Performance evaluation of RF-Backplane option for MTCA.4 system

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3rd MTCA Workshop
DESY, 10.12.2014

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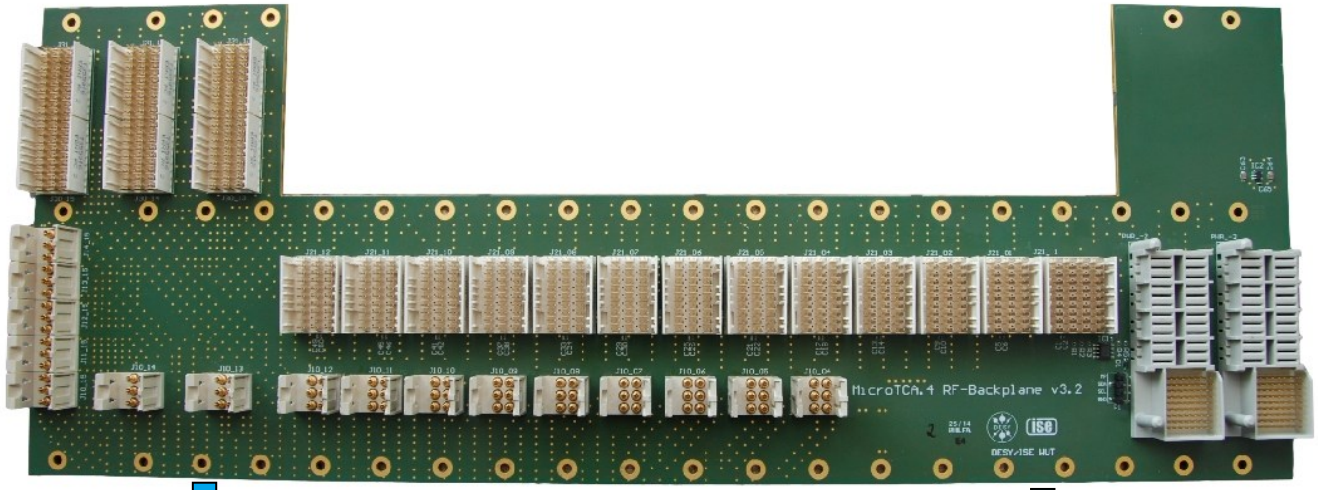
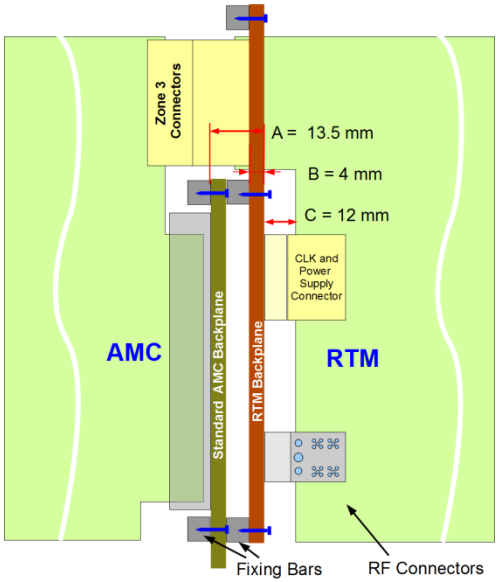
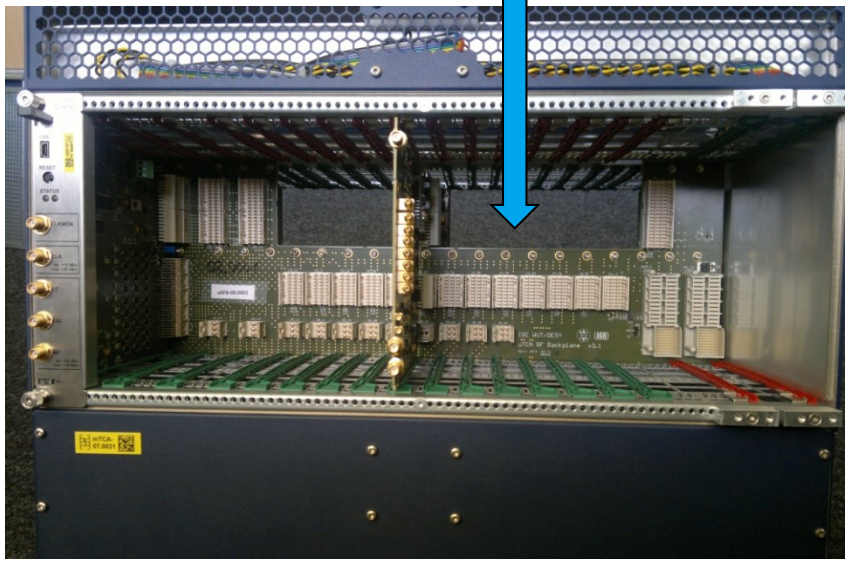
Reminder: What is the RF-Backplane?



