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An introduction to diagnostics on PROFIBUS



Aims


The aims of this mornings presentation and discussion are to:

- Show PROFIBUS works on the physical level
- Discuss what can go wrong on a PROFIBUS system
- Showing how the problem can be found in the system.
- Discuss the importance of knowing the cause of a fault and not just the solution
- Discuss how to prepare before system failures
- Discuss how to equip staff to properly diagnose system problems



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Introduction – Me, PCC

Who has never had a problem with communication on a PROFIBUS network?

I have given several presentations over the last few years where I have gone about showing all the types of things that can go wrong on a PROFIBUS systems. The main point behind those presentations was to try and bring to a focus the importance of getting people that know what they are doing to install systems – over and over I have emphasised the point that installation faults are the cause of more than 90% of all PROFIBUS related downtime.

In fact I remember on customer coming up to me after such a talk to compliment me by say – “You were scary!” These scare tactics although real concerns may have gone a little too far and given some the impression that PROFIBUS is this big beast and woe to them that start to have problems... I want to redress some of that today by giving you a “behind the scenes” look into how PROFIBUS systems can be diagnosed.

It will be quite technical but I think that you may be quite surprised what simple sense all of what I will tell you will make. I don't expect that you will arrive back at your plants and go and sort out the next problem in 5 minutes... I only have a hour with you but I really do hope to make you feel more comfortable about what can be done to prepare staff to troubleshoot PROFIBUS, what tools and training will make their lives easier and perhaps remove some of the mystery and magic behind how PROFIBUS operates.

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Different classes of faults:

- ❖ Process Diagnostics
- ❖ System/Device Diagnostics
- ❖ Diagnosing Communications Failures

These are what we are interested in today!!

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Firstly, just for completeness I need to mention that we have several different kind of diagnostics that take place on a PROFIBUS system:

Process Diagnostics

Indicate process values outside acceptable ranges. Sensor drift / process response required

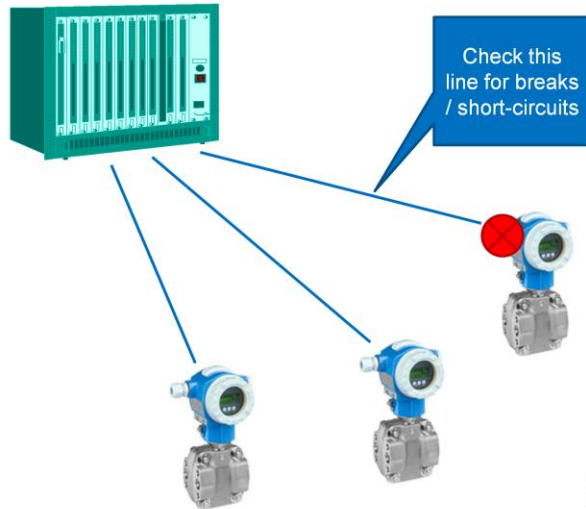
System/Device diagnostics

PROFIBUS has a built in diagnostics mechanism to report such problems and as long as it has been implemented in your SCADA this information should be available to you.

Communications Breakdowns

Can't get diagnostics on this because the mechanism to read these diagnostics is broken!

Traditional System: Point-to-Point



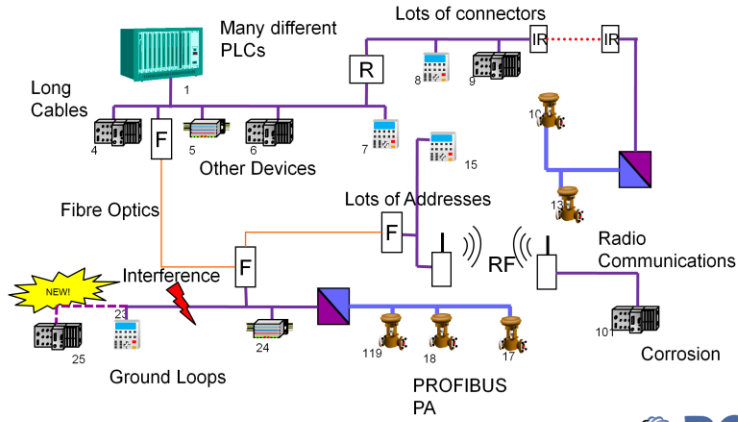
Communications break down is relatively simple – must be the cable.

