P-NET

4Wire P-NET

A proposal for a new way
of installing P-NET devices

P-NET

Introduction

- The classic P-NET uses a shielded pair as the cable, with galvanic isolation.
- The shield is used to:
  - improve EMC.
  - The shield is used as a voltage equalizer.
- The galvanic isolation:
  - to prevent: current in the P-NET cable.
  - Accepts voltage drop in the supply lines.
  - Reducing the influence of electrical noise.

P-NET

Short circuit of the galvanic isolation

- The EMC standards have forced:
  - Large capacitor across the galvanic isolation to prevent RF emission.
  - A 250 V varistor to protect the capacitor against lightning.
  - This tends towards a short circuit at higher frequencies.
- The galvanic isolation is only used:
  - to prevent DC current flowing in the P-NET cable.
  - when one of the supply connections to a device is disconnected.

4WIRE P-NET aims

- To reduce the cost of P-NET devices.
- To reduce the installation costs and the knowledge required when installing the system.
- Increase the use of fieldbus technology and P-NET.
- To take new EMC regulations into consideration, surge tests (emulating lightning).
- RF emission limits for communication cables will also be specified.

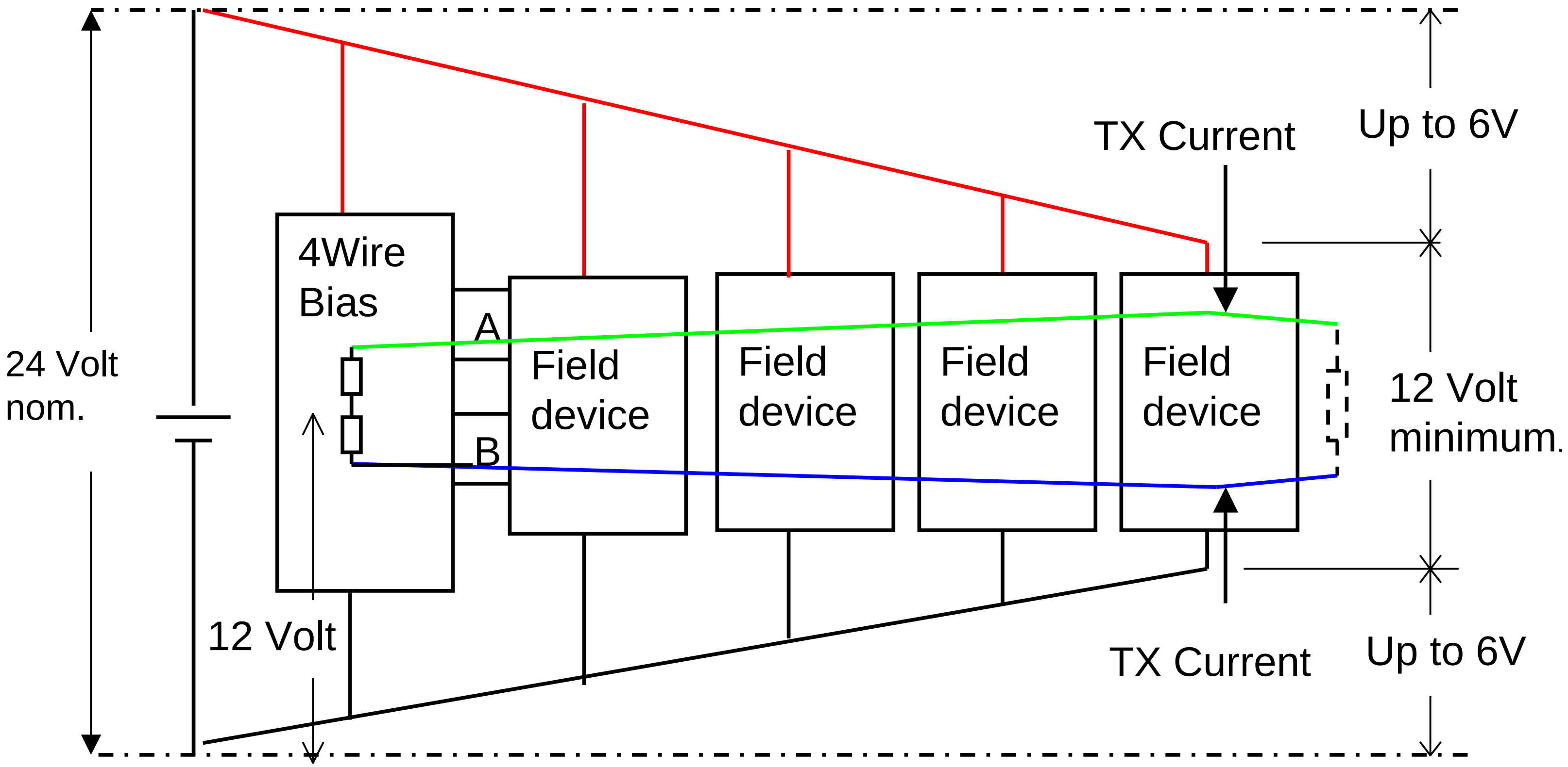
How ?

