ECEU574 Wireless Communication Circuits — Spring, 04

Assignment 2 Solutions — Prof. Brady

(1 a) (40/100 pts.)

$X_1X_2X_3$	min f_{VFO}	max f_{VFO}	min $f_{VFO,i}$	max $f_{VFO,i}$	f_{BFO}	$f_{BFO,i}$
LLL	2.07+09	2.155+09	1.74e+09	1.825e+09	3.3e+08	3.3e+08
LLH	2.07+09	2.155+09	1.74e+09	1.825e+09	3.3e+08	3.299e+08
LHL	2.07+09	2.155+09	1.74e+09	1.825e+09	3.3e+08	3.3e+08
LHH	2.07+09	2.155+09	1.74e+09	1.825e+09	3.3e+08	3.301e+08
HLL	2.73+09	2.815+09	3.06e+09	3.145e+09	3.3e+08	3.3e+08
HLH	2.73+09	2.815+09	3.06e+09	3.145e+09	3.3e+08	3.299e+08
HHL	2.73+09	2.815+09	3.06e+09	3.145e+09	3.3e+08	3.3e+08
HHH	2.73+09	2.815+09	3.06e+09	3.145e+09	3.3e+08	3.301e+08

$X_1X_2X_3$	$center_{RF}$	BW_{RF}	$center_{BFO}$	BW_{BFO}
LLL	2.442e+09	1.235e+09	3.3e+08	4000
LLH	2.442e+09	1.235e+09	3.3e+08	1.2e+05
LHL	2.442e+09	1.235e+09	3.3e+08	4000
LHH	2.442e+09	1.235e+09	3.3e+08	1.2e+05
HLL	2.442e+09	1.235e+09	3.3e+08	4000
HLH	2.442e+09	1.235e+09	3.3e+08	1.2e+05
HHL	2.442e+09	1.235e+09	3.3e+08	4000
HHH	2.442e+09	1.235e+09	3.3e+08	1.2e+05

(1.b) (20/100 pts.) Any design with $X_3 = H$ yields an IF image rejection filter with a wider bandwidth. Any one of the following four graphs is an acceptable answer.

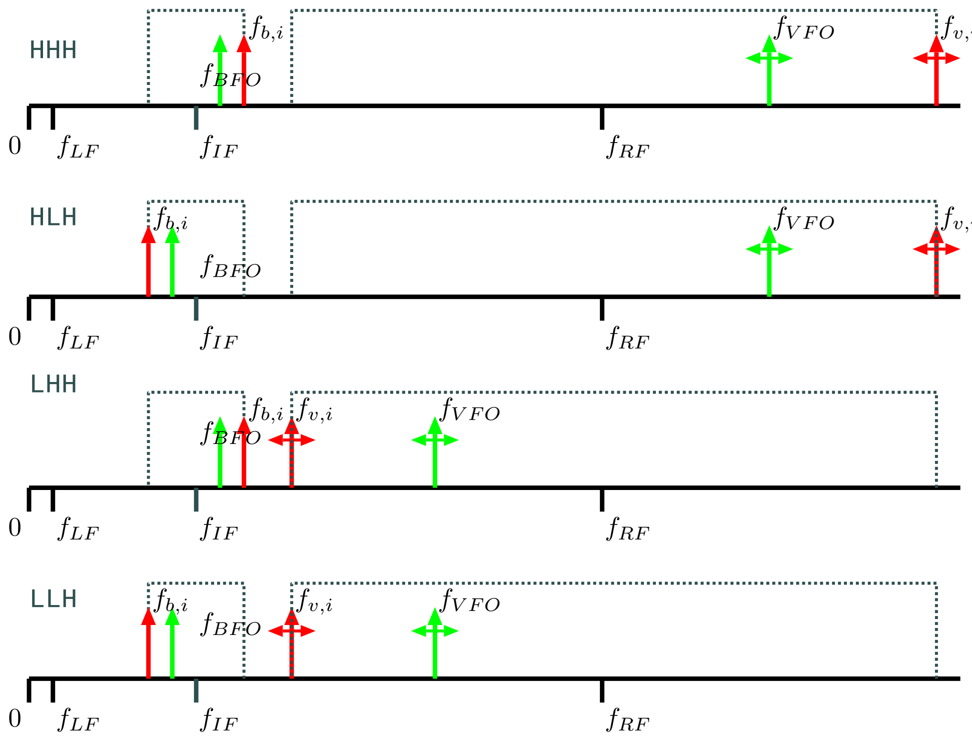

Figure 1: Four possible solutions to part 1b.