Many devices sharing the same cables!



Many devices on a cable means

- Lots of factors to consider...



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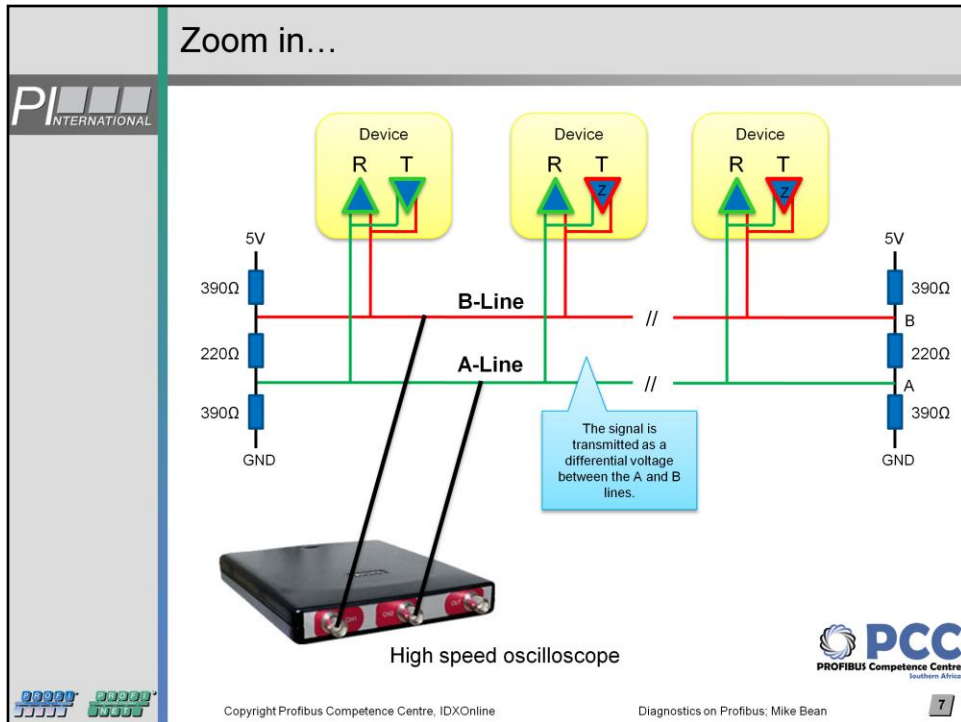
How do we go about troubleshooting all of this?

A multimeter is NOT enough!



If an installer arrives at your site and all he has is a multimeter – be afraid!

Don't throw it away, I still carry mine around in my bag. But you cannot expect to find your problem in a hurry without something more advanced.