- Acceptability of a voltage drop in the supply lines, but without specifying galvanic isolation.
- Omitting the DC converter and related EMC components to reduce the cost.
- Freedom of topology cabling, without shield, will also simplify the installation.

- The new 4Wire P-NET **is not** a new protocol, it is a new way of installing P-NET devices in the field, where the power supply is included in the same cable as the data pair (A, B).

P-NET

4Wire P-NET principle



Values

- A 4WIRE P-NET device is powered with 24V DC.
- The shield is not used as the voltage equalizer.
- Installations without shielding are possible.
- Maximum voltage drop of 6 Volt in each supply wire.
- At higher voltage drops, the device must not interfere with the communication between other devices.
- The nominal Supply voltage is 24V.
- The maximum Supply voltage = 32V.
- Down to 12V, supply from a 12V car battery.

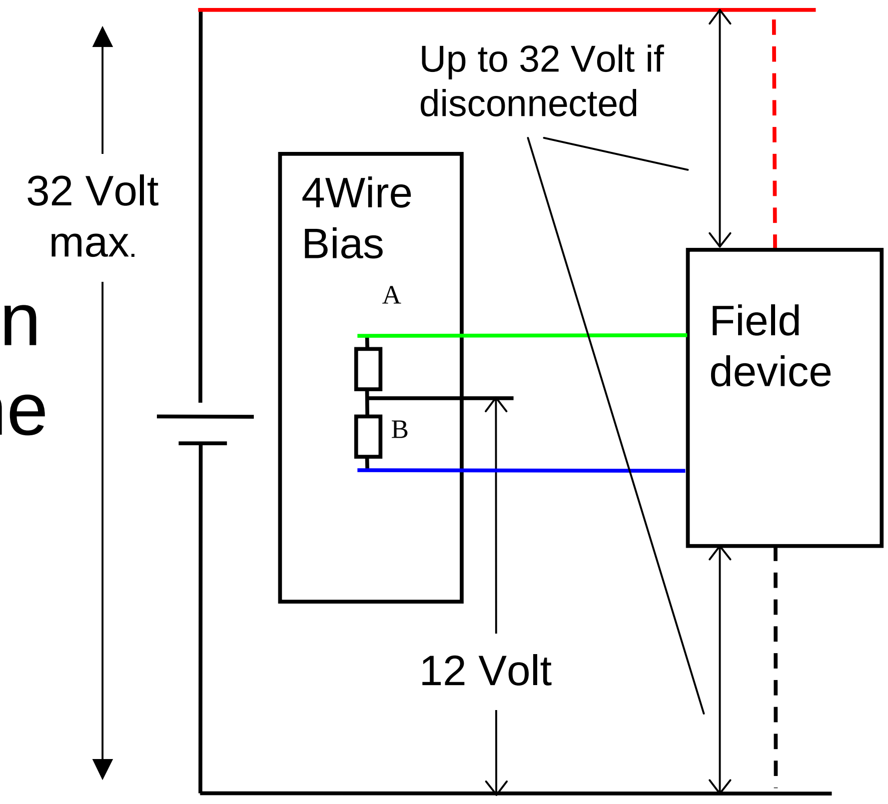
P-NET

4Wire bias circuit

- The 4Wire bias circuit has the task:
- Of biasing A/B to around half the supply voltage.
- To generate an Idle “1” on the bus when no devices are transmitting.
- To clamp and terminating circuitry, to reduce reflections on the cable.
- To provide a Shield output, biased 2.5 V lower than A and B, for compatibility with the classic P-NET
- The 4Wire Bias circuit, powered from the supply lines, could be designed as a small moulded block with 4(5) wires.
- With a cable length of less than 500 meters, only one 4Wire Bias circuit would be required.