(1.c) (30/100 pts) A correct answer for this part is one of the four plots for each graph (not all four).

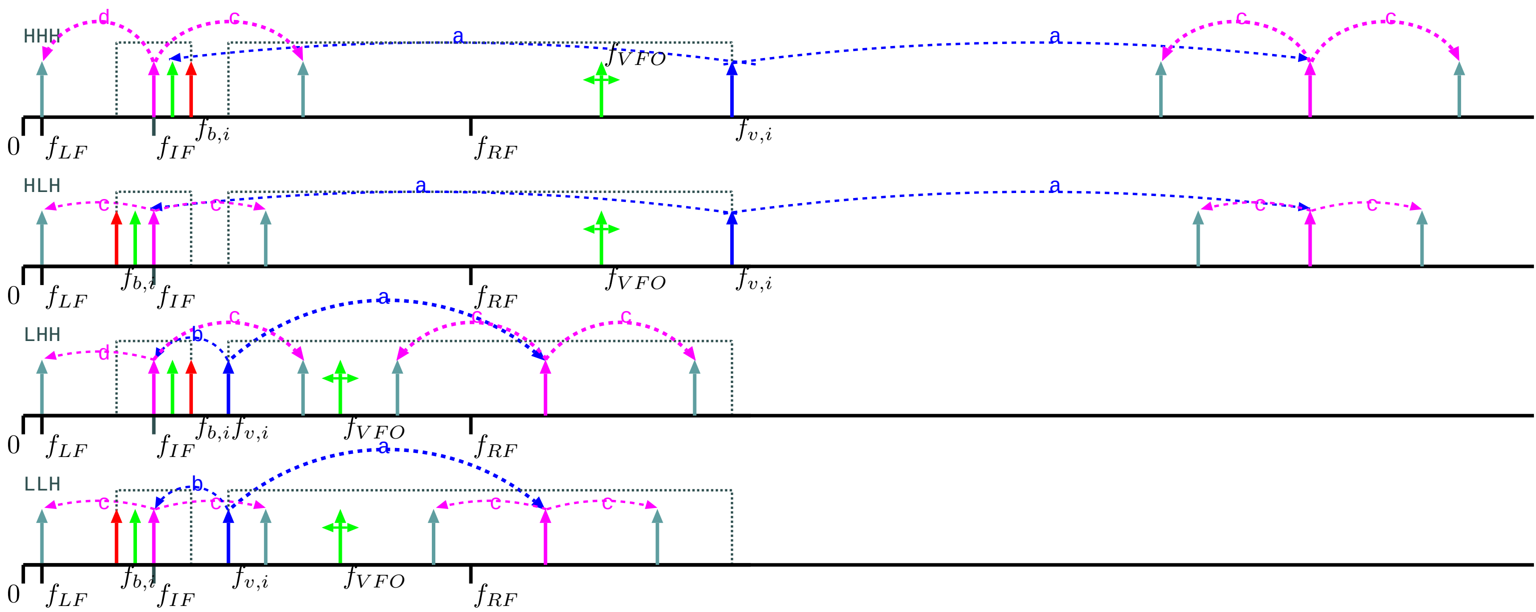

Figure 2: Four possible solutions to part 1c, when considering spurious components at $f_{v,i}$. Frequency axis not to scale, and the translation of each spurious signal is indicated by colored arcs, with the translation amount as the arc label. Blue arcs denote translation by the RF mixer, and magenta denotes translation by the product detector. Blue spectral lines denote components before RF mixing, and magenta lines denote spectral components before product detection, and slate lines denote spectral components after product detection. Label a represents a translation by an amount f_{VFO}, label b represents a translation by an amount $|f_{VFO} - f_{v,i}|$, c represents a translation by an amount f_{BFO}, and label d denotes a translation by an amount $|f_{BFO} - f_{b,i}|$.