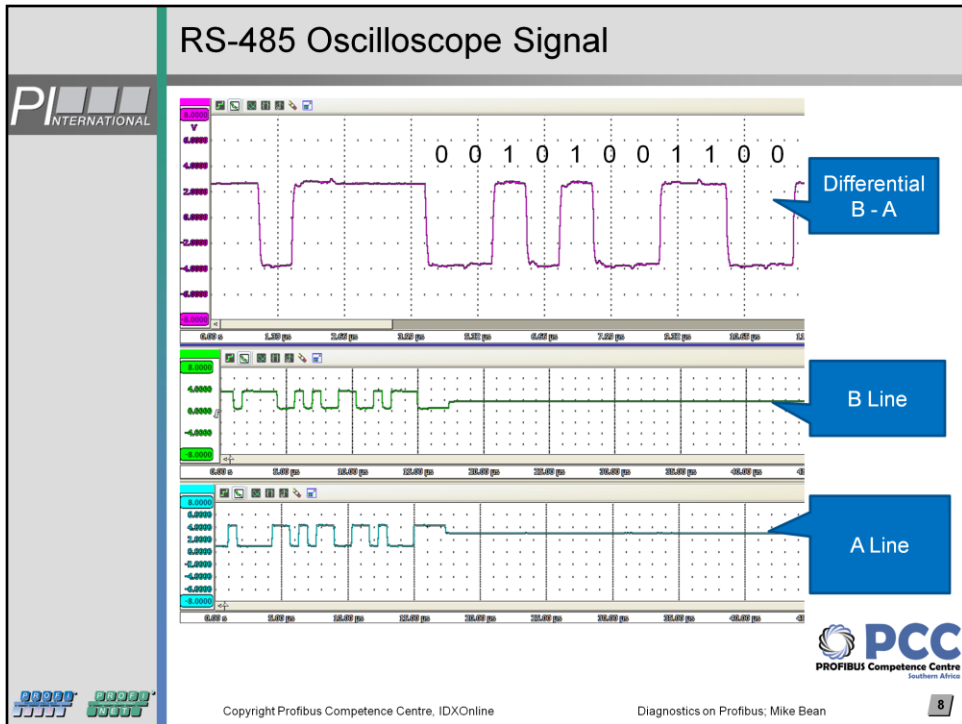
Zoom up inside the cable.... Lay some foundations

Red and Green Line, Data + Data -, Differential Signal

Bus drivers attached to the bus one is switched to transmit at a time. All are set to receive. It is imperative that only one bus driver is active at a time. The rest are “Tri-States”.

High frequencies.

Attach a “High Speed” oscilloscope to A and to B. Not too hard? ☺



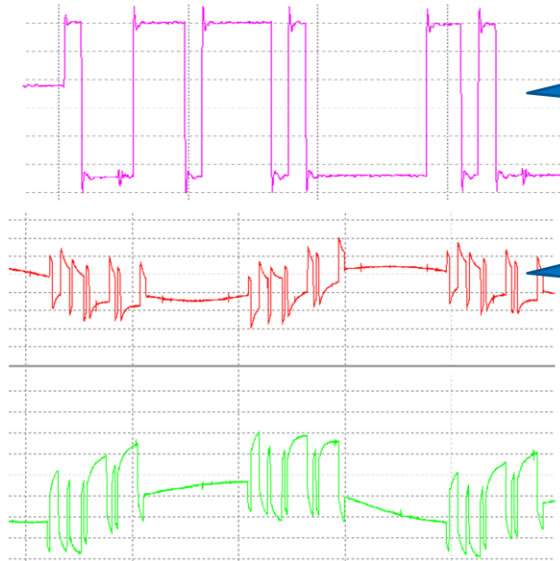
This is what your signal should look like – nice square wave.

Not always like this in practice!

Differential clears up common mode interference.

Low frequency noise issue

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Differential
Looks fine
– Bus is
running!

Significant
Noise
problem is
“hidden”!