Connection's.

- A field device must withstand any combination of incorrect connection or short circuit of the 4-wires, without destroying the device.



P-NET

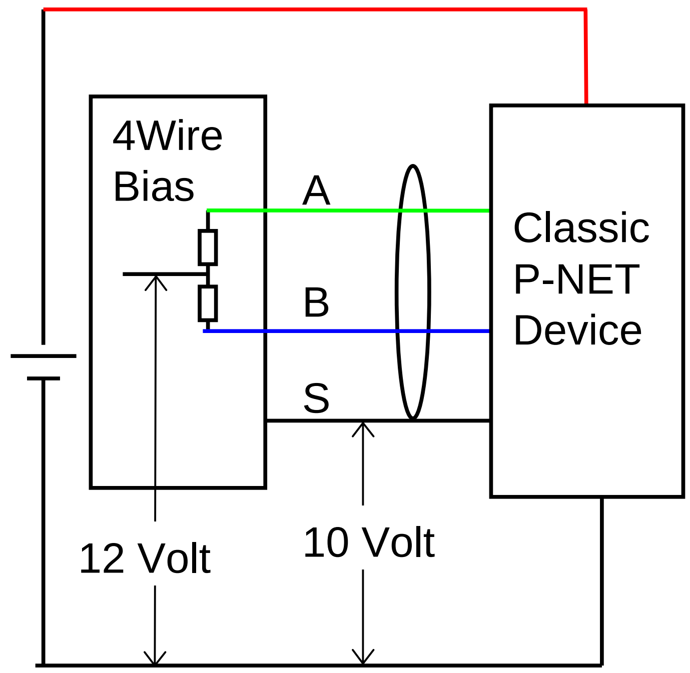
Transceiver

- Active common mode voltage range: from the negative supply plus 3V, to the positive supply minus 3V.
- The behavior of the signals on A/B will be compatible to the RS 485:
  - with a differential voltage around 2 V,
  - input impedance > 25k ohm
  - input sensitivity < 100 mV.

P-NET

Classic P-NET

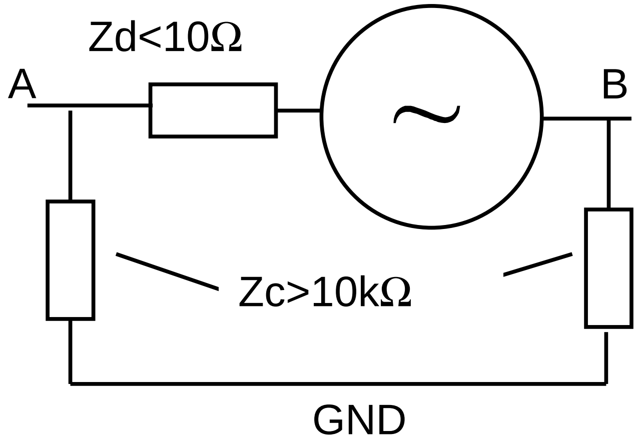
- A classic P-NET device can be connected to the 4wire system by connecting the shield of the P-NET cable to the 10 V output of the 4Wire bias circuitry.



P-NET

4Wire P-NET driver

- Driver = voltage generator, with a low differential impedance < 10Ω.
- Common mode impedance >10kΩ
- to allow the bias circuit to control the common mode voltage of A/B.
- The current in A and B must be balanced,to reduce RF emissions from the cable.



- If the load impedance < 50Ω, the current must be limited to 50 mA, and the differential voltage between A and B will be lower than the normal 2Volt

Surge Test

- The anticipated surge test requirements are a 500 volt 8/20 µs pulse, applied between the power supply lines from a 2 Ω generator.
- Equivalent to a **225 Amp** peak-current, for supply terminals clamped with a 50V zener diode.
- Signal cables, as A and B, the test applies a 2kV 8/20 µs pulse from a 40 Ω generator, equivalent to a 25 Amp peak-current.
- Zener diodes, which are able to handle 25 A peak, act as a capacitor (up to 2000pF) that will interact with the cable impedance.