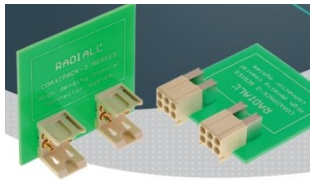




Basic Features of RF-Backplane

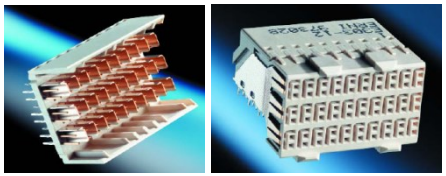
- RF channels (27 single-ended channels, star topology)

  DC to 6GHz, optimized phase drifts, insertion losses and signal reflections (target: -15dB of |S11|)



Radiall Coaxipack2 6-pin, 6GHz RF connectors

- Low-jitter CLK distribution (22 differential pairs, star topology)



ERMET ZD, 3x10 diff. pairs

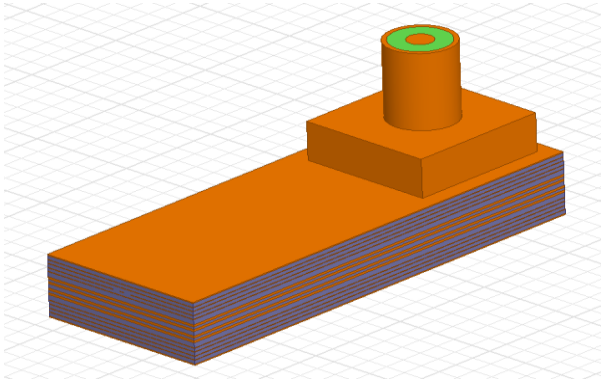
- DC power distribution network for each µRTM (+VV, -VV) and eRTM (PP)

Performance Tests

- Return and insertion losses
- RF channel-to-channel crosstalks
- CLK to RF channel-to-channel crosstalks
- Phase stability over temperature (phase drifts)

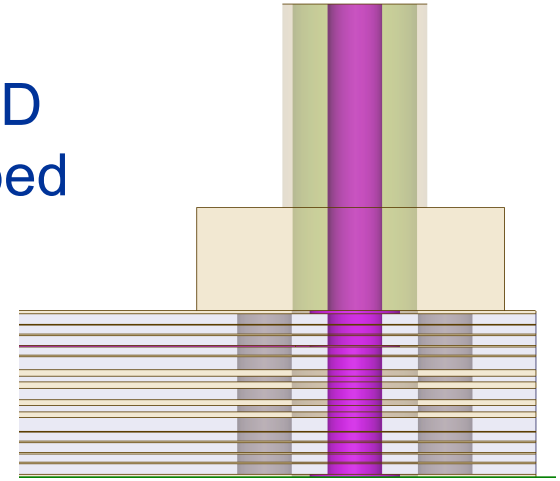
RF Design Optimization

- Poor reflection coefficient and high attenuation in early versions of RF-Backplane

