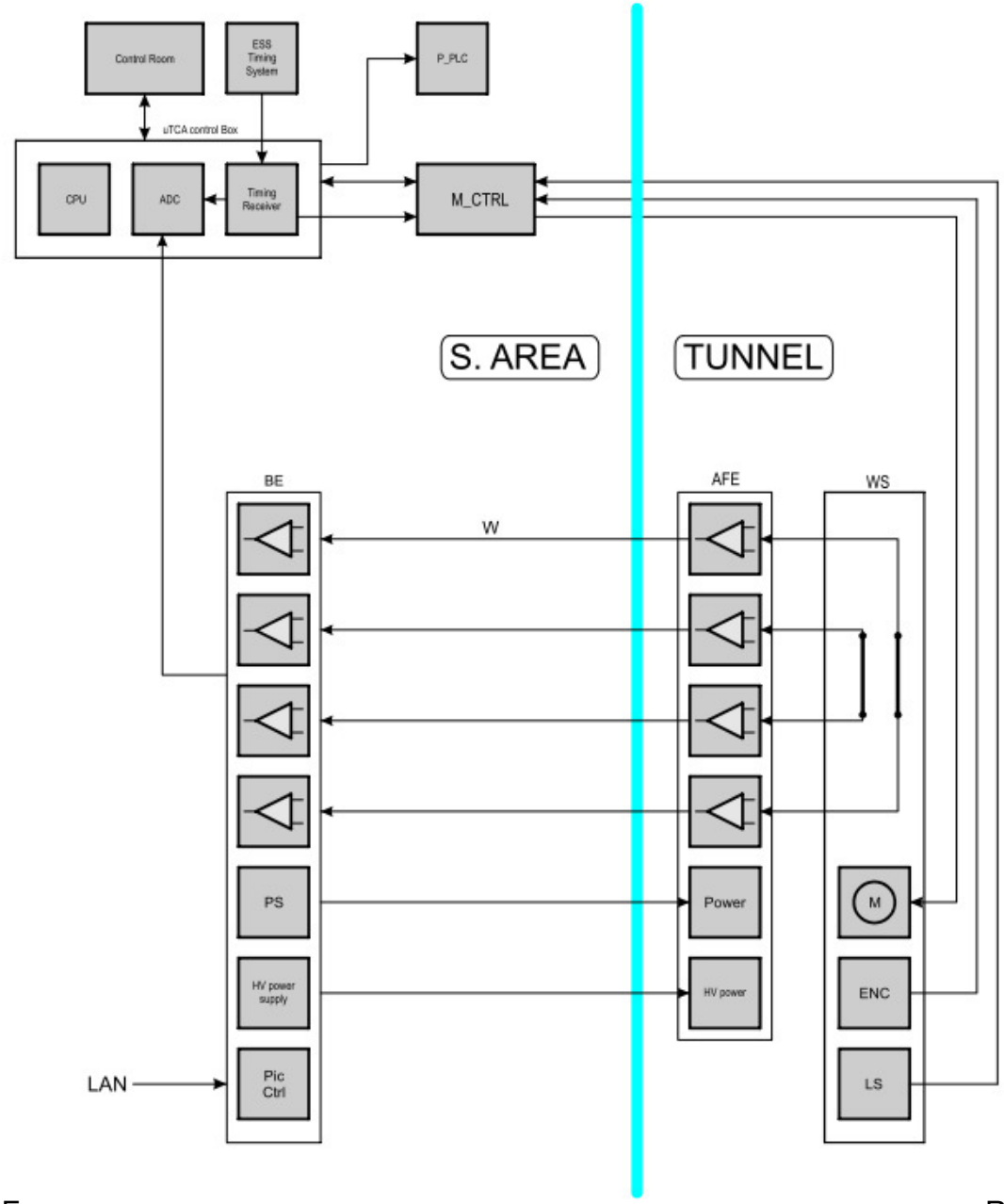
Elettra Sincrotrone Trieste

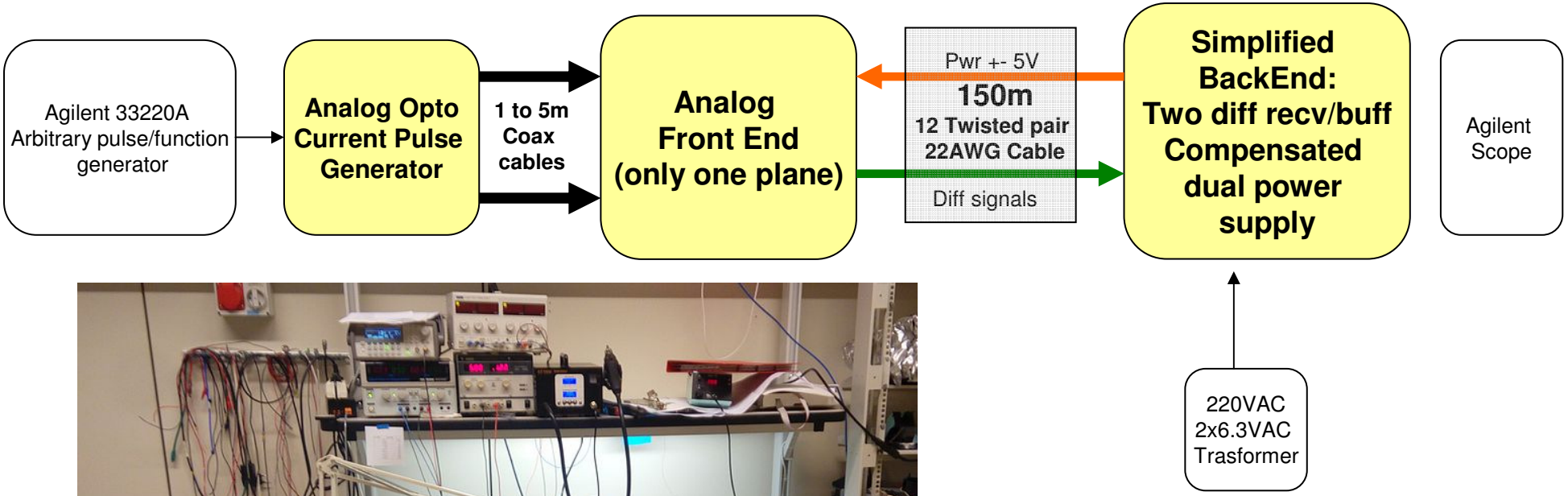
Wire Scanner AFE Electronics:
Preliminary results, performances and open issues.

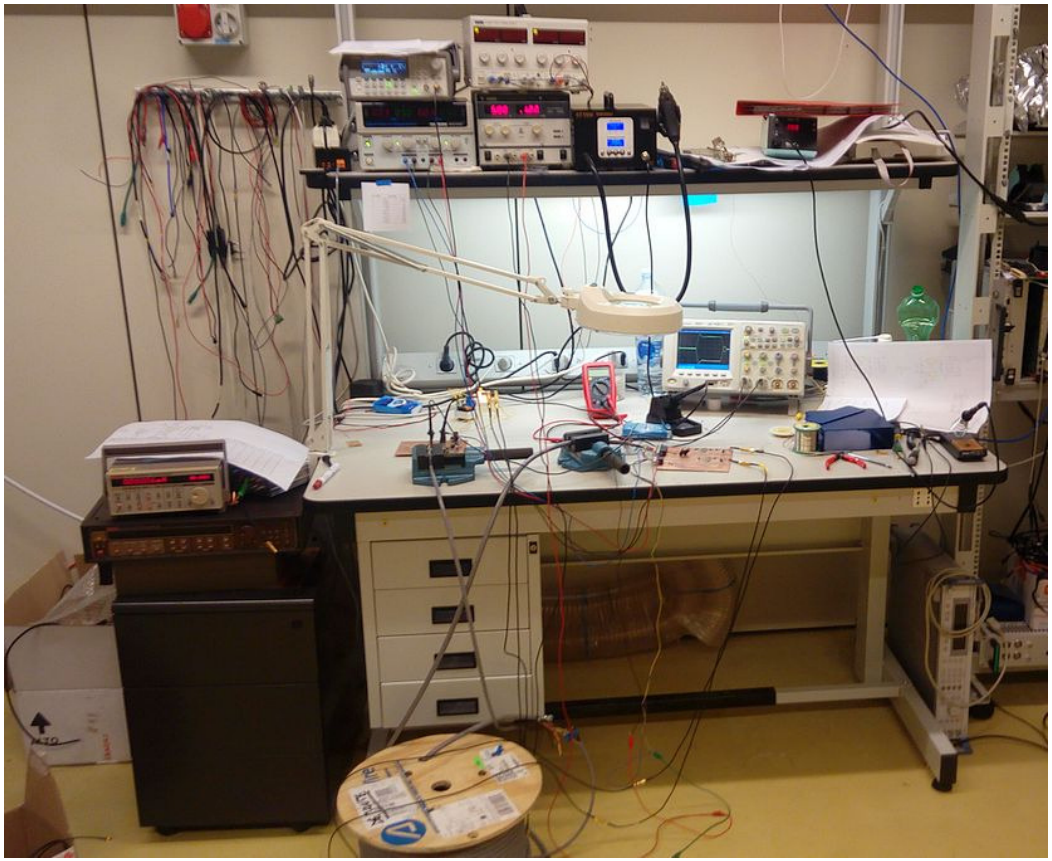
WSAS simplified system block diagram

Diagram by S.Grulja



WSAS simplified system laboratory test bench

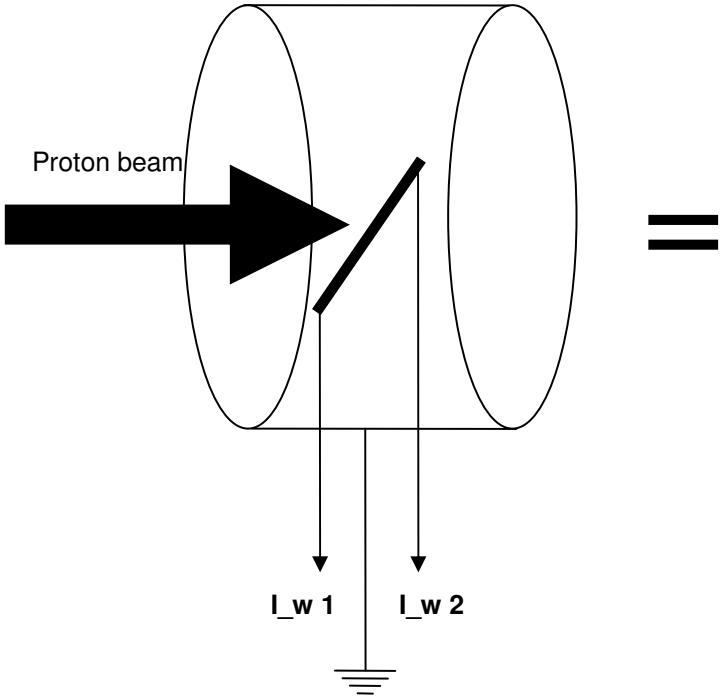




Analog Opto Current Pulse Generator

Signal simulation:
It is necessary to generate two pulsed signals, equals and with ultra low currents to feed the AFE prototype.
Square Wave Pulses: from 10nA to 400µA , from 10µs to 100µs.
Commercial available current generators aren't able to simulate this kind of signals.
We are using an in-house developed solution.
The beam's simulator is made using an analog high precision optocoupler driven by a pulser with variabile output.
The circuit is calibrated in DC, by driving the variable current/voltage circuit and reading the output with pico-ammeter.
Then the known current/voltage driving will be pulsed.
To validate this method we also put a DC current from Keythley picoAmpere source generator at the circuit input and we measure the corresponding voltage from TIA (Transimpedance Input Amplifier) at various currents from 100nA to 300µA .