Practical installation

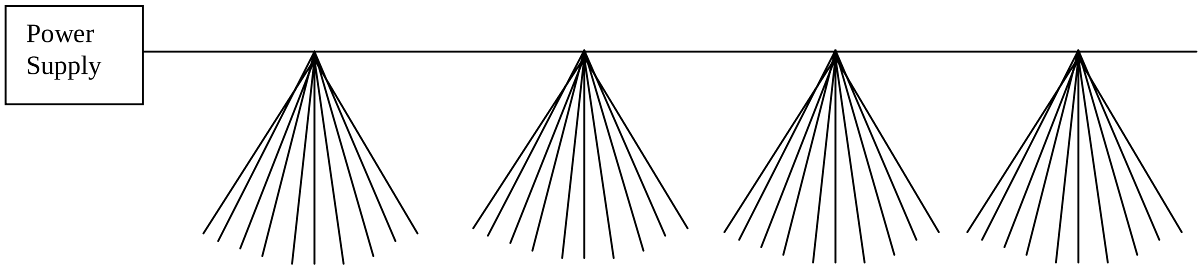
- For a practical installation of P-NET, freedom of topology is desirable.
- Where any combinations of cable connections are permitted.
- This is already true for the classic P-NET, when a shorter total length of cable is used. (100 m ?)
- PROCES-DATA has done some research how to extend the length of cable with free topology concept.

Free topology

- Using a non-specific topology, not all cable ends can be correctly terminated.
- When more cables are connected in the same point a mismatch will occur.
- The mismatch will result in reflections caused by the non-ideal termination of the cable.
- By using an analogue driver and sending the TXD signal through a low-pass filter, leading to a reduction in the harmonics in the signal and the reflections.
- RF emission from the communication cables will also be attenuated when reducing the harmonics.

Trunk and Drop cables

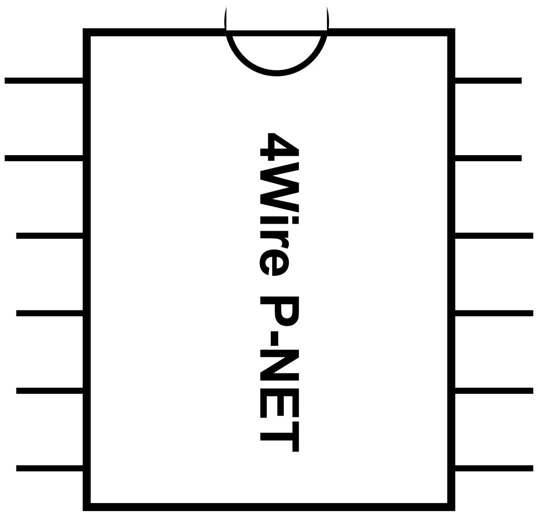
- The free topology also includes Trunk and Drop cables



P-NET

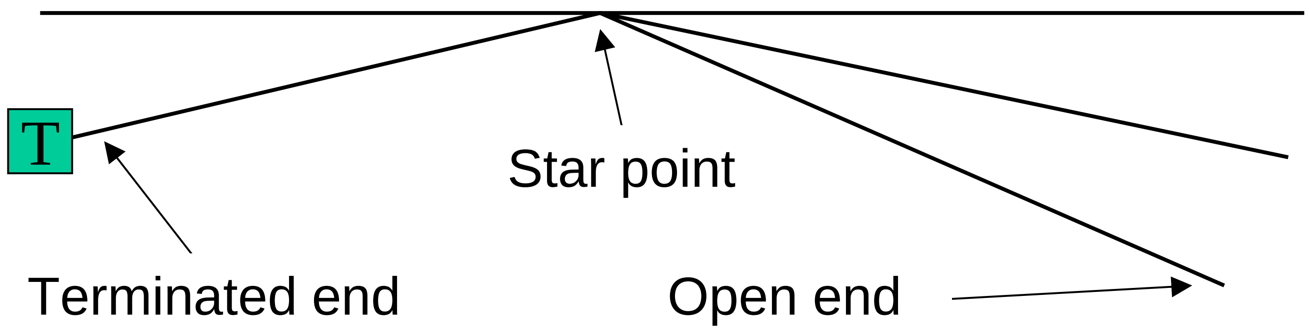
4Wire P-NET transceiver CHIP

- The “Industrial RS 485 “ can be built using 40-50 standard SMD components (transistors, diodes and resistors).
- A better way would be to develop a special analogue driver chip, incorporating:
- Temperature protection of the chip in the event of short circuits to A/B.
- Low-pass filter
- 5/3V output and a reset signal for the microprocessor.
- Surge protection (25/250A).