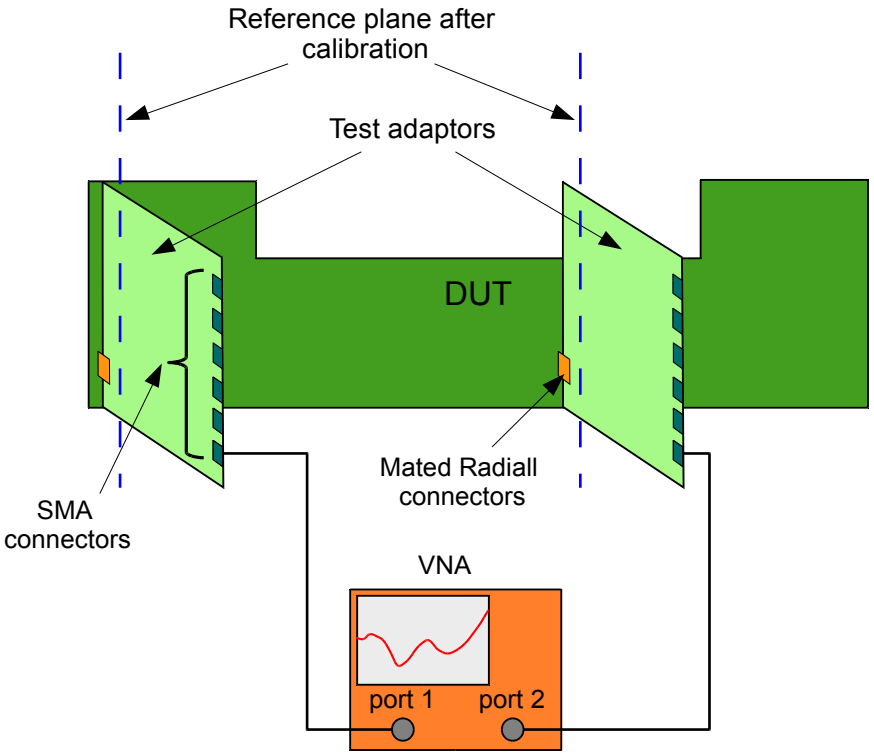


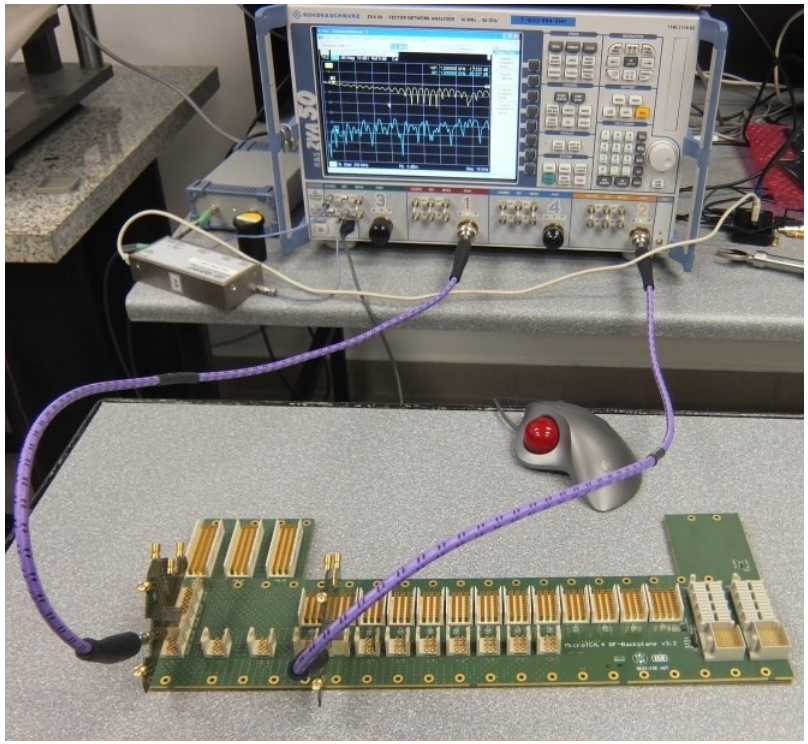
- Changed to RF PCB substrate for final version

- Optimized PCB layout for RF connectors (3D EM simulations): antipad size, elippse-shaped antipad, minimized via stub



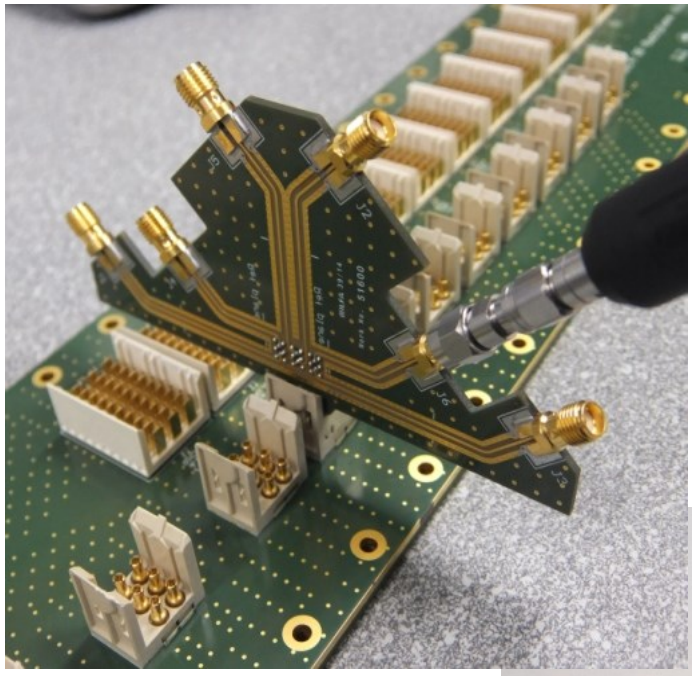
Return and insertion losses measurement setup