Wire scanner electronic simulator



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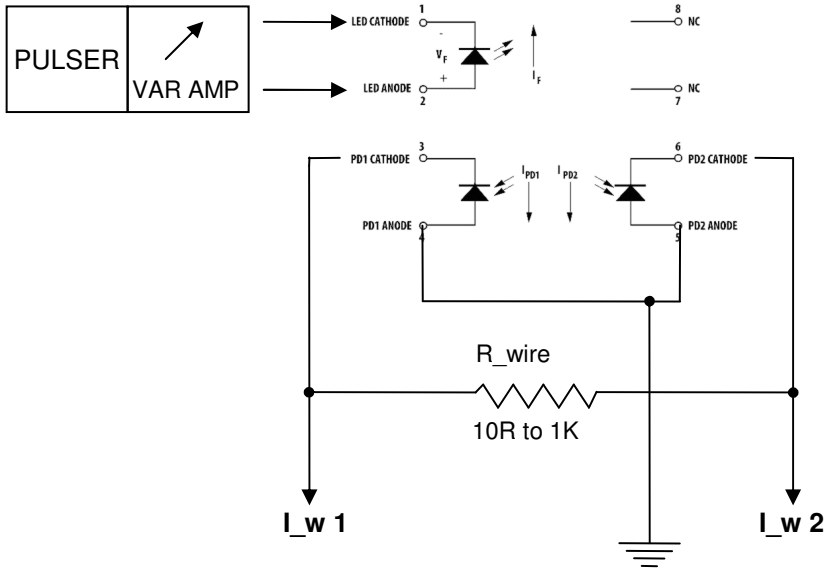
HCNR201
High-Linearity Analog Optocoupler

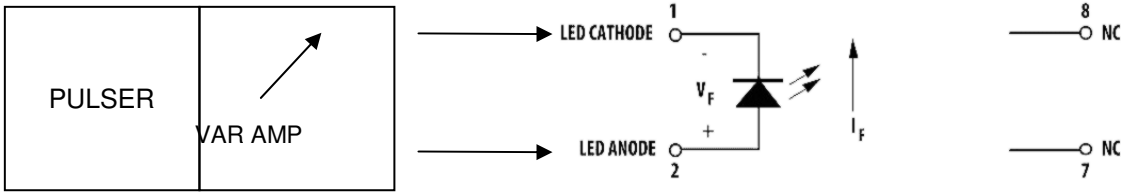


R_wire simulate the wire resistance in the two possibile conditions: tungsten or carbon

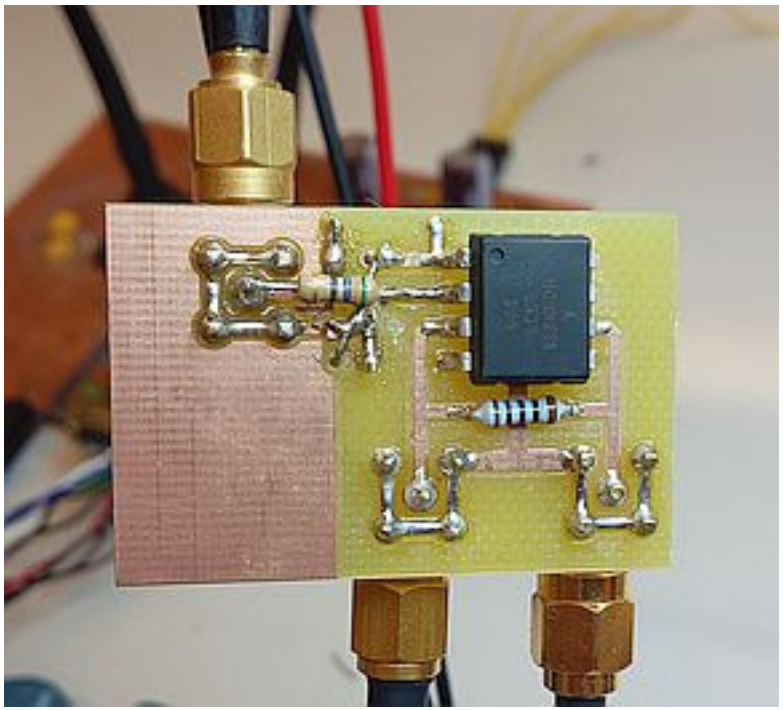
T_A = 25°C unless otherwise specified.

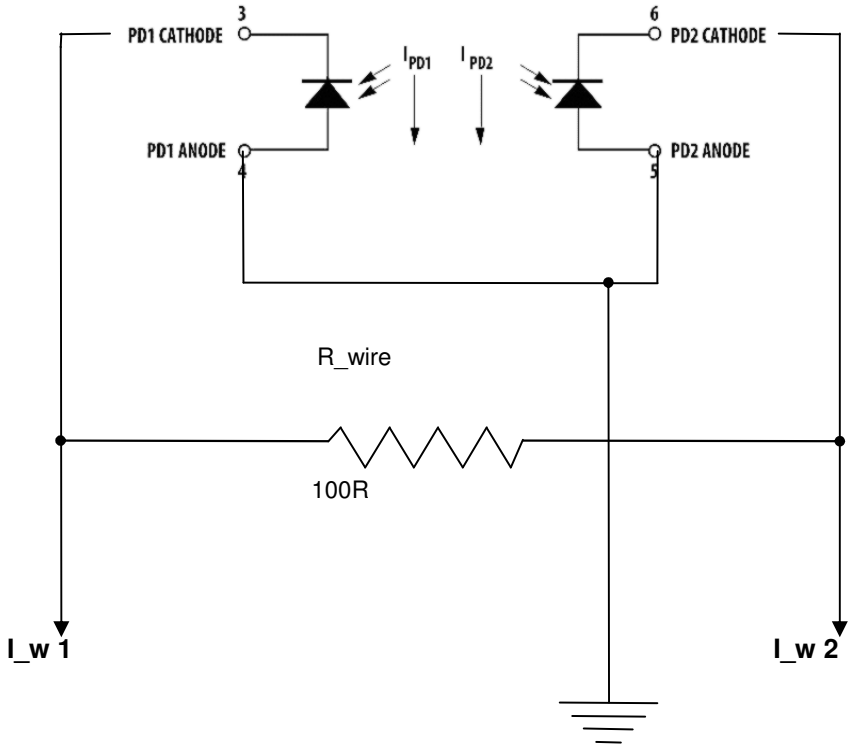
Parameter	Symbol	Device	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
Transfer Gain	K_3	HCNR200	0.85	1.00	1.15		5 nA < I_{PD} < 50 µA, 0 V < V_{PD} < 15 V	2,3	1
		HCNR201	0.95	1.00	1.05		5 nA < I_{PD} < 50 µA, 0 V < V_{PD} < 15 V		1

Wire scanner electronic simulator



HCNR201
High-Linearity Analog Optocoupler



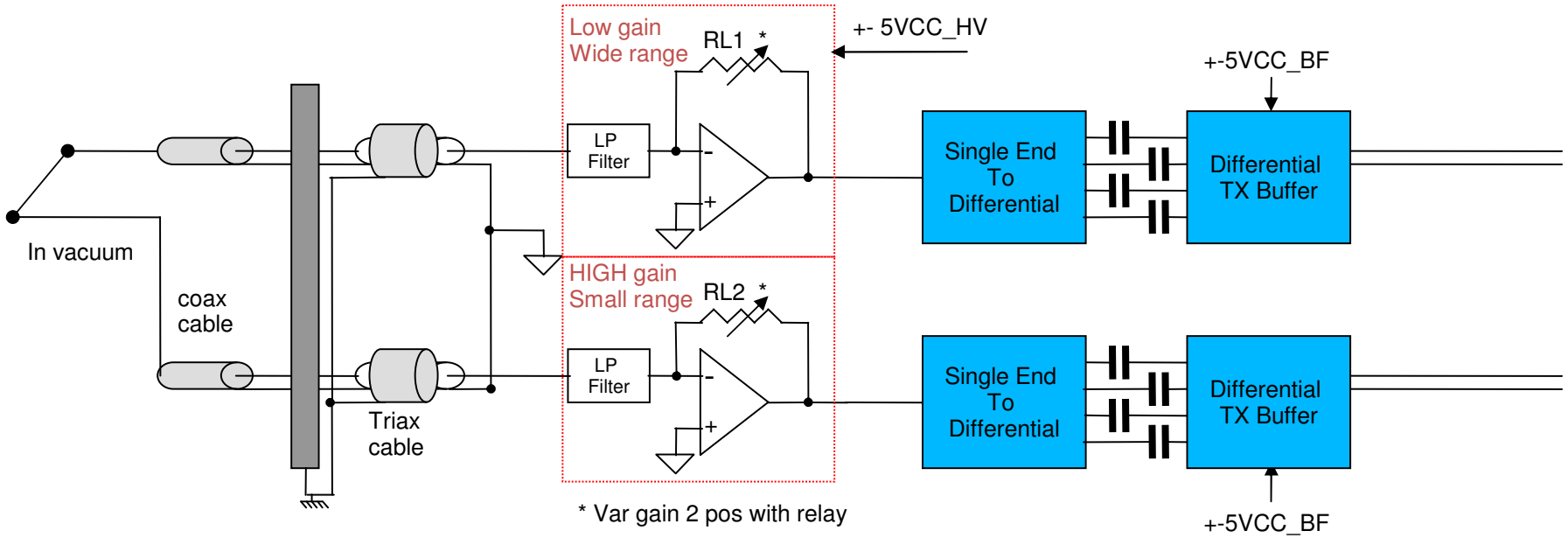


V LED	uA Tot
1,300	0,1
1,421	0,5
1,449	1
1,530	5
1,590	10
1,691	20
1,791	30
1,867	40
1,952	50
2,380	100
3,110	160
3,500	200
4,800	300