SPICE.

The following curves are the result of a SPICE simulation. Five pieces of cable (UNITRONIC-LAN), each with a length of 200m were used. These five cables were connected into a star.



P-NET

Test Cable

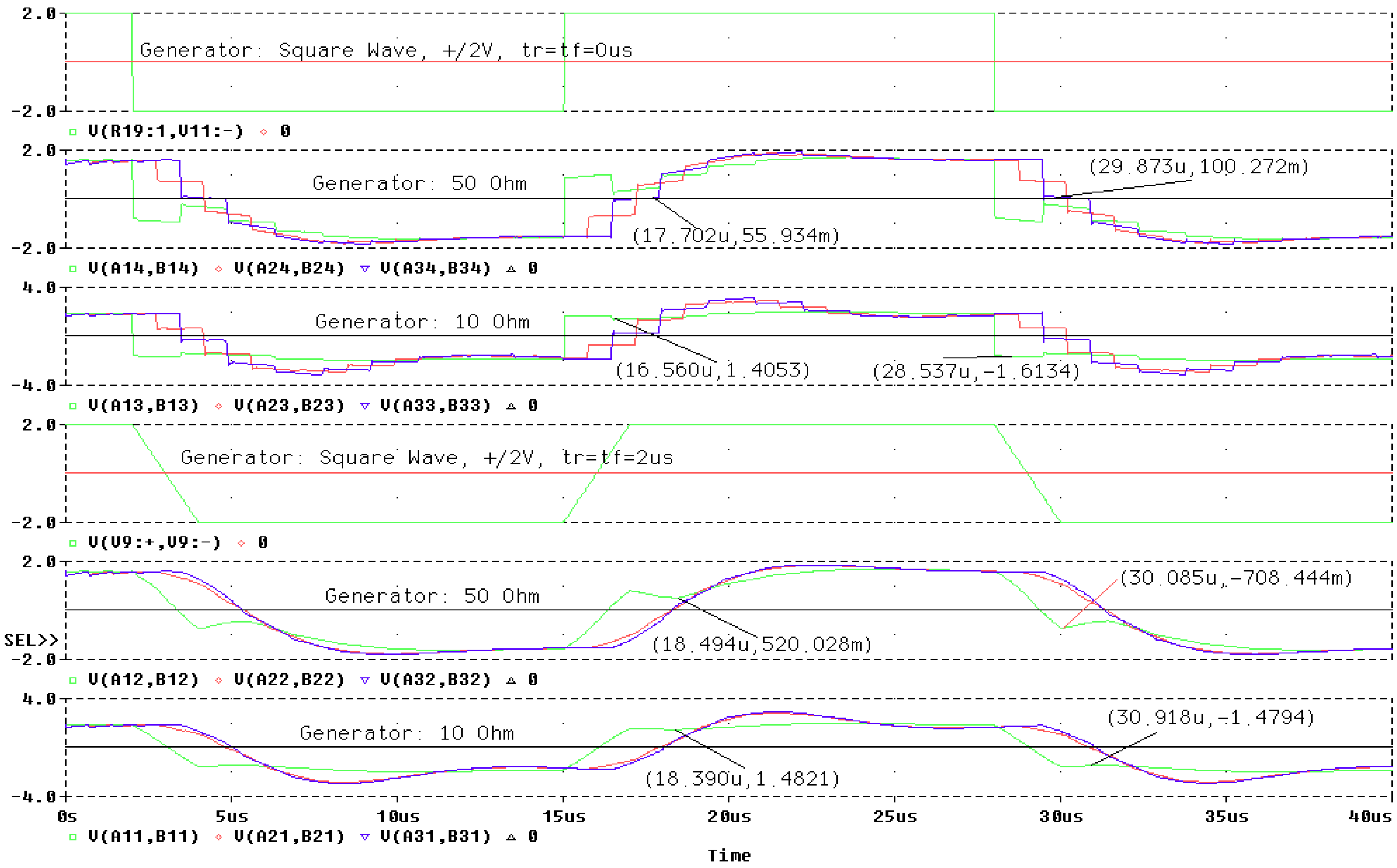
- The characteristic of the UNITRONIC-LAN cable:
- Cable loop resistance: R = 130mΩ/m
- Cable capacitance: C = 36pF/m
- Cable inductance: L = 360nH/m
- Cable conductance: G = 200pS/km
- Characteristic impedance: Z = 100Ω
- Cable outer diameter: Ø6