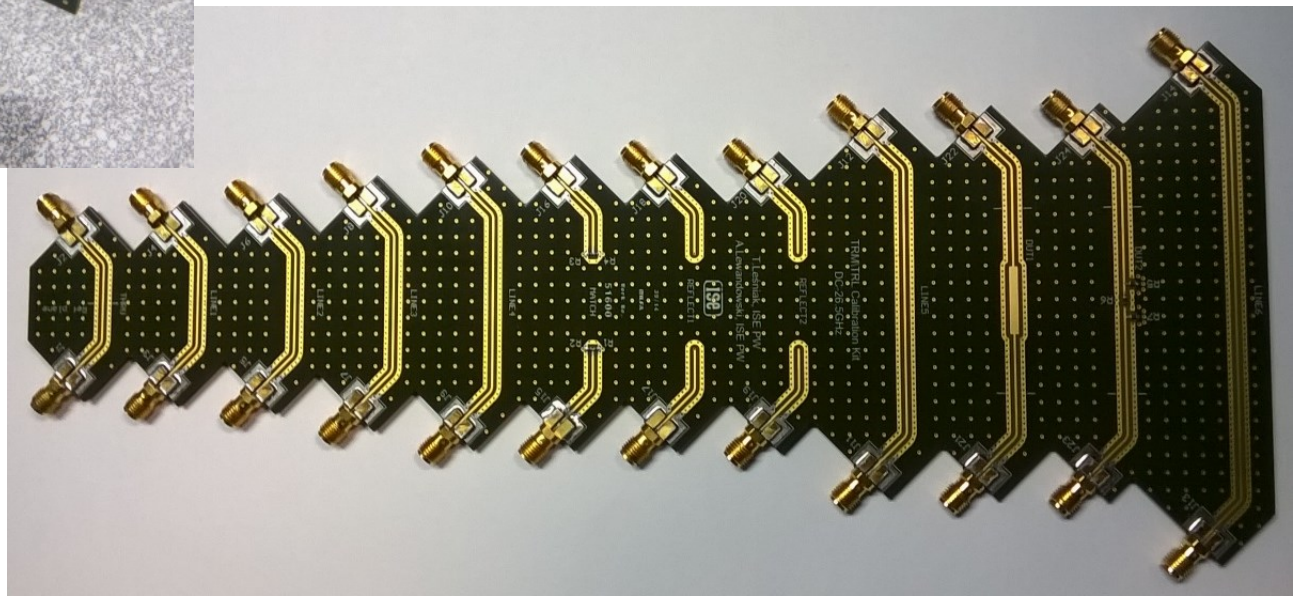


- Measurements in laboratory performed by calibrated VNA (multiline TRL calibration)
- Broadband 0.2-7GHz S-parameter characteristics were gathered

Return and insertion losses measurement setup (2)



Input/output SMA to Radiall adaptors

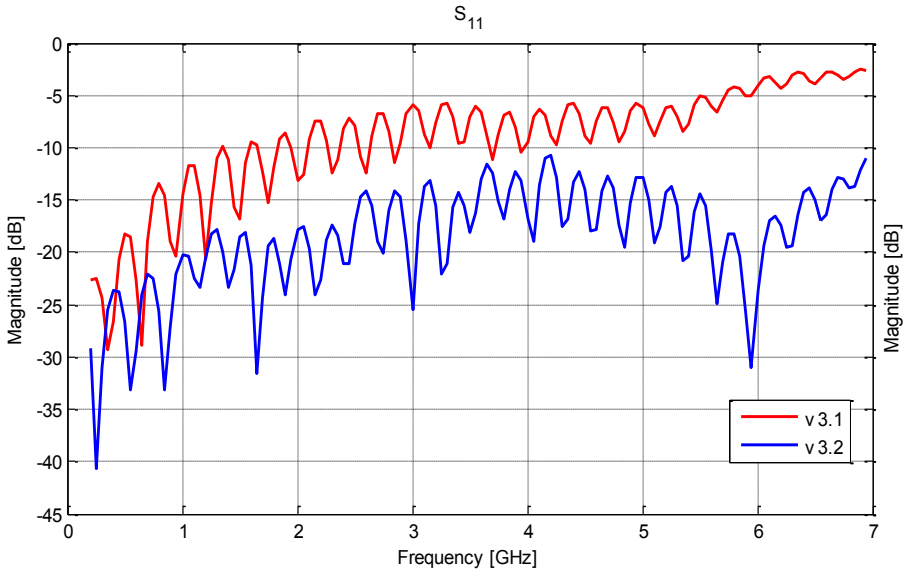


TRL calibration kit PCB

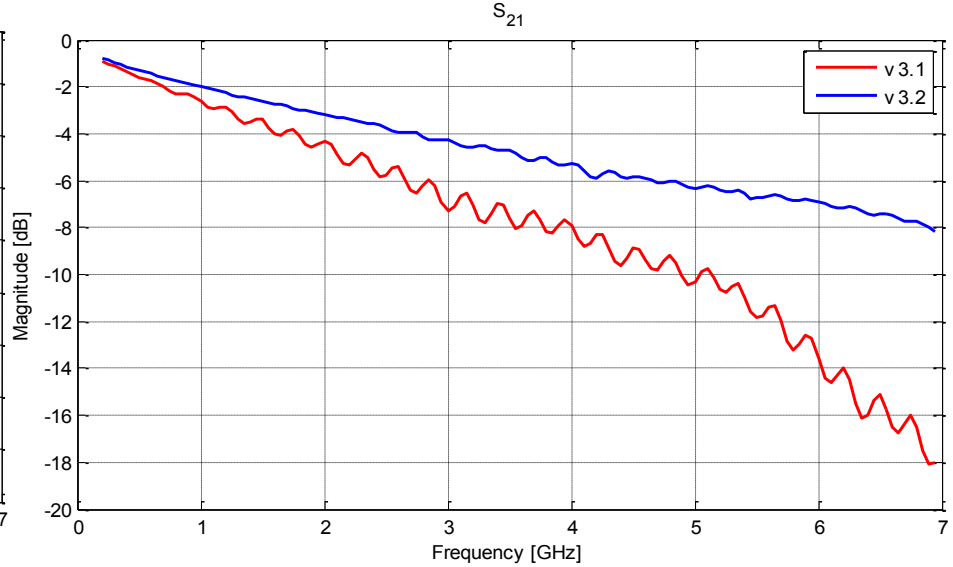
Return and insertion losses (2)