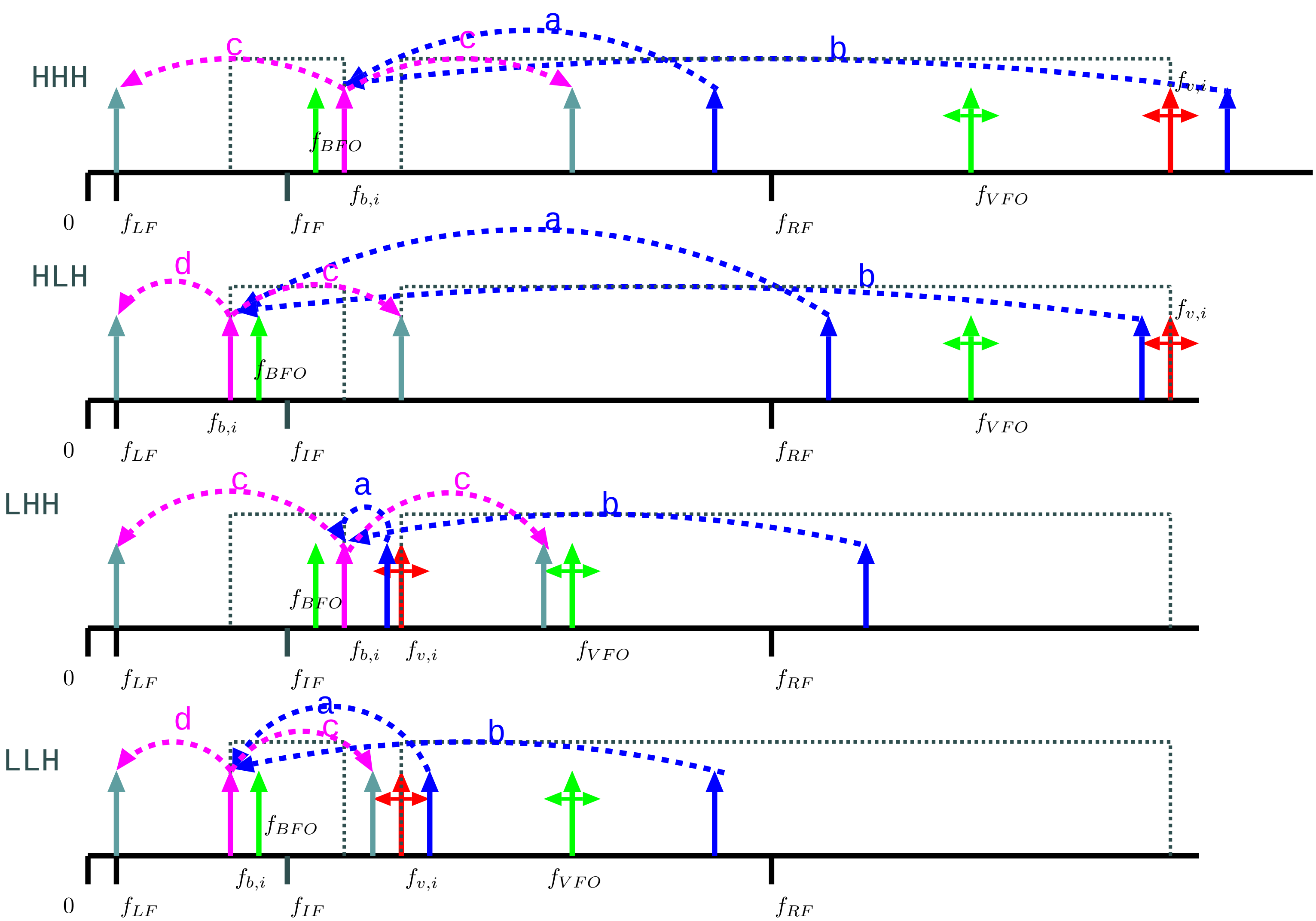

Figure 3: Four possible solutions to part 1c, when considering spurious components at $f_{b,i}$. Frequency axis not to scale, and the translation of each spurious signal is indicated by colored arcs, with the translation amount as the arc label, as in Figure 2. Label a represents a translation by an amount $f_{VFO} - f_{BFO}$, label b denotes a translation by an amount f_{VFO}, label c denotes translation by f_{BFO} Hz, and label d denotes translation by $|f_{BFO} - f_{LF}$ Hz.

The $1/2f_{IF}$ components are harmful, since mixers are often implemented with an adder, squarer, and bandpass filter. In the squaring operation, input components at $1/2f_{IF}$ create components at DC and at f_{IF}, which could interfere with the desired signal.