P-NET

Four different generators

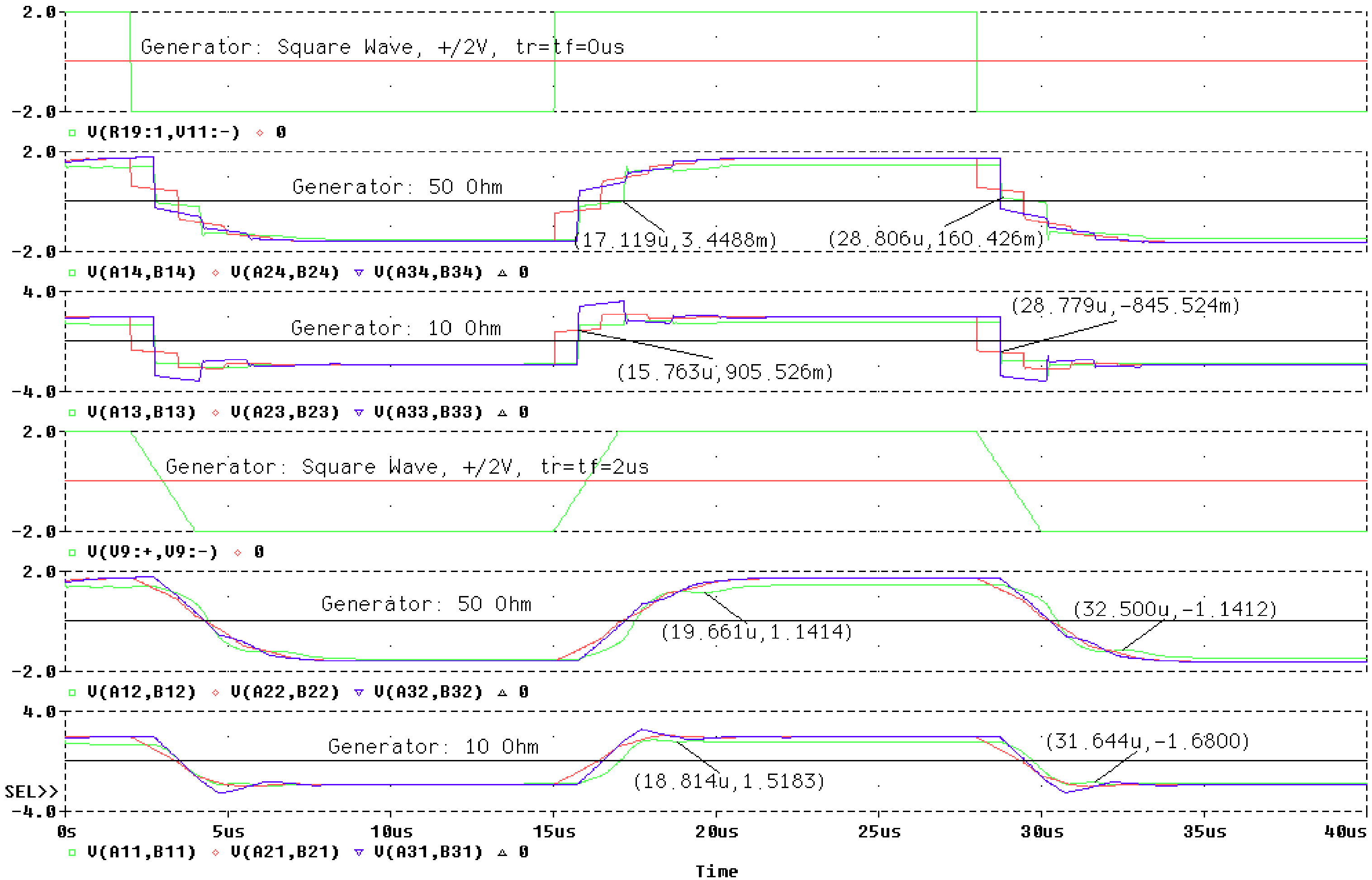
- Ideal voltage generator in series with a 50 Ω and 0µs rise and fall time.
- Ideal voltage generator in series with a 10 Ω and 0µs rise and fall time.
- Ideal voltage generator in series with a 50 Ω and 2µs rise and fall time.
- Ideal voltage generator in series with a 10 Ω and 2µs rise and fall time
- At three locations, i.e. the terminated cable end, the star point and one of the open ends, simulations were performed using the four individual generators.