Slot	A_{REF} [dB]	$\|\Gamma_{REF}\|$ [dB]	A_{LO} [dB]	$\|\Gamma_{LO}\|$ [dB]	A_{CAL} [dB]	$\|\Gamma_{CAL}\|$ [dB]
4	2.4	-24.3	2.9	-40.0	2.5	-26.1
5	2.1	-23.4	2.7	-20.5	2.4	-17.9
6	2	-20.4	2.3	-25.7	2.3	-22.4
7	2	-15.9	2.2	-18.7	2.1	-22.3
8	1.6	-22.5	2.2	-21.0	2.0	-19.0
9	1.6	-24.5	2.0	-23.0	1.7	-26.8
10	1.5	-16.0	1.9	-18.6	1.6	-18.8
11	1.4	-19.4	1.5	-22.4	1.5	-19.6
12	1.1	-16.2	1.4	-19.1	1.4	-30.0

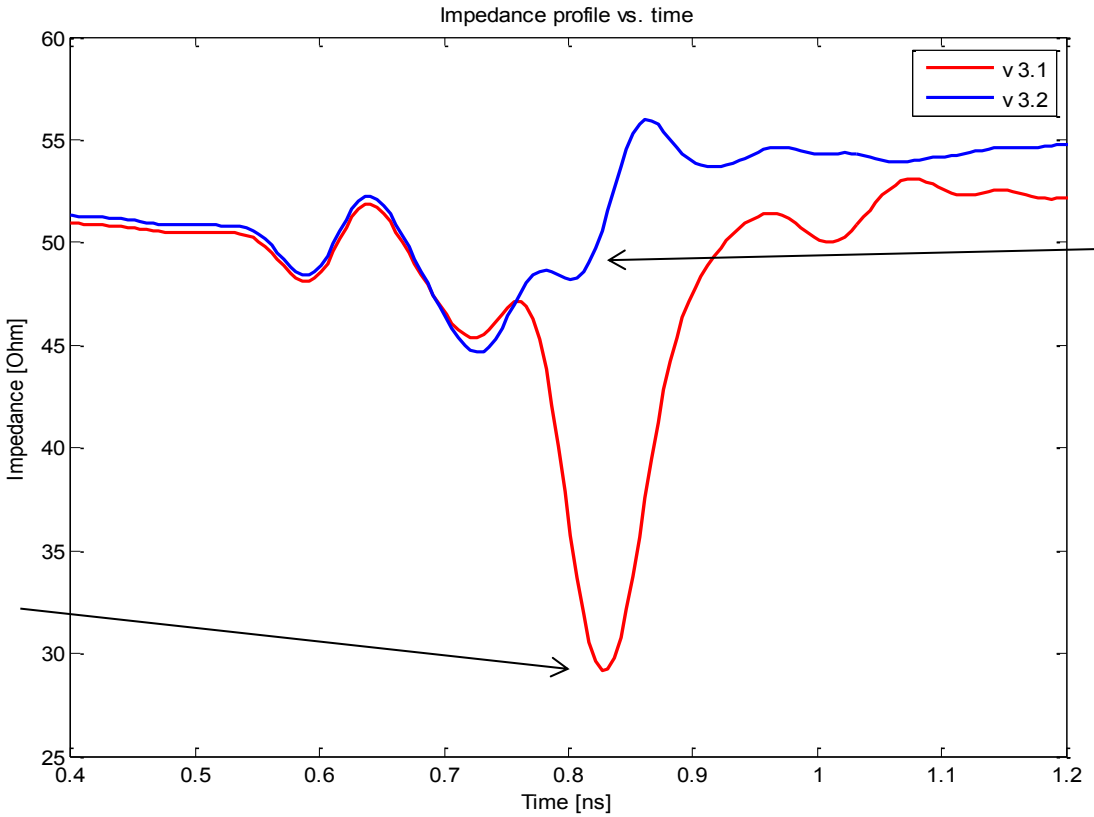
Return losses



Insertion losses



Time Domain Reflectivity Measurements

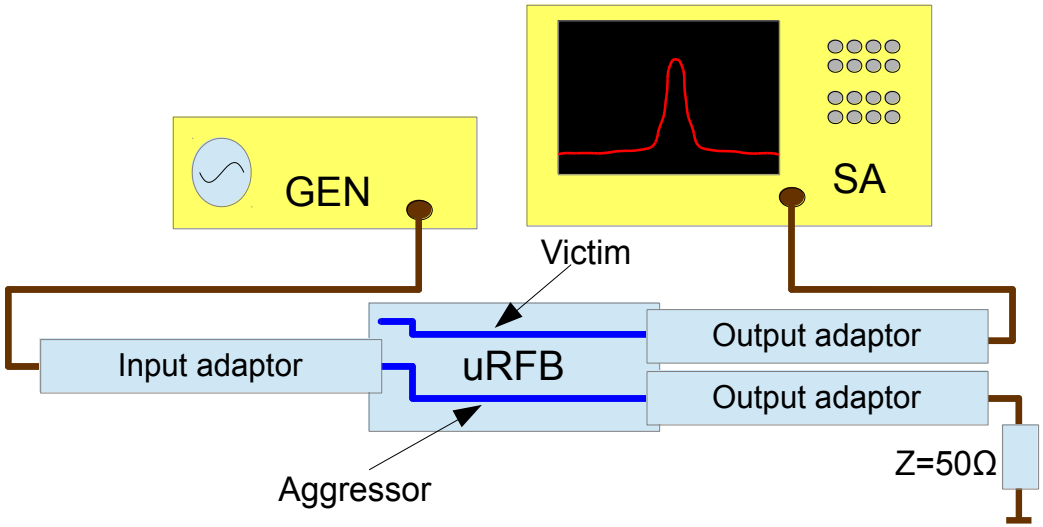


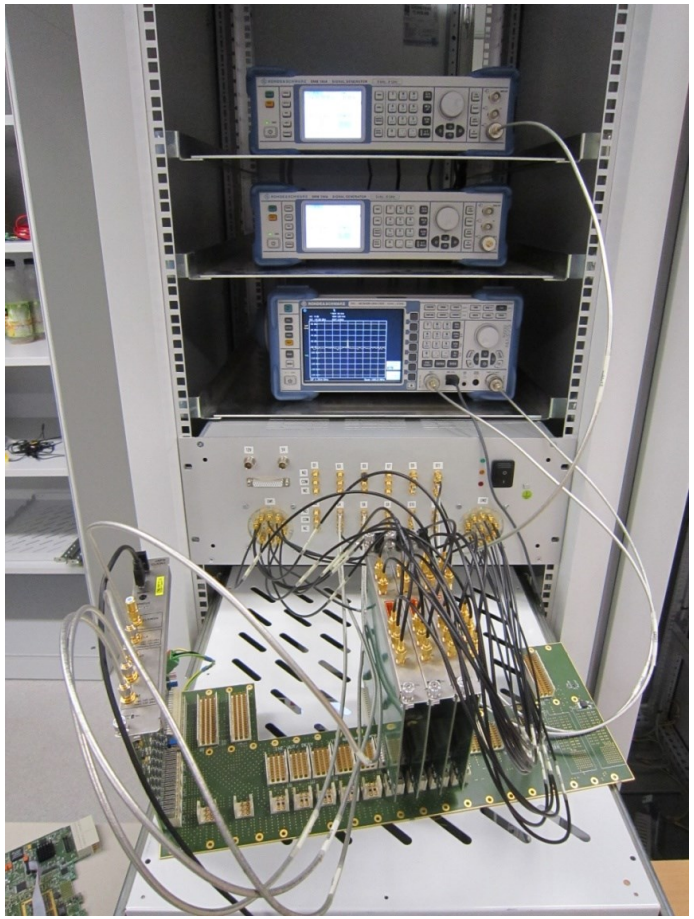
30 Ohm discontinuity before connector layout optimization

Almost 50Ohm match after connector layout optimization

TDR measurements of impedance profile versus time

Crosstalk Measurements Setup





- Setup description:

Input adaptor – µRFB_CLKIN3 input test board
Output adaptor – µRFB_OUTv3.0 output test board
µRFB – RF-Backplane v3.2
SA – spectrum analyser (ZVL6 from Rohde&Schwarz)
GEN – signal generator (SMB-106A from Rohde&Schwarz)