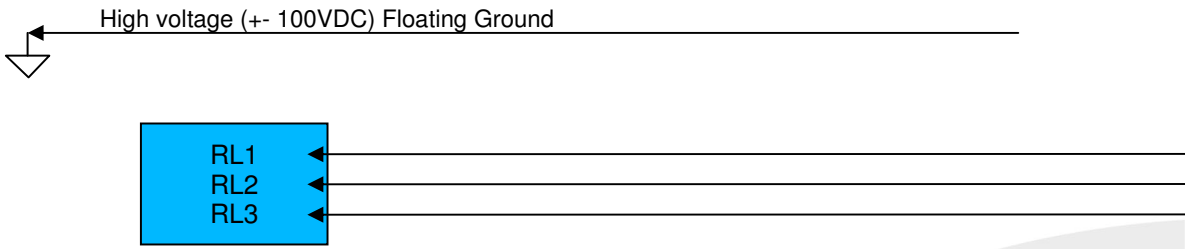
R_wire simulate the wire resistance in the two possibile conditions: tungsten or carbon

Simplified Block Diagram for AFE

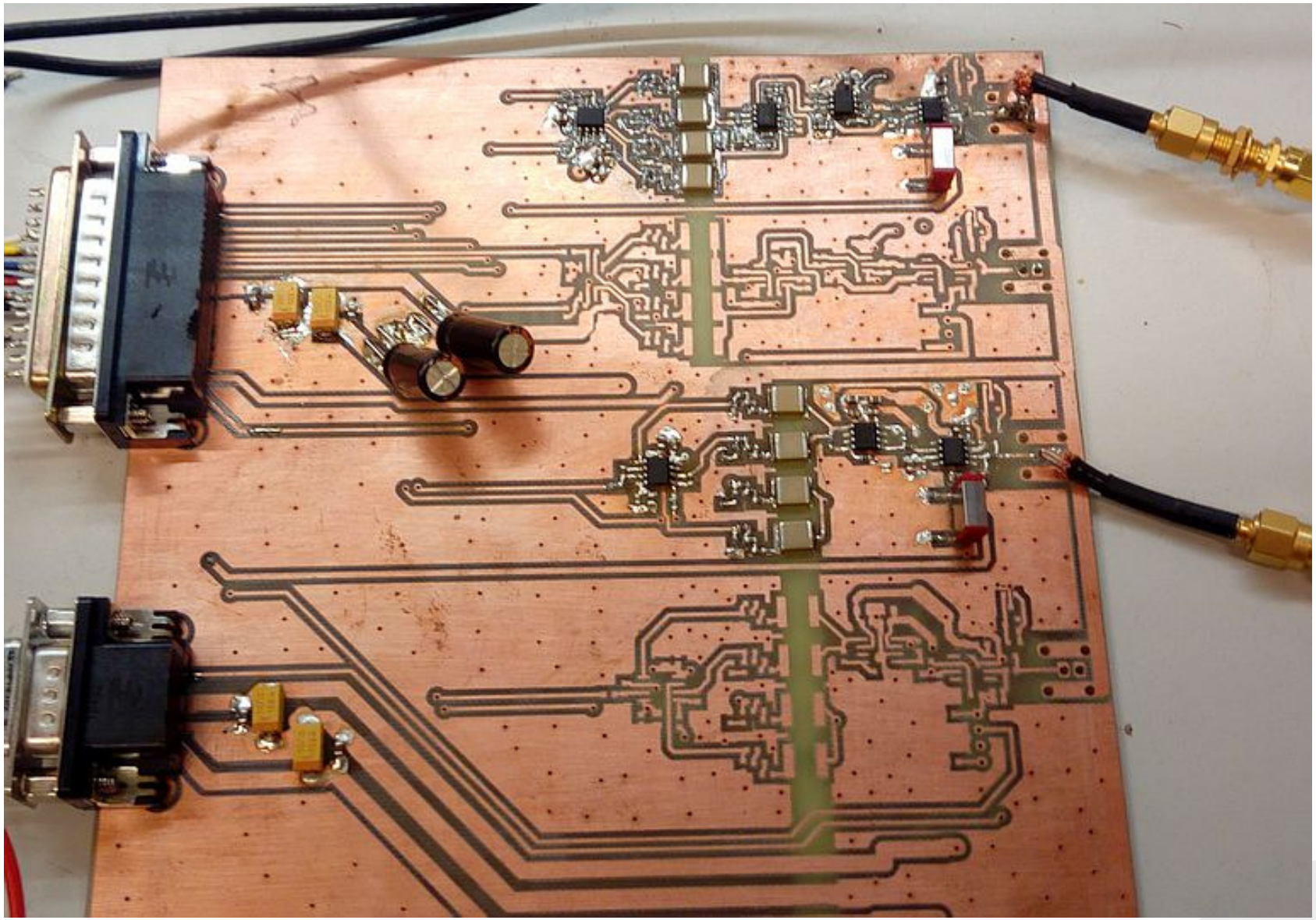
Analog Front End
TWO IDENTICAL STAGES: Horizontal and Vertical



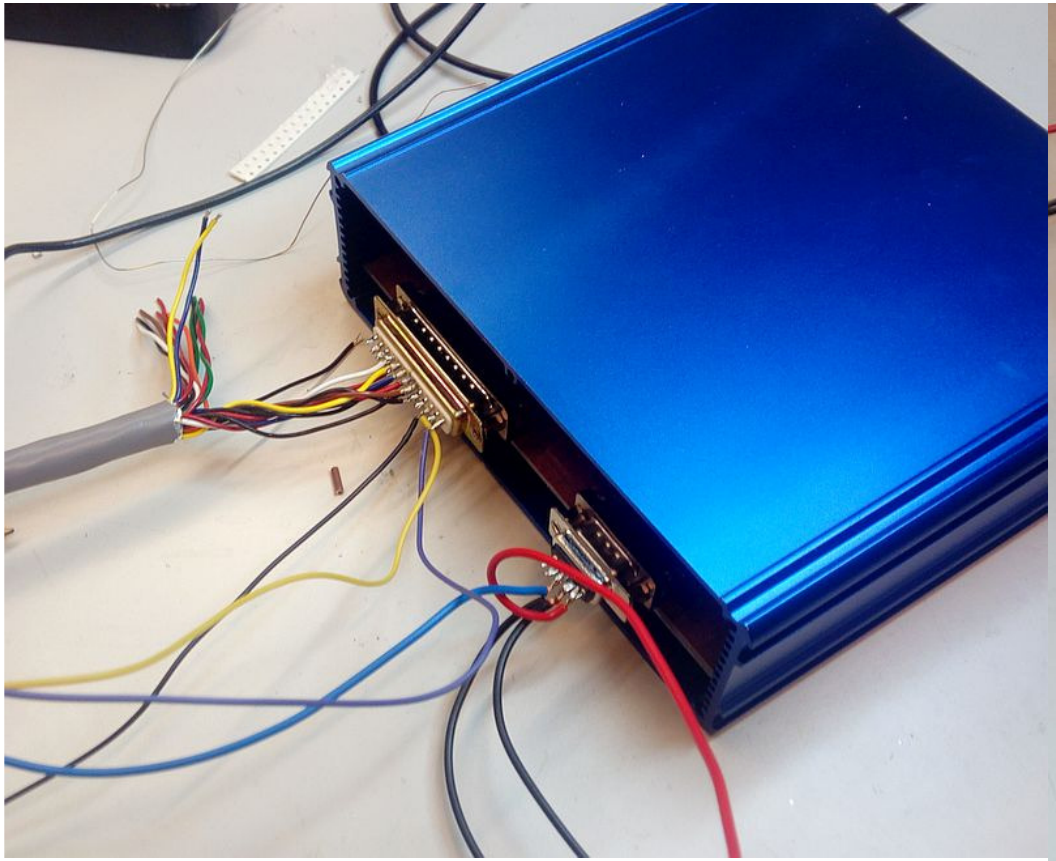
The AFE input stage is a trans impedance amplifier (TIA) converting currents generated in the wire into a voltage.
Then, the signal is conditioned as differential, ground isolated from the machine ground using AC differential coupling technique.
Finally, it is buffered for the transmission over the twisted pair cable connected to the BE module.