00000 00000
TTTTT TTTTT

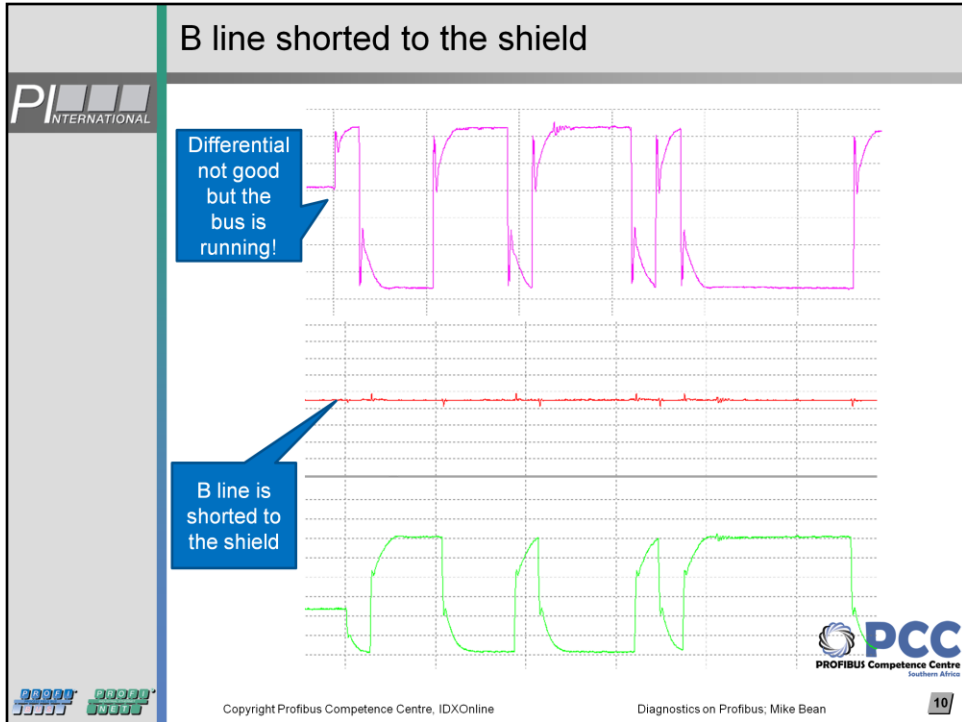
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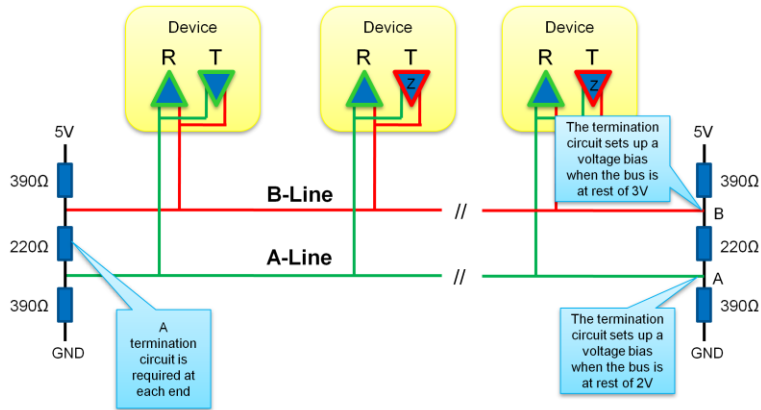
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Differential removes common mode noise! I have sinusoids of over 8v imposed on a PROFIBUS system – may hit opamp supply rails.



Bad but common situation... the bus often still works but is far more susceptible to interference and to fluctuations in ground potential!