- Acceptable crosstalk < 80dB

- Automated test setup for crosstalk measurements (generator, switch matrix, adapter boards, spectrum analyser, software)

RF channel-to-channel crosstalks

Victims \ Aggressors	REF4	REF5	REF6	REF7	REF8	REF9	REF10	REF11	REF12
CAL4	90	111	96	104	110	103	94	99	97
CAL5	102	89	99	106	105	111	99	101	107
CAL6	101	105	97	115	108	100	105	104	109
CAL7	107	111	106	90	109	108	107	106	112
CAL8	114	104	107	112	87	104	108	107	115
CAL9	111	104	108	108	110	94	109	107	108
CAL10	110	100	108	104	111	103	90	104	109
CAL11	103	104	108	105	112	102	111	102	104
CAL12	96	104	104	104	107	103	101	103	92

Victims \ Aggressors	REF4	REF5	REF6	REF7	REF8	REF9	REF10	REF11	REF12
LO4	93	109	95	97	115	105	105	112	113
LO5	103	102	106	93	114	101	109	109	112
LO6	102	95	93	113	119	112	106	111	117
LO7	100	102	104	97	113	104	111	109	113
LO8	95	102	109	103	97	106	106	113	114
LO9	95	97	111	111	115	93	107	108	109
LO10	97	100	114	112	118	111	103	109	105
LO11	95	111	112	114	113	102	107	95	109
LO12	103	105	108	106	109	101	107	109	93