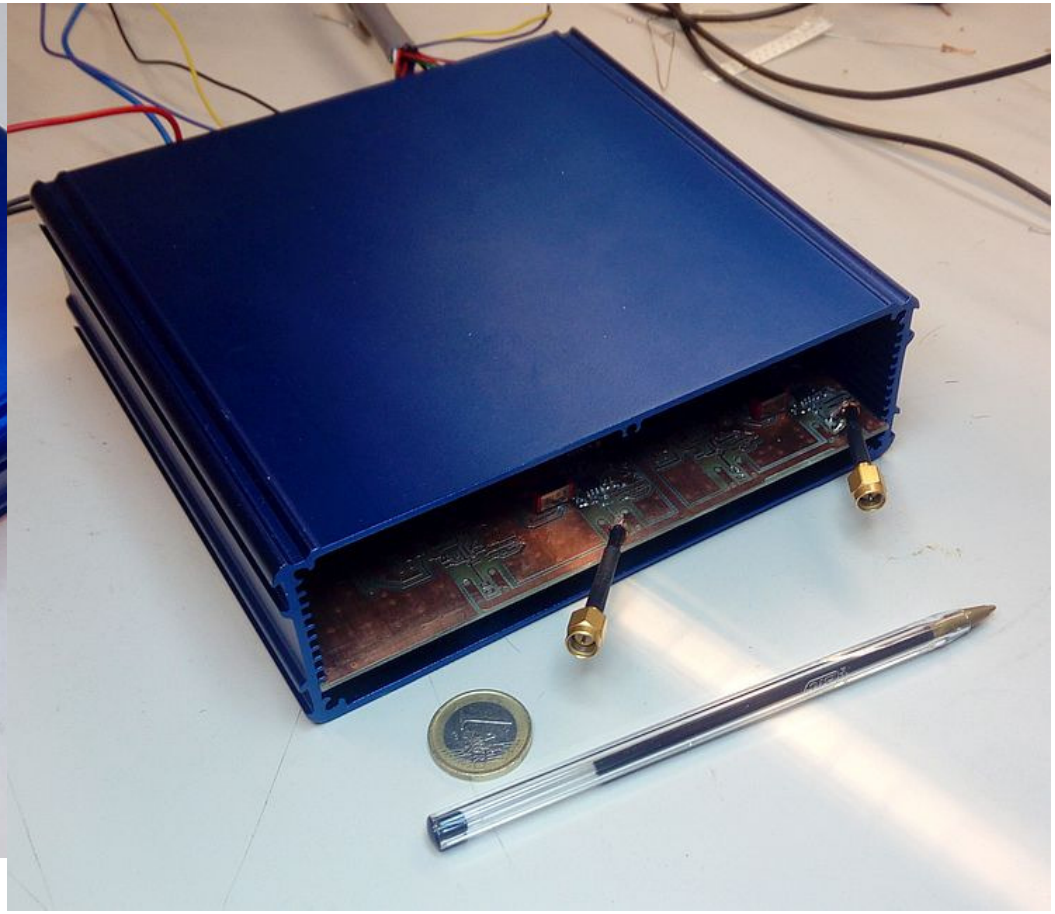


AFE prototype



AFE prototype Box Enclosure

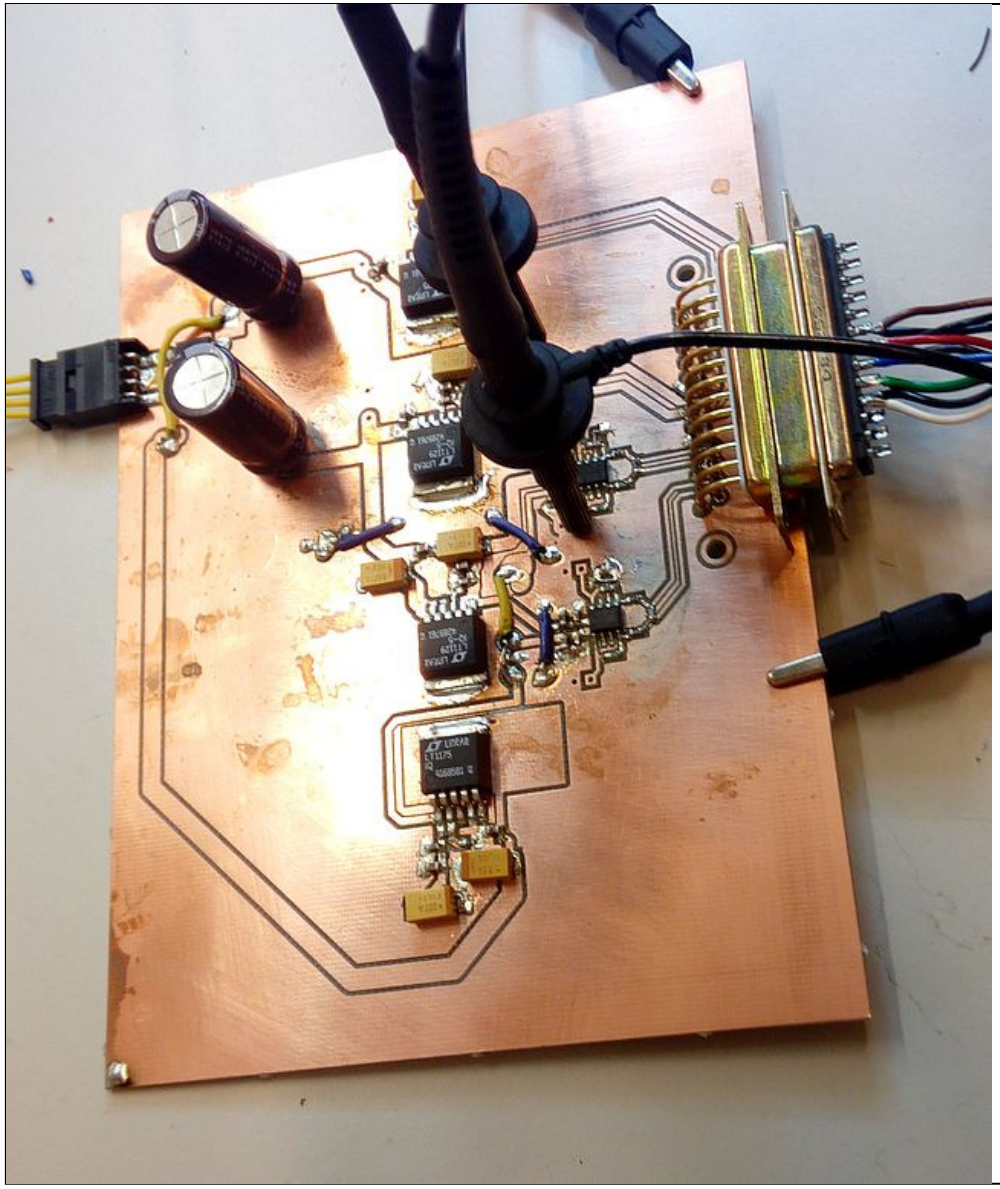


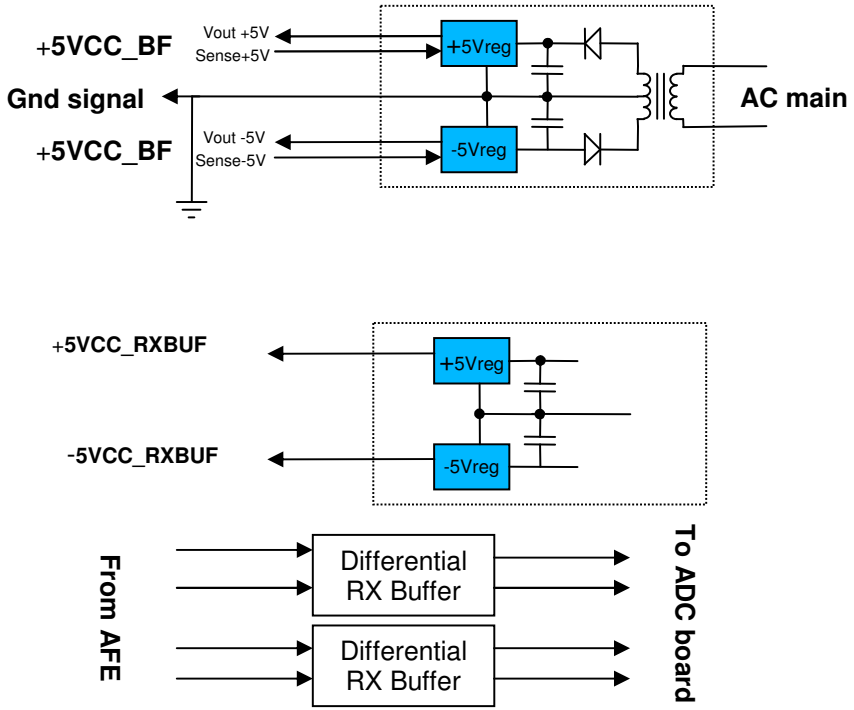


AFE specifications

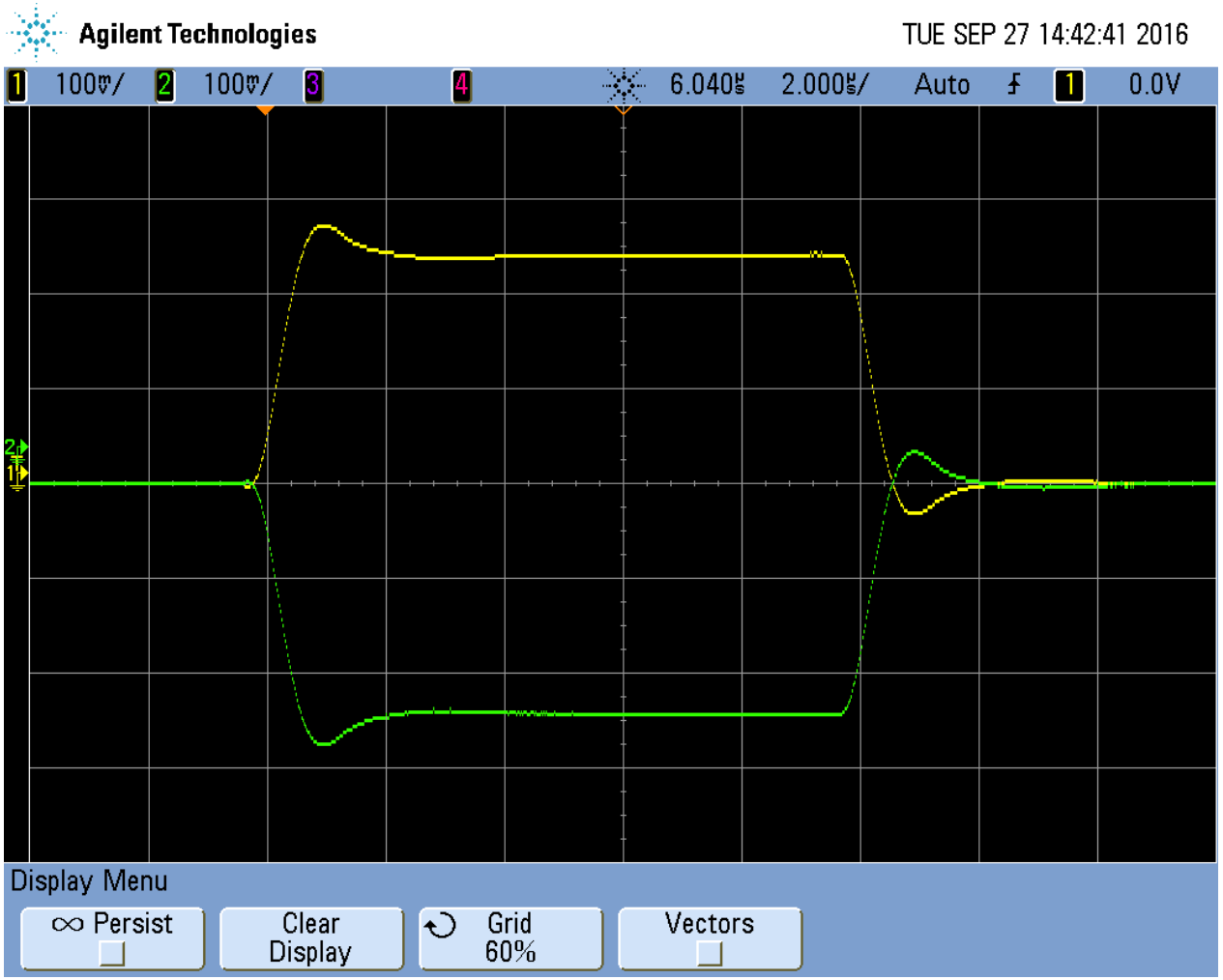
Parameter	Value	Symbol	Notes
Input channel	4	I_Wi; i=1...4	Tri-axial
Max Input Voltage	3VAC	I_W_{MAX}	Input diode protected
Max Input Current	N/A	I_W_{MIN}	
Input Impedance	50 ohm	Z_{IN}	Not well matched
Bandwidth	2MHz	BW_{AFE}	
Output channel	4	$OUT_{AFE}i$	Balanced twisted pair
Minimum Gain	1V/400µA	G_{MIN}	V / A
Maximum Gain	1V/1µA	G_{MAX}	V / A
Power supply	+/- 5 V **@ 100mA MAX**	I_{supply}	via BE cable
Dimension	170 x 160 x 54		mm
Weight	400 g		