Terminations

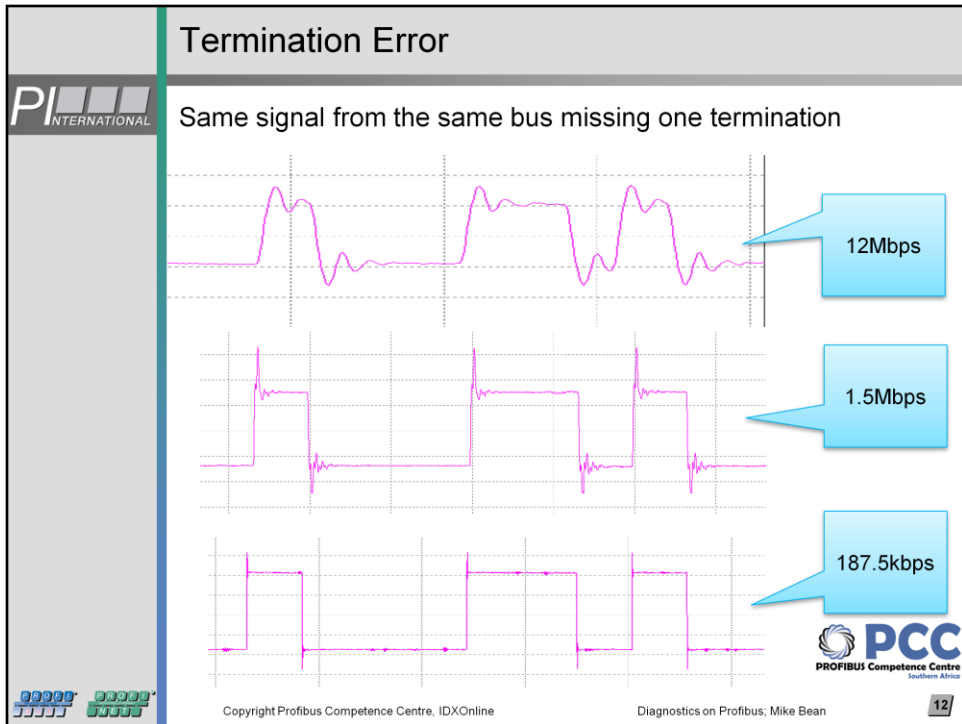


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Real conductors have effects on high frequency signals that **must** be accounted for terminations prevent reflections.



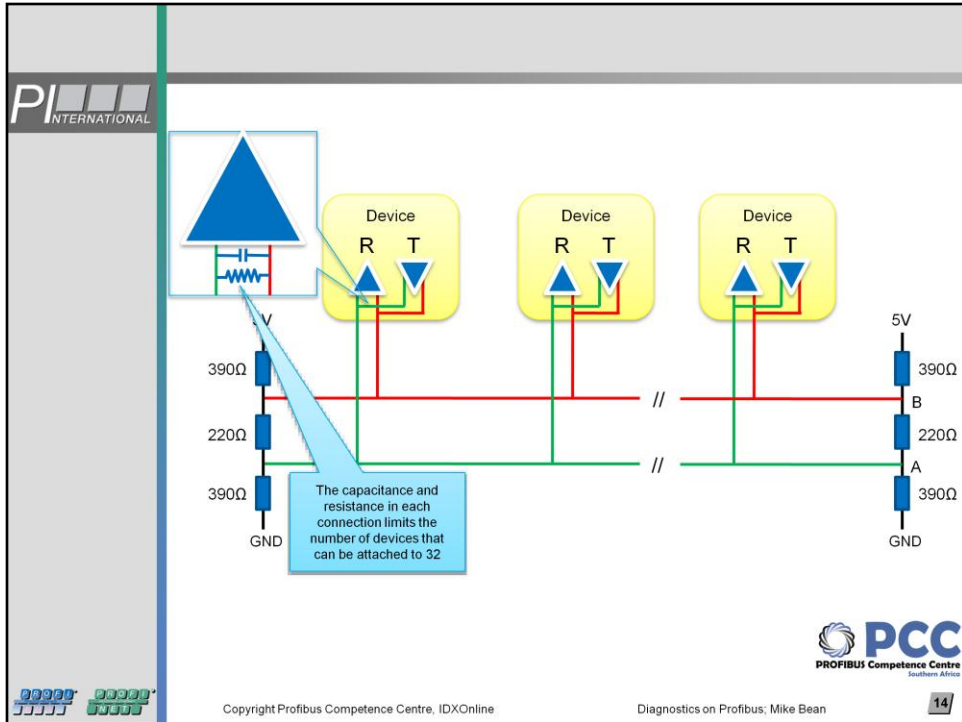
What is the difference? We are operating at 3 different speeds. These are very short cables so the reflections die out quite quickly

Make life easy!!

Run the bus at as low a baud rate as you can!