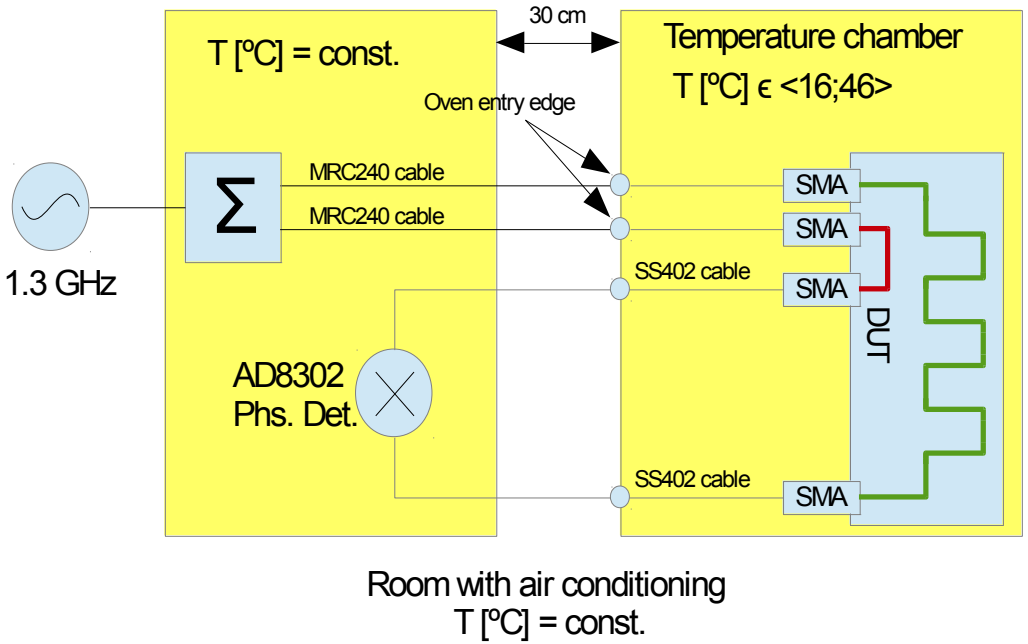
Victims \ Aggressors	LO4	LO5	LO6	LO7	LO8	LO9	LO10	LO11	LO12
CAL4	88	102	113	110	114	108	110	112	110
CAL5	113	90	108	112	111	111	109	109	114
CAL6	103	106	94	105	113	109	111	110	117
CAL7	101	108	111	95	111	110	112	111	116
CAL8	97	103	106	111	97	111	109	111	111
CAL9	92	104	102	105	119	100	107	110	106
CAL10	90	114	104	101	108	109	96	111	114
CAL11	89	102	109	101	114	110	109	97	113
CAL12	104	113	112	113	118	103	107	102	99

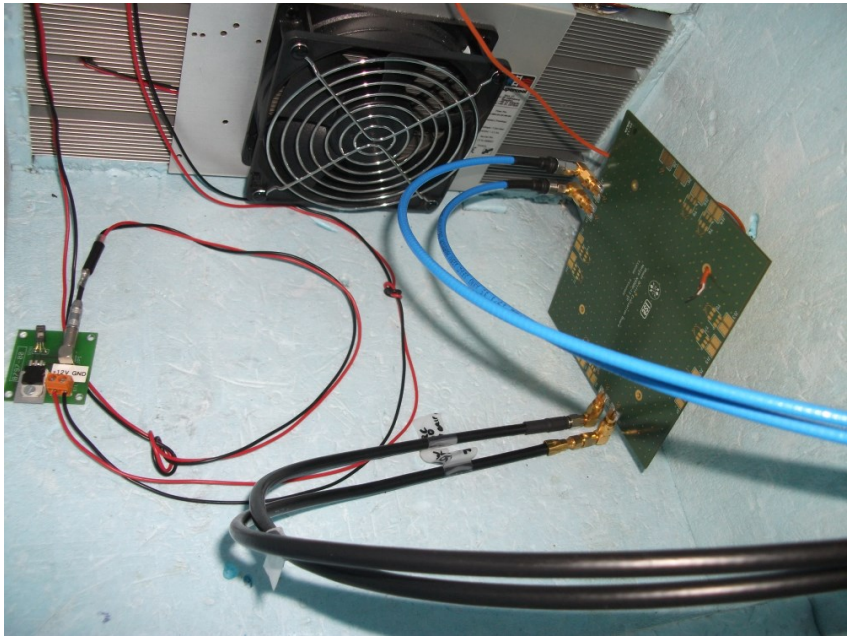
CLK to RF channel-to-channel crosstalks

Aggressors \ Victims	REF4	REF5	REF6	REF7	REF8	REF9	REF10	REF11	REF12
CLKA4	109	108	110	110	109	110	111	108	109
CLKA5	111	108	107	108	107	109	110	109	113
CLKA6	106	111	108	108	108	110	110	108	110
CLKA7	110	109	109	108	106	107	108	110	111
CLKA8	110	111	109	109	109	108	109	108	109
CLKA9	111	111	108	110	110	111	111	110	109
CLKA10	109	113	109	110	110	109	110	109	110
CLKA11	110	107	109	111	110	109	111	111	108
CLKA12	106	108	111	110	110	108	110	111	108
CLKB4	106	111	111	111	112	107	109	110	109
CLKB5	111	109	107	111	108	108	108	110	110
CLKB6	111	109	108	110	111	110	109	110	108
CLKB7	108	110	110	109	109	111	108	109	108
CLKB8	110	107	111	111	111	109	108	110	108
CLKB9	108	111	109	110	110	110	108	111	109
CLKB10	109	109	107	109	110	109	110	111	109
CLKB11	107	111	108	111	109	109	109	108	110
CLKB12	110	109	109	109	108	109	108	110	108

RF-Backplane provides excellent isolation between CLK and RF channels.
Results might be limited by dynamic range of measurement setup/fixture.