WS Analog Back-End Test circuit





Test Circuit RESULTS



Conditions:

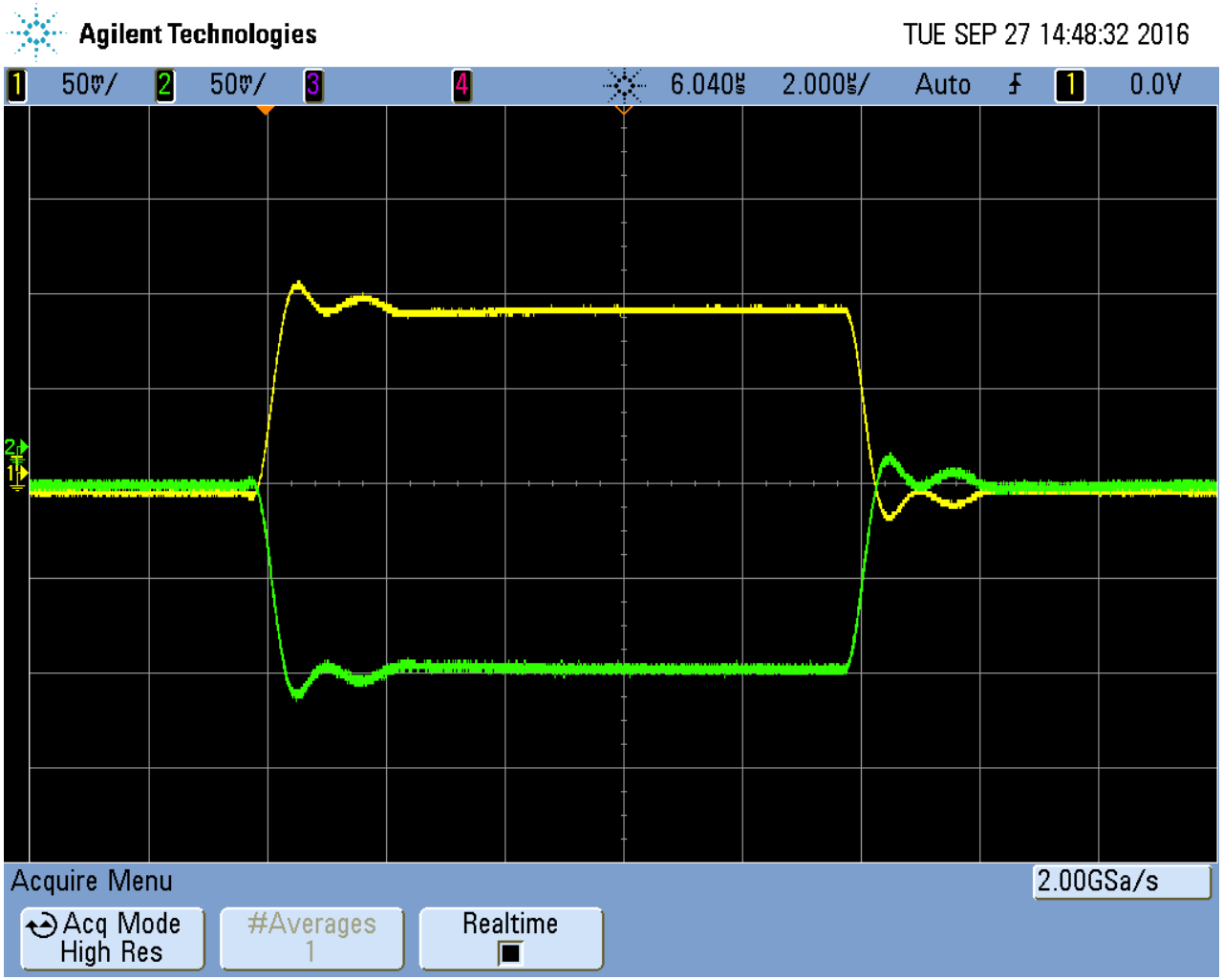
10uSec Pulse

0.5uA

GAIN =HI

Sensor cable = 1m RG174

Test Circuit RESULTS



Conditions:

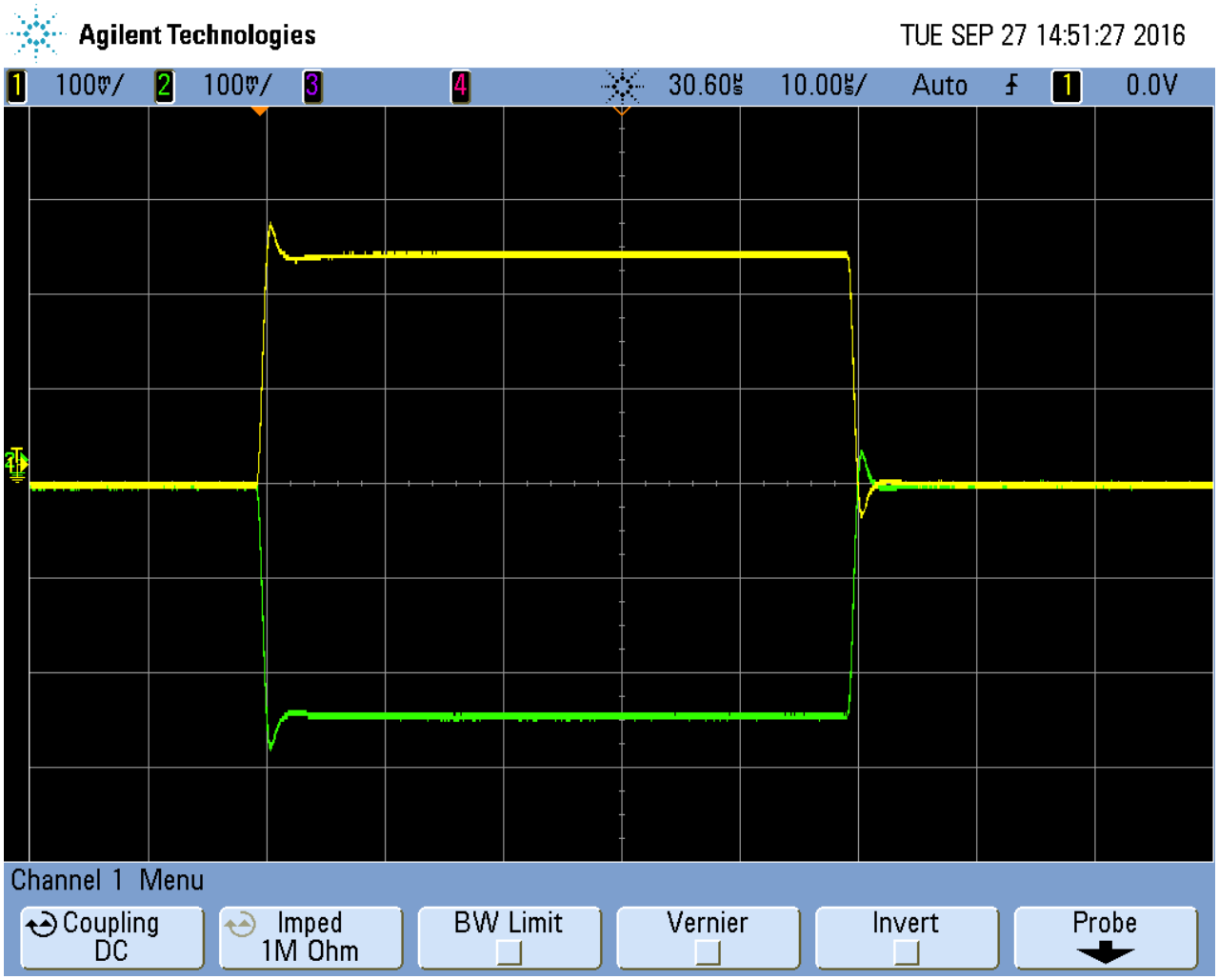
10uSec Pulse

0.5uA

GAIN =LOW

Sensor cable = 1m RG174

Test Circuit RESULTS



Conditions:

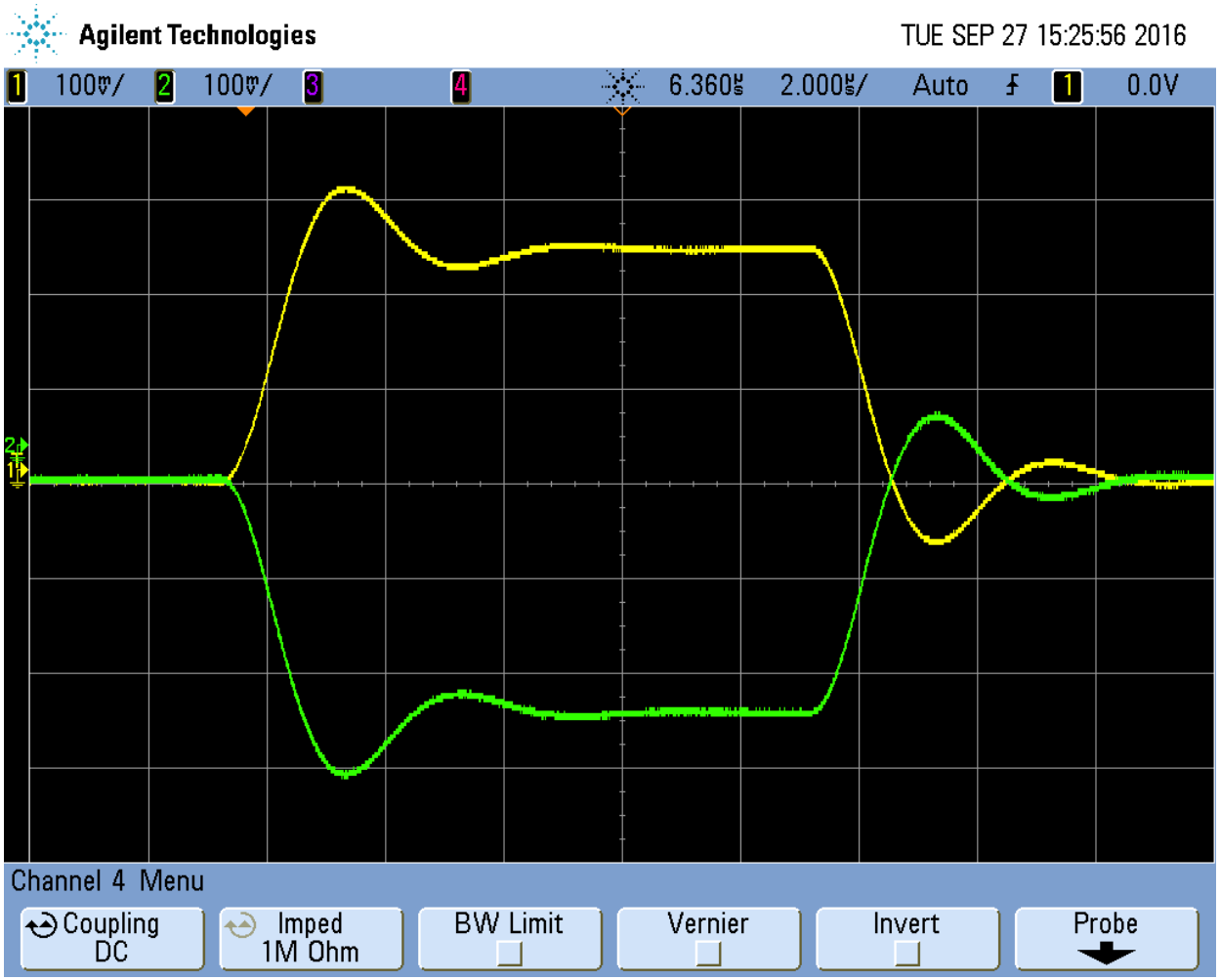
50uSec Pulse

0.5uA

GAIN =HI

Sensor cable = 1m RG174

Test Circuit RESULTS



Conditions:

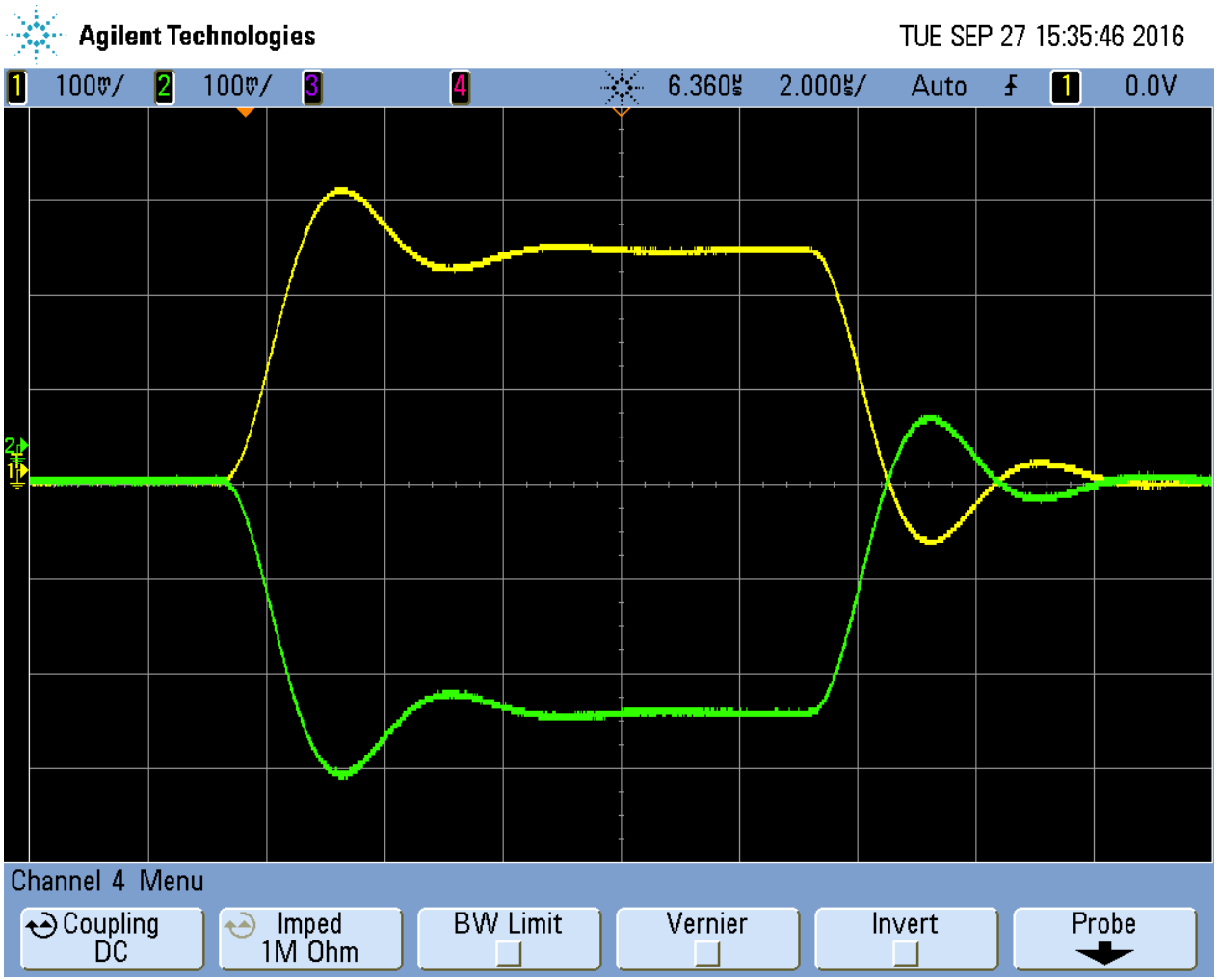
10uSec Pulse

0.5uA

GAIN =HI

Sensor cable = 5m RG223

Test Circuit RESULTS



Conditions:

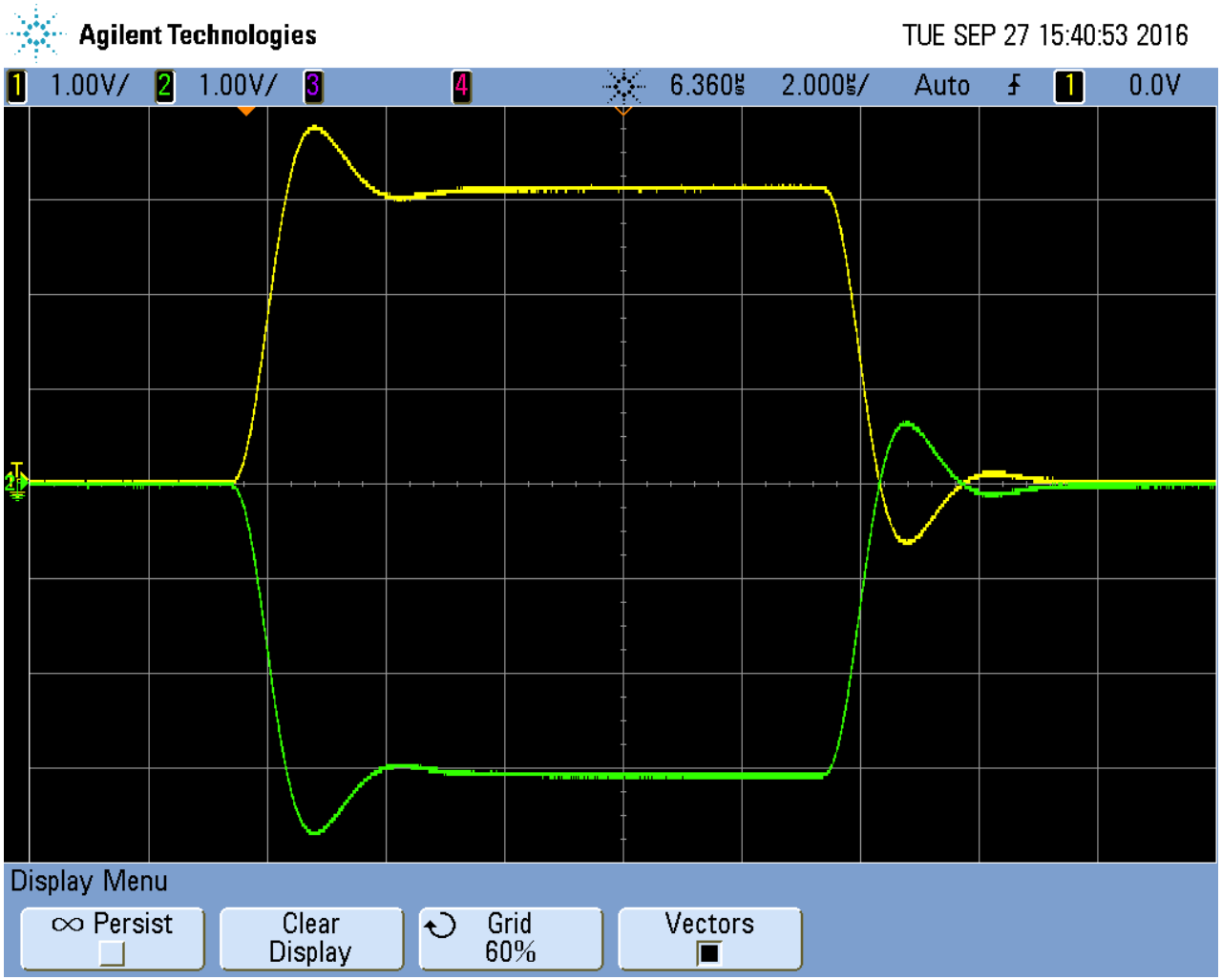
10uSec Pulse

0.5uA

GAIN =HI

Sensor cable = 5m Minicircuits 18GHz cable

Test Circuit RESULTS



Conditions:

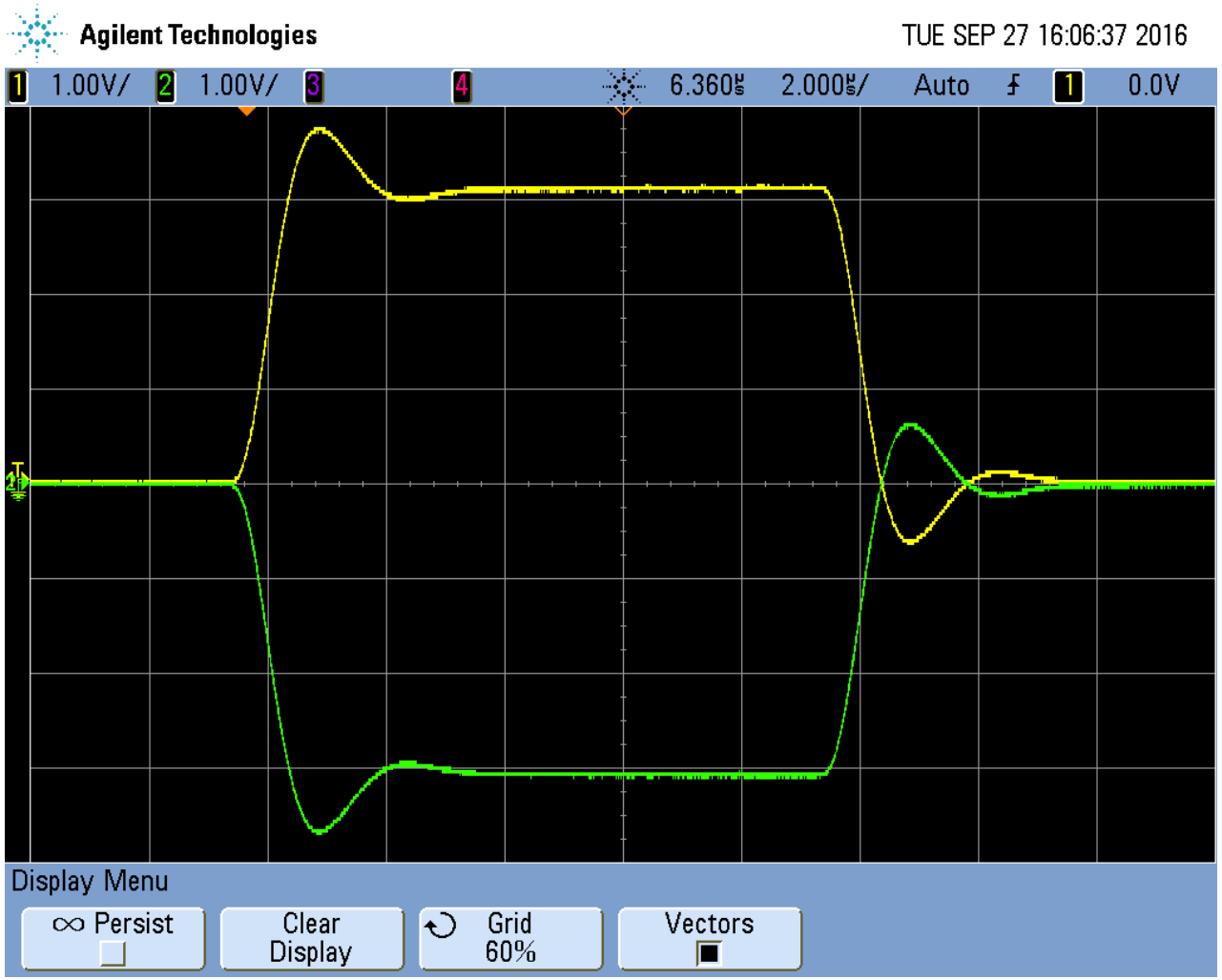
10uSec Pulse

200uA

GAIN =LO

Sensor cable = 5m Minicircuits 18GHz cable

Test Circuit RESULTS



Conditions:

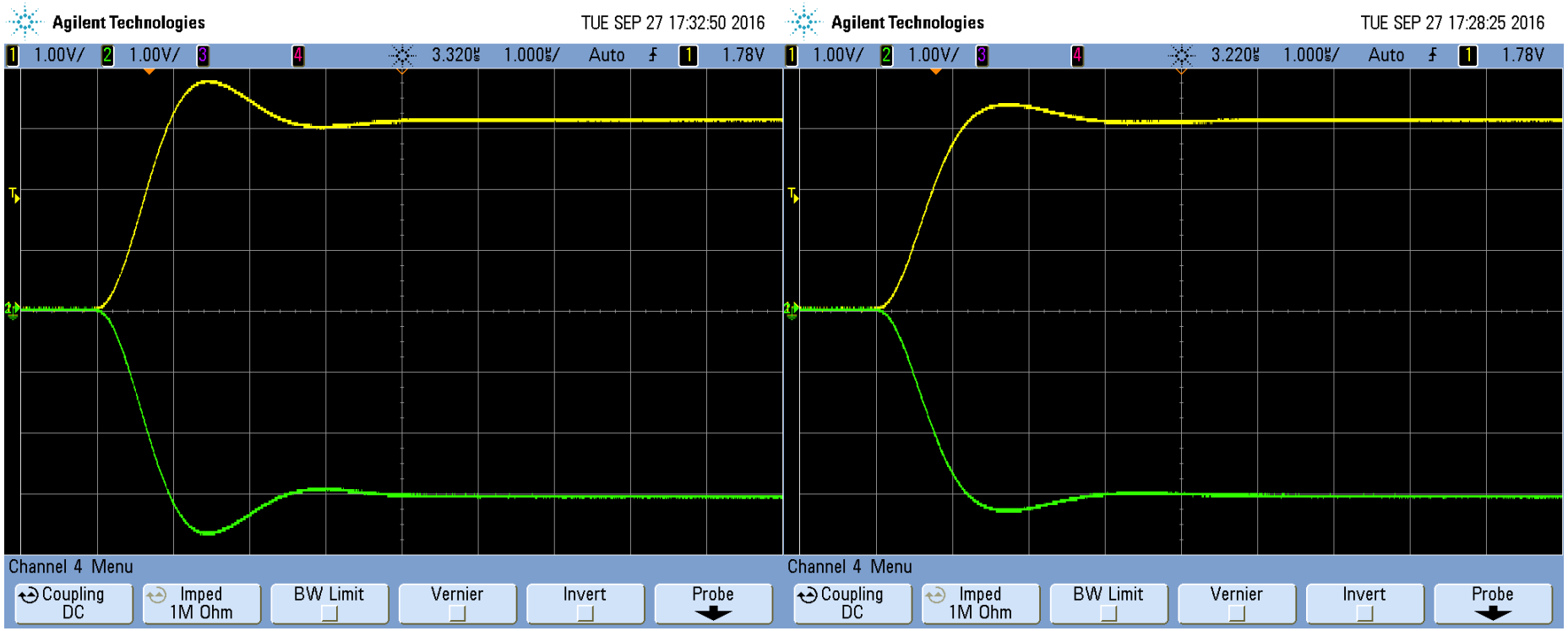
10uSec Pulse

200uA

GAIN =LO

Sensor able = 5m RG174

Test Circuit RESULTS



normal compensation

Big feedback compensation (220pF)

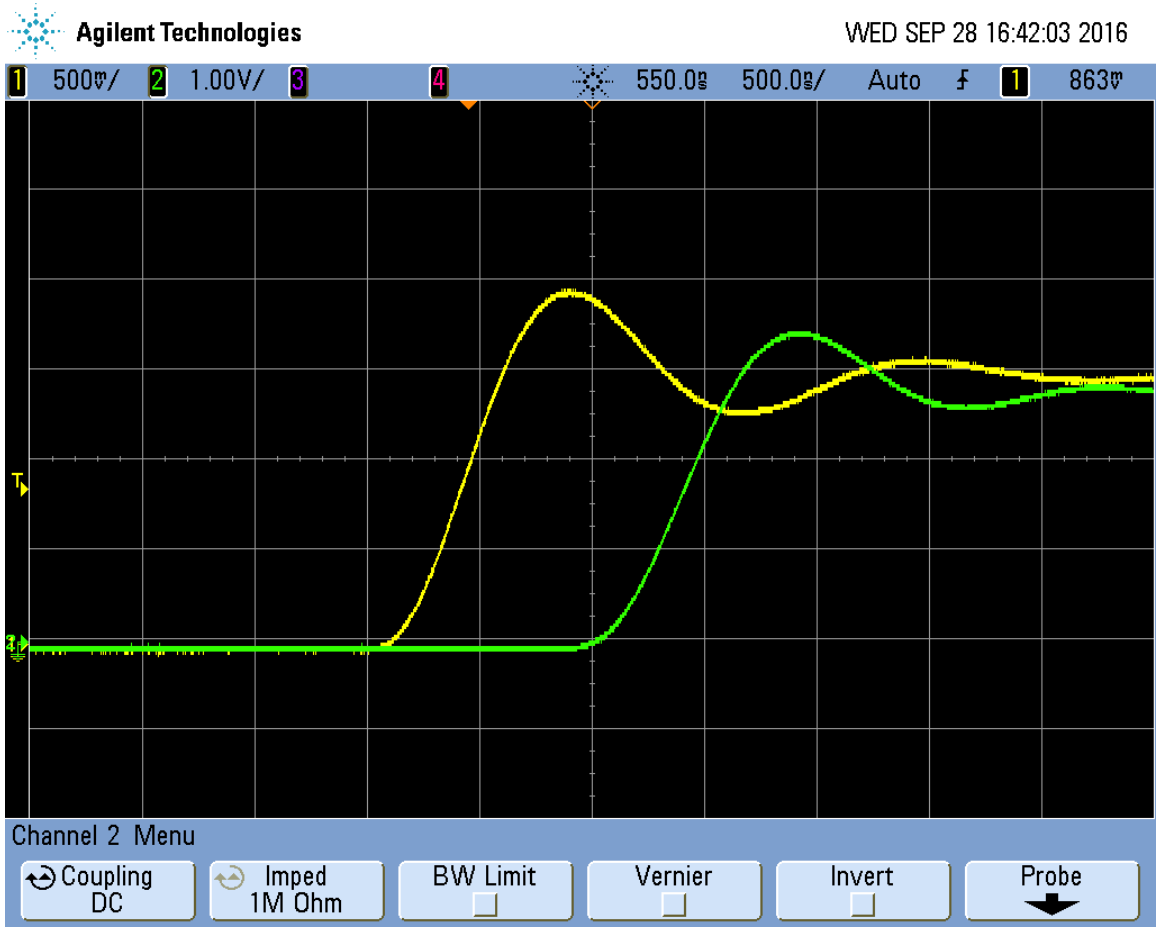
Conditions:

200uA

GAIN =LO

Sensor cable = 5m RG174

Test Circuit RESULTS



Conditions:

200uA

GAIN =LO

Sensor Cable = 1m RG174

Conclusions

Fixed requirements:

- Max signal to AFE cable lenght: 5mt
- Max cable lenght from the AFE to BE :150mt.
- Acquisition ADC clock MUST BE syncronous with trigger (beam) because of pulse shortness and waveform shape

Measured performances

- The AFE Circuit is capable to detect the range of the requested currents.
- Best results will be reached building two different versions of the AFE one for the WS with high signals current and one for low current. The difference will be only one resistor value.
- The frequency response of the long distance transmission circuit is adeguate.
- The ground isolation for the floating part has been tested and validated.
- The power supply system has been checked
- A second gain switch will be inserted in the second stage signal gain

Caveats - issues

- In case of very low currents (<300nA) the noise is growing to high values
- The input cable lenght is critical: max 4mt for good performances
- A different capacitor on the first TIA has to be mounted depending on the input signal cable length.

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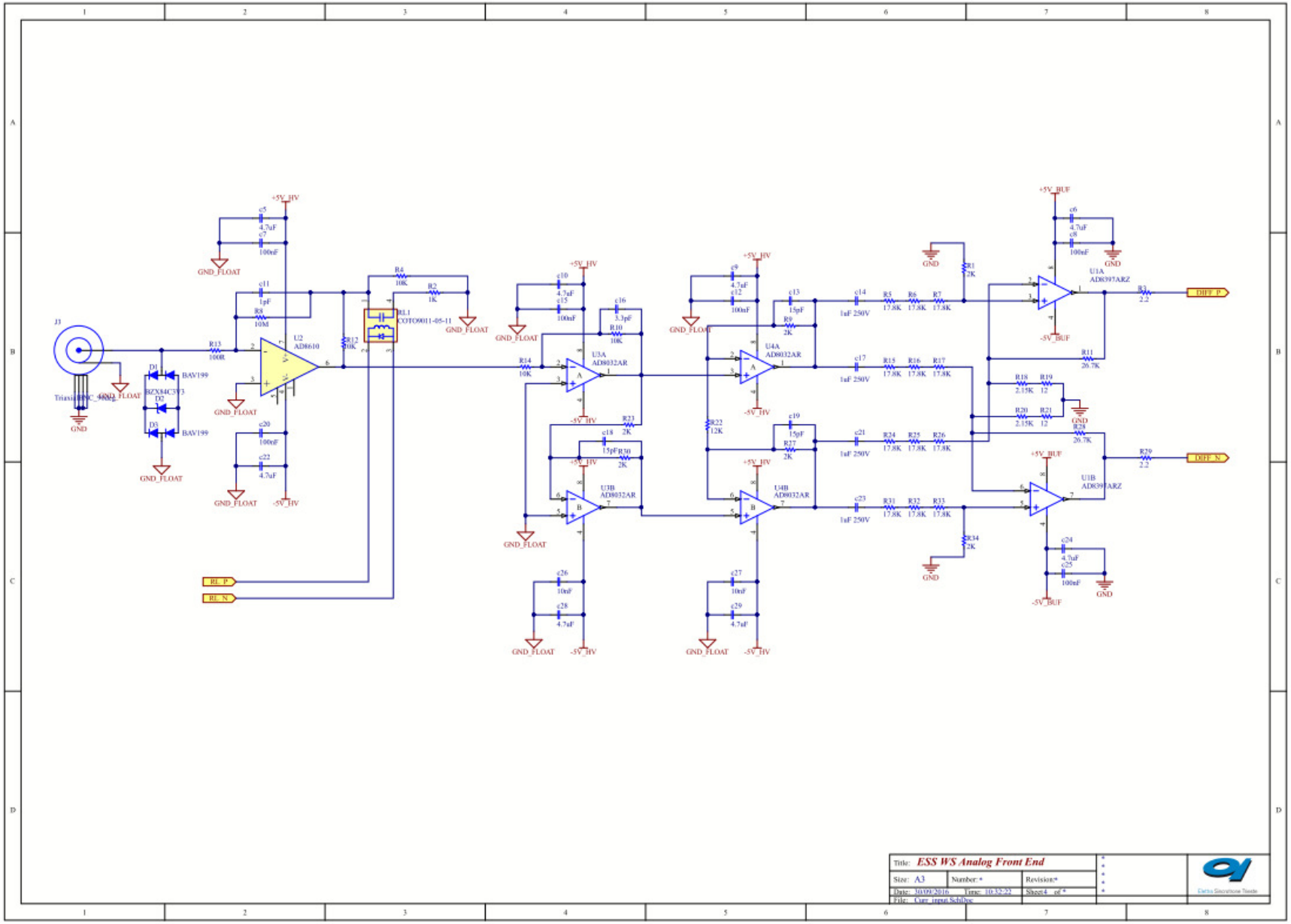
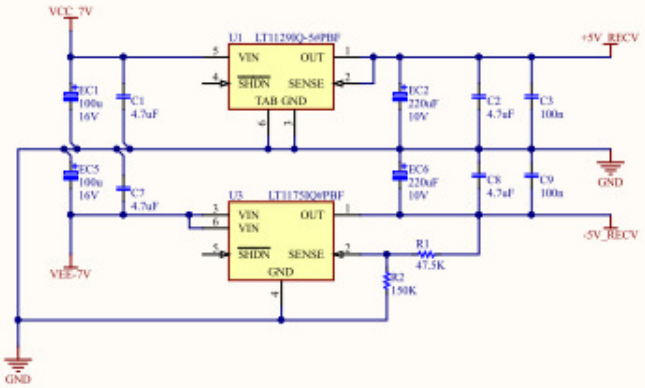
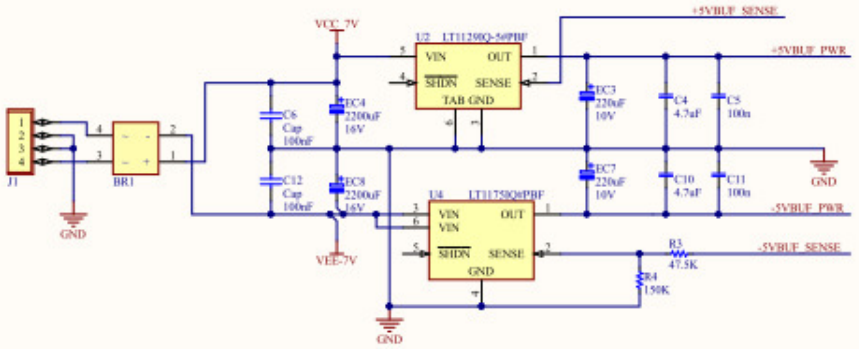
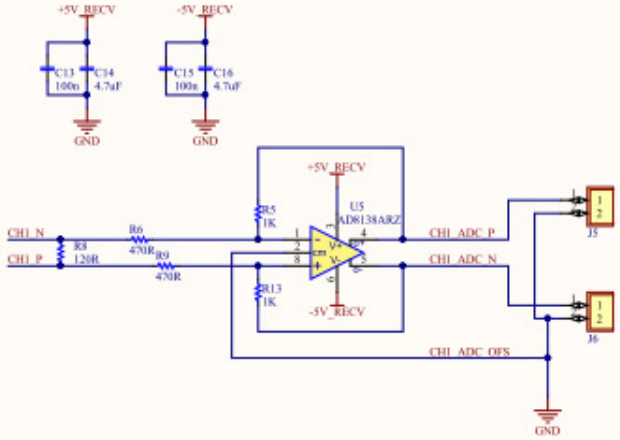
SPARE SLIDES

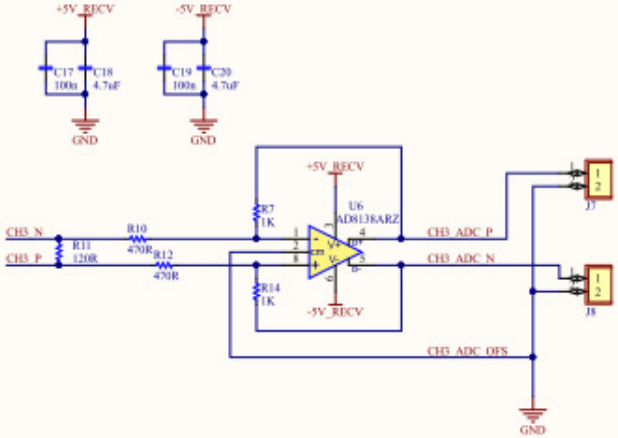


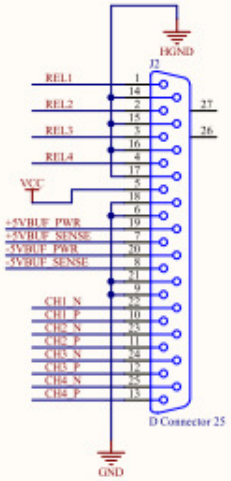
SPARE SLIDES











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