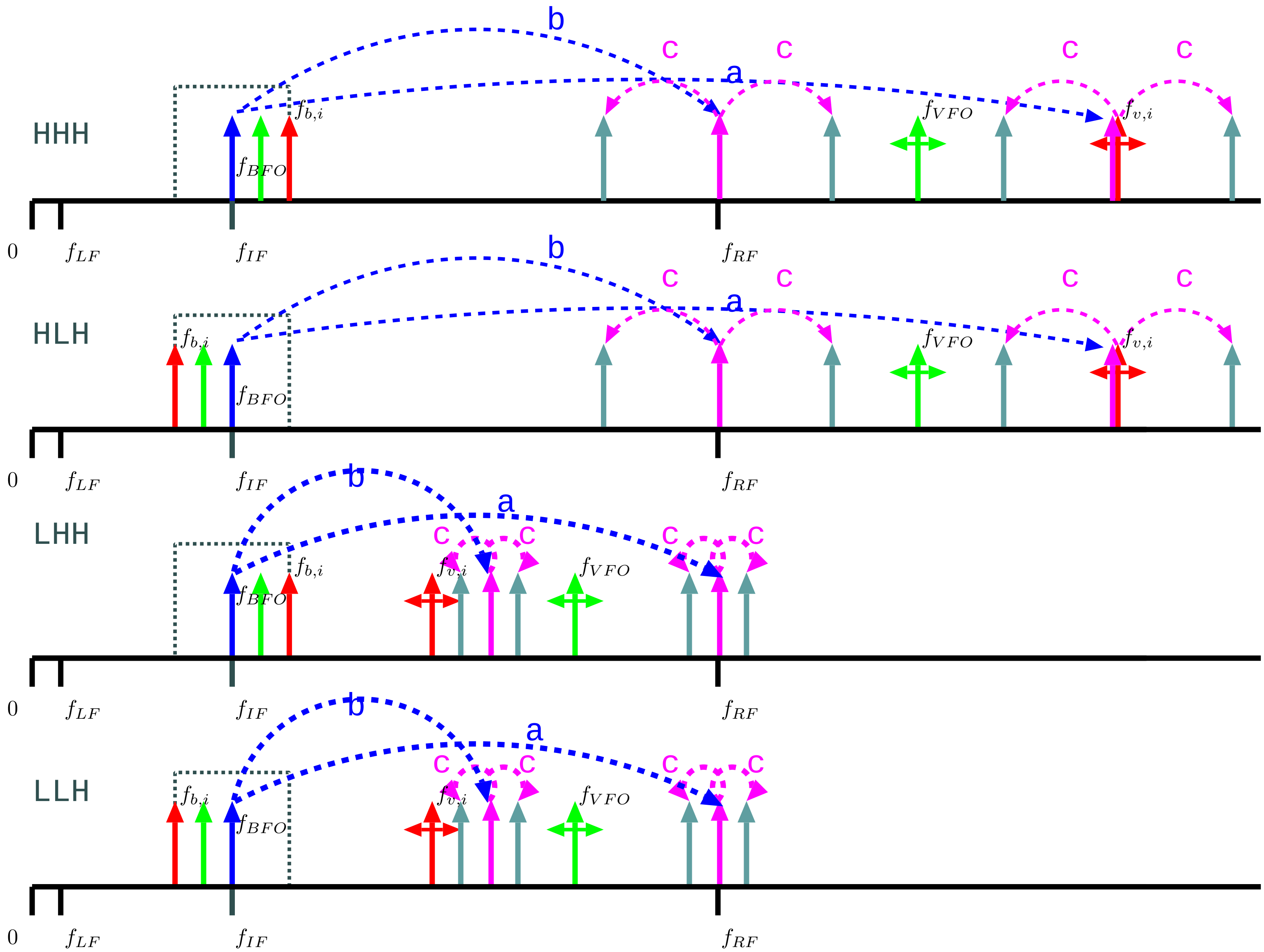

Figure 4: Four possible solutions to part 1c, when considering spurious components at f_{IF}. Frequency axis not to scale, and the translation of each spurious signal is indicated by colored arcs, with the translation amount as the arc label, as in Figure 2. Label a represents a translation by an amount f_{VFO}, label b denotes a translation by an amount $|f_{IF} - f_{VFO}|$, label c denotes a translation by an amount f_{BFO}.