Phase Stability Over Temperature (1)

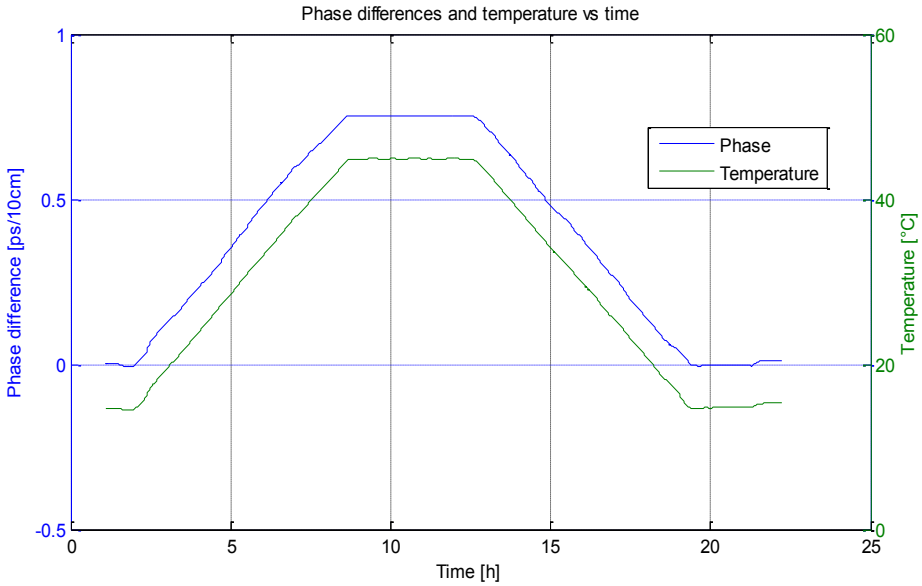




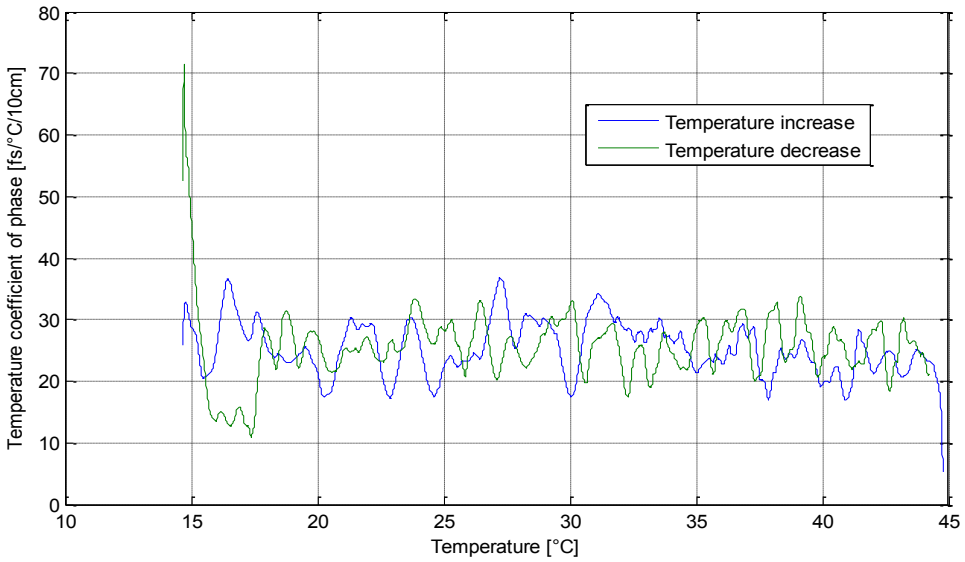
- Test board based on the same subtrate and stackup as RF-Backplane
- Differential approach: two RF paths that differ only in lenght of stripline affected by phase drifts

Phase Stability Over Temperature (2)

Results for 10 cm long test stripline:



Measured phase drift



Temperature coefficient

Phase drift coefficient for the longest RF line (34cm) on the RF-Backplane is about 85fs/K

Conclusions

- Return losses up to 6 GHz are better than -10dB (@1.3GHz |S11| < -16dB)
- Insertion losses are less than 3dB
- RF channel-to-channel crosstalk of below -87dB (excellent)
- Crosstalk between CLK and RF channels lower than -106 dB (probably even better, limited by measurement equipment)
- Phase drift coefficient versus temperature for longest RF channels does not exceed 85fs/K
- Phase stability over humidity tests are planned this month

Thank you for attention!