Generator at the terminated cable end

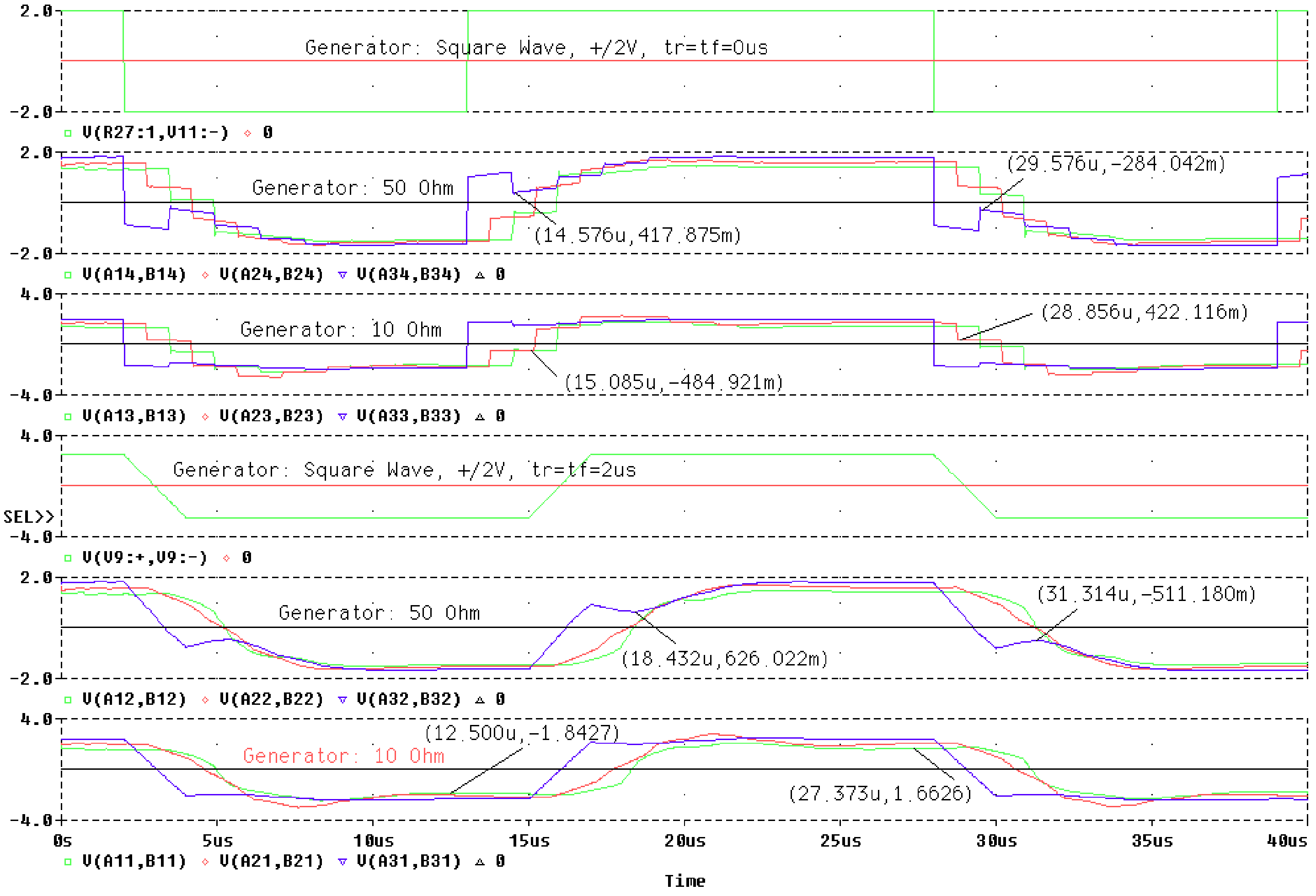


P-NET

Generator at the cable star point



Generator at a non-terminated end.



P-NET

Results.

- The best results were achieved with the generator with low internal impedance and slow rise and fall time. The minimum differential voltage at any points is around +/-1.7Volt.
- Further simulation and real test must be performed before rules for cable length and other limiting factors can be described.