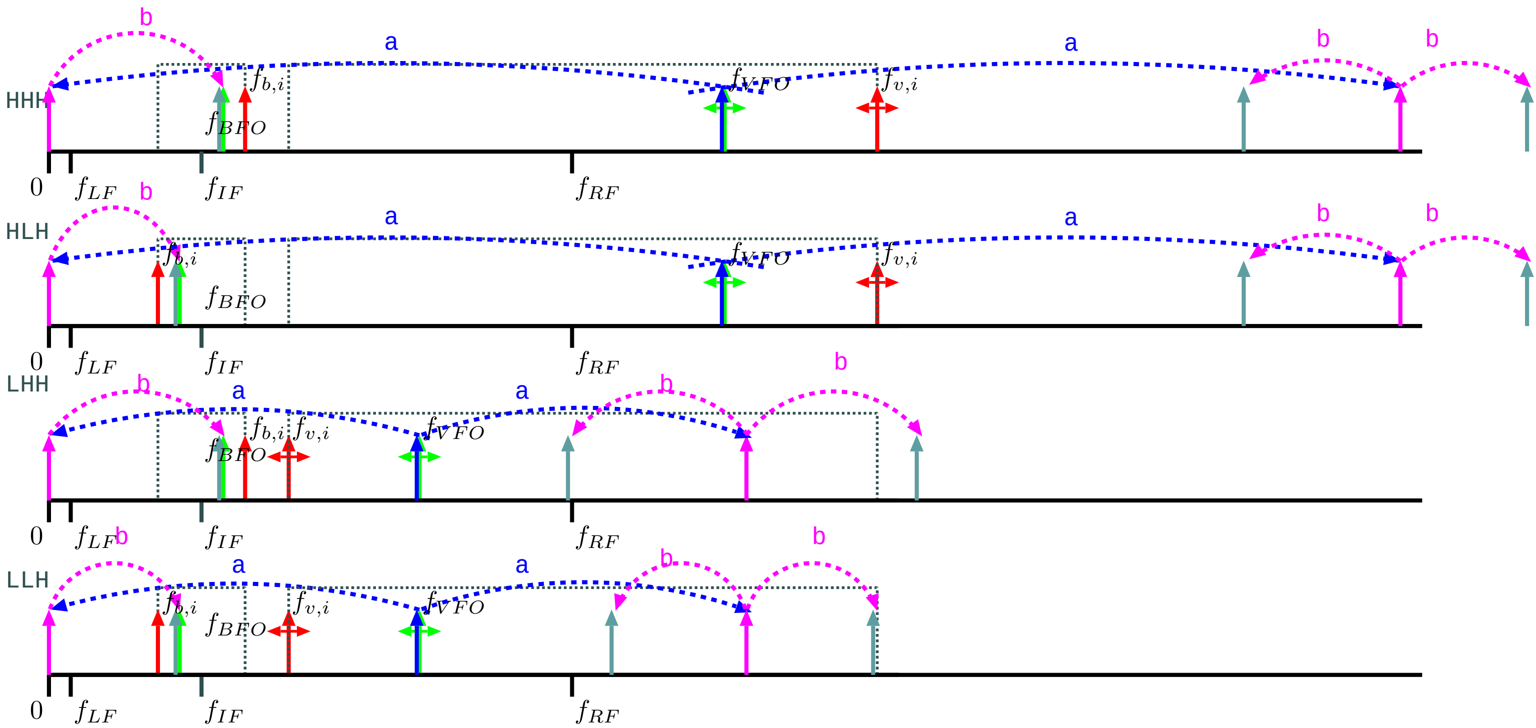

Figure 5: Four possible solutions to part 1c, when considering spurious components at f_{VFO}. Frequency axis not to scale, and the translation of each spurious signal is indicated by colored arcs, with the translation amount as the arc label, as in Figure 2. Label a represents a translation by an amount f_{VFO}, label b denotes a translation by an amount f_{BFO}.

(1.d) (0/100 pts) Both series filters reject some of the same spurious frequencies, since each conductor acts like an antenna, and may pick up spurious frequencies. In addition, the effect of filtering twice in series is to add the order of the filters, improving the rejection ratio.

(1.e)(10/100pts) The injection filter should have a center frequency equaling the midpoint of the VFO frequency range (see table), and a bandwidth just greater than the range of the VFO frequency (see table).

