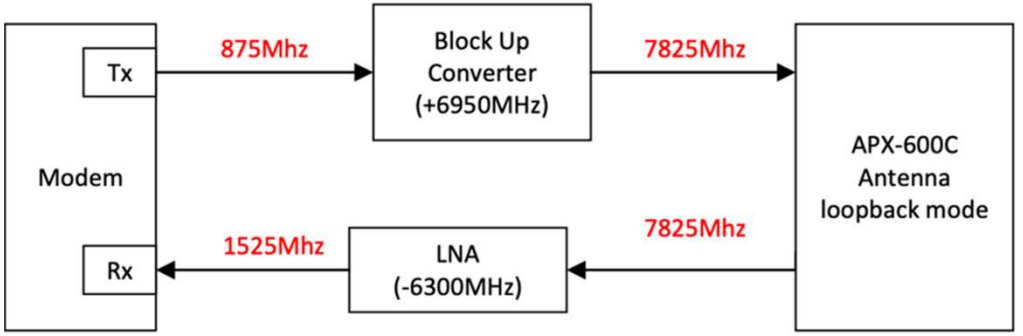
Example with Tx at high end (7750MHz) of the 500MHz of X-band Spectrum



Example showing extreme modem ranges required to do loopback without 650MHz on satellite translation if modem cannot go below 950MHz



Example showing extreme modem ranges required to do loopback without 650MHz on satellite translation



Red frequencies are outside standard X-band Modem IF and RF ranges