Default 1.5Mbps -> 187.5kbps



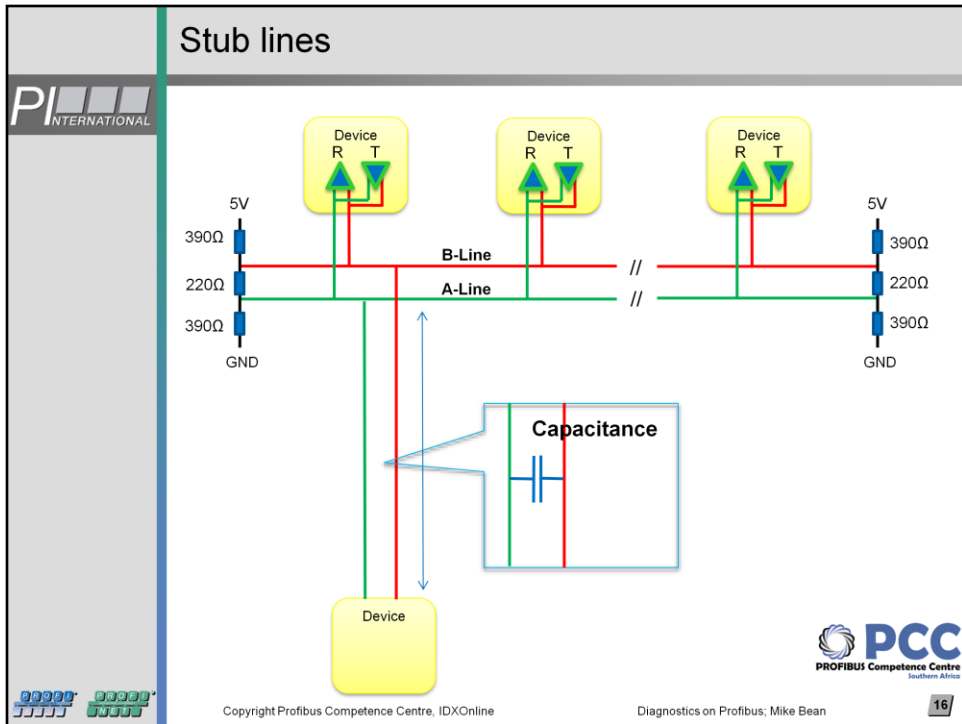


Real conductors have effects on high frequency signals that **must** be accounted for. Another property of real conductors and real devices!

Device interface capacitance

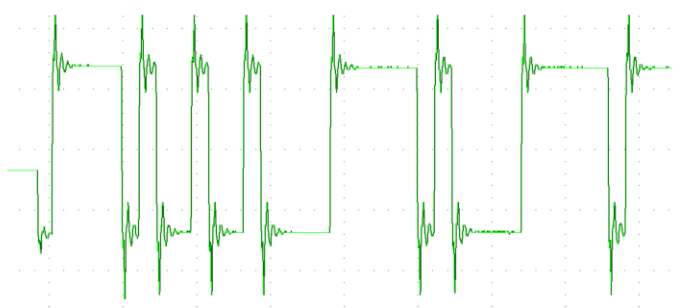


Devices interfaces with a high capacitance tend to cause these little notches – many devices close together exacerbates this problem! Long spikes like this usually indicate too many devices close together on the bus.



A new device has been added

Stub oscilloscope picture



Stubs cause deterioration of the electrical signal quality



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Something better than an Oscilloscope



IMPORTANT!!!

The signal that you see can change depending on

- **Where you are plugged in on the bus!**
- **Which device is transmitting when your scope takes it's snapshot!**

An Oscilloscope is NOT enough!



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Someone cannot certify and installation with only an oscilloscope!

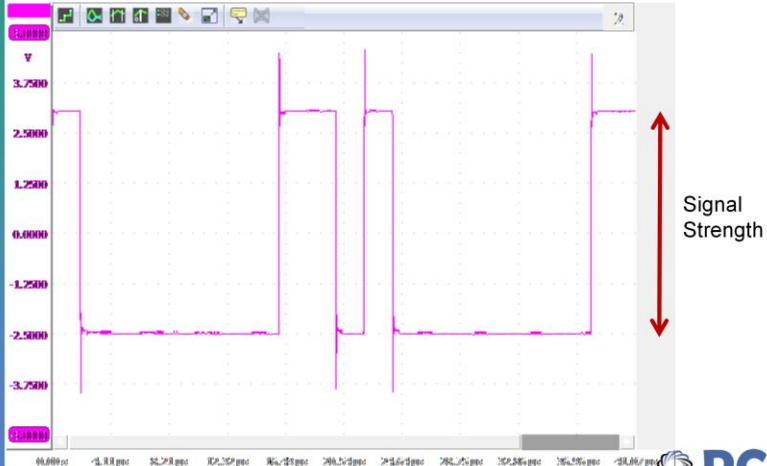
You need an intelligent triggering device that can trigger the oscilloscope based on a particular device response.