(1.f)(0/100 pts.) not graded.

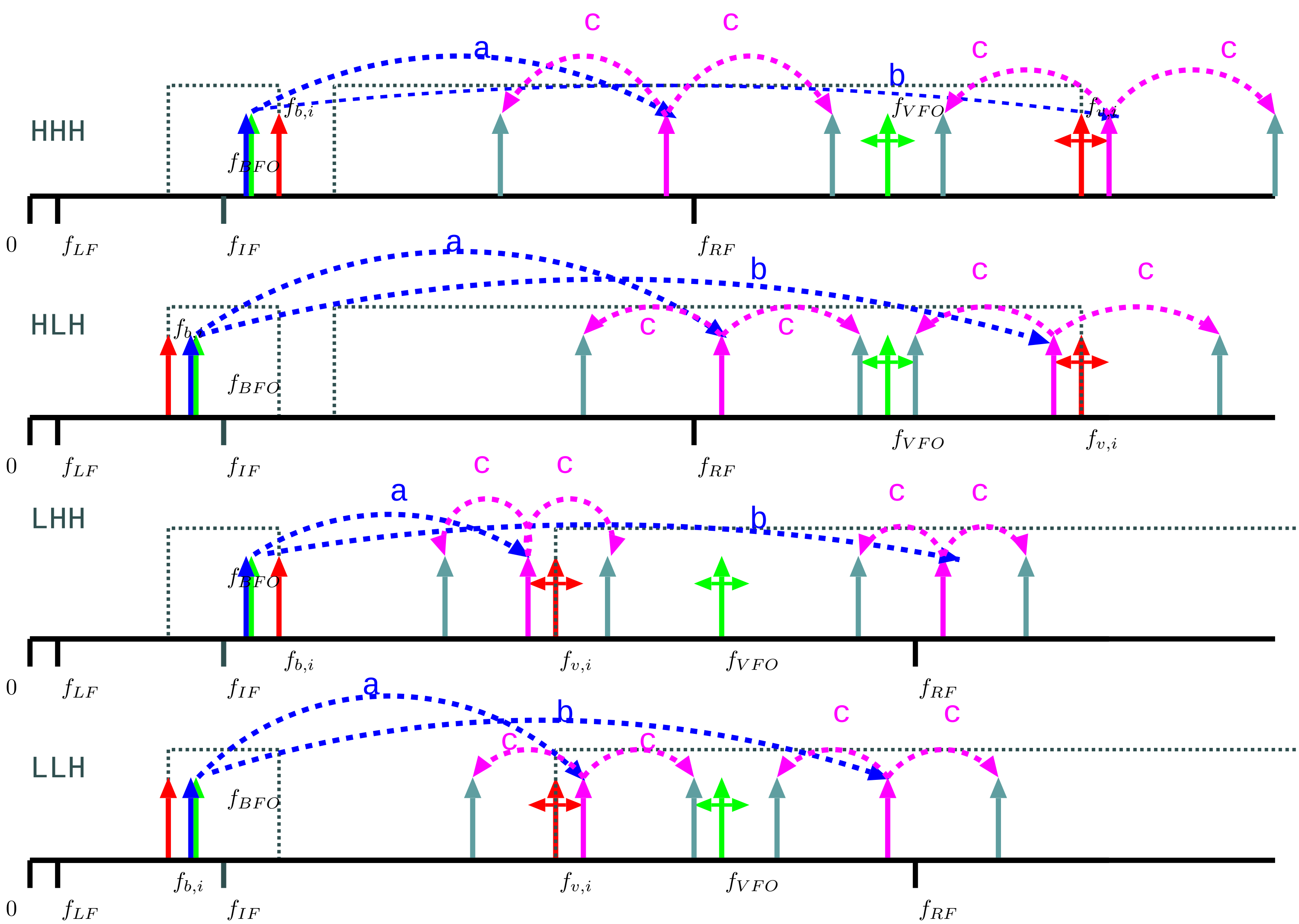

Figure 6: Four possible solutions to part 1c, when considering spurious components at f_{BFO}. Frequency axis not to scale, and the translation of each spurious signal is indicated by colored arcs, with the translation amount as the arc label, as in Figure 2. Label a represents a translation by an amount $f_{VFO} - f_{BFO}$, label b denotes a translation by an amount f_{VFO}, and label c denotes a translation by an amount f_{BFO}.