PROFITrace Ultra
Softing PBT3
others...



ProfiTrace Ultra is the best as it combines all of the needed functionality in a single tool.

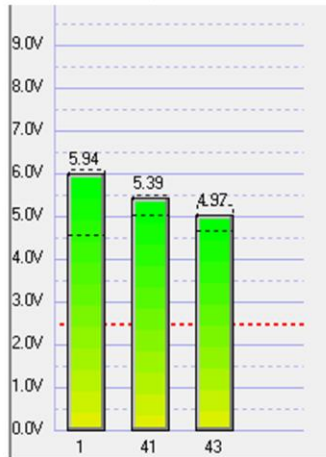
Signal strength must be above 2.5v for all devices at all points in the network



Signal strength



All signals strengths are good



One device's signal strength is weak



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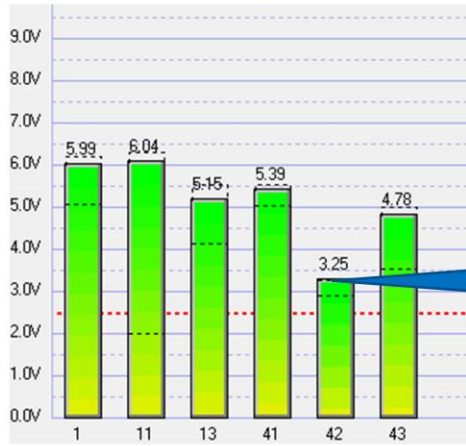
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Numerous tools provide you with this information.
Could be before and after a repeater.

Look for the odd one out!



Might be damaged



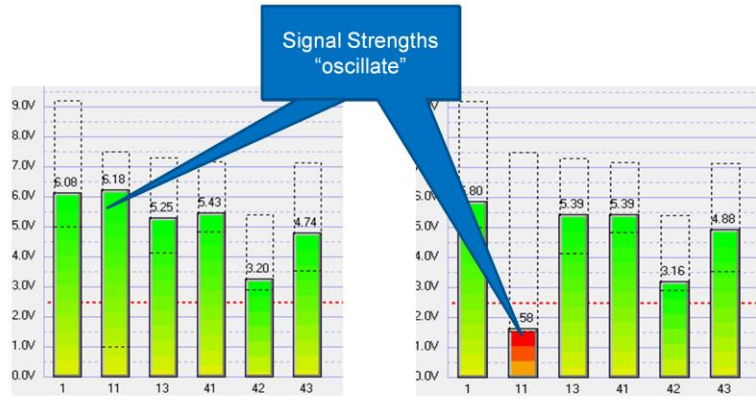
Two devices at the same address



Two devices transmitting at the same time "fight" for control of the bus.



Two devices at the same address



Message Tracing tools



- ❖ Some times problems are not evident or are difficult to see on the physical level
- ❖ Message tracing tools are powerful diagnostic tools that show the actual series of events taking place on a bus.

FrameNr	Timestamp	Attention	Frame	Addr	Service	Req type	Req/Resp/APP	Datalen	Data
43	7920 Bit		SD1	1->19	FDL Status		Req		
44	8188 Bit		SD4	1->1	Token pass	Pass token	Req		
45	8287 Bit		SD1	1->20	FDL Status		Req		
46	8528 Bit		SD4	1->1	Token pass	Pass token	Req		
47	8594 Bit		SD1	1->21	FDL Status		Req		
48	8862 Bit		SD4	1->1	Token pass	Pass token	Req		
49	8931 Bit		SD1	1->22	FDL Status		Req		
50	9200 Bit		SD4	1->1	Token pass	Pass token	Req		
51	9269 Bit		SD1	1->23	FDL Status		Req		
52	9537 Bit		SD2	1->100	SDO_MWCH	Data Exchange	Req	1	00
53	9659 Bit		SD2	1<-100	SDO_MWCH	Data Exchange	Res	4	18 00 00 00
54	9883 Bit		SD2	1->101	SDO_MWCH	Data Exchange	Req	1	00
55	9974 Bit		SD2	1<-101	SDO_MWCH	Data Exchange	Res	4	18 00 00 00
56	10169 Bit		SD2	1->102	SDO_MWCH	Data Exchange	Req	1	00
57	10291 Bit		SD2	1<-102	SDO_MWCH	Data Exchange	Res	4	18 00 00 00
58	10488 Bit		SD2	1->103	SDO_MWCH	Data Exchange	Req	1	00
59	10606 Bit		SD2	1<-103	SDO_MWCH	Data Exchange	Res	4	18 00 00 00
60	10901 Bit		SD2	1->104	SDO_MWCH	Data Exchange	Req	1	00
61	11117 Bit		SD2	1->105	SDO_MWCH	Data Exchange	Req	1	00
62	11433 Bit		SD2	1->106	SDO_MWCH	Data Exchange	Req	1	00
63	11748 Bit		SD2	1->107	SDO_MWCH	Data Exchange	Req	1	00
64	12063 Bit		SD4	1->1	Token pass	Pass token	Req		
65	12132 Bit		SD1	1->24	FDL Status		Req		
66	12401 Bit		SD4	1->1	Token pass	Pass token	Req		
67	12470 Bit		SD1	1->25	FDL Status		Req		
68	12738 Bit		SD4	1->1	Token pass	Pass token	Req		
69	12807 Bit		SD1	1->26	FDL Status		Req		
70	13075 Bit		SD4	1->1	Token pass	Pass token	Req		
71	13144 Bit		SD1	1->27	FDL Status		Req		
72	13412 Bit		SD4	1->1	Token pass	Pass token	Req		
73	13481 Bit		SD1	1->28	FDL Status		Req		
74	13749 Bit		SD4	1->1	Token pass	Pass token	Req		
75	13818 Bit		SD1	1->29	FDL Status		Req		
76	14086 Bit		SD4	1->1	Token pass	Pass token	Req		
77	14155 Bit		SD1	1->30	FDL Status		Req		
78	14423 Bit		SD4	1->1	Token pass	Pass token	Req		
79	14492 Bit		SD1	1->31	FDL Status		Req		
80	14760 Bit		SD4	1->1	Token pass	Pass token	Req		
81	14829 Bit		SD1	1->32	FDL Status		Req		
82	15097 Bit		SD4	1->1	Token pass	Pass token	Req		




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Early versions of these tools were really basic and would just passively record what was taking place on the bus. These days they are far more intelligent



No Response

Timestamp	Attention	Frame	Addr	Service	Msg type	Req/Res	SAPS	Datalen	Data
7920	Bit	SD1	1->19	FDL Status		Req			
8188	Bit	SD4	1->1	Token pass	Pass token				
8257	Bit	SD1	1->20	FDL Status		Req			
8525	Bit	SD4	1->1	Token pass	Pass token				
8594	Bit	SD1	1->21	FDL Status		Req			
8862	Bit	SD4	1->1	Token pass	Pass token				
8931	Bit	SD1	1->22	FDL Status		Req			
9200	Bit	SD4	1->1	Token pass	Pass token				
9269	Bit	SD1	1->23	FDL Status		Req			
9537	Bit	SD2	1->100	SRD_HIGH	Data Exchange	Req	1	00	
9659	Bit	SD2	1->100	DL	Data Exchange	Res	4	18 00 00 00	
9853	Bit	SD2	1->101	SRD_HIGH	Data Exchange	Req	1	00	
9974	Bit	SD2	1->101	DL	Data Exchange	Res	4	18 00 00 00	
10169	Bit	SD2	1->102	SRD_HIGH	Data Exchange	Req	1	00	
10291	Bit	SD2	1->102	DL	Data Exchange	Res	4	18 00 00 00	
10485	Bit	SD2	1->103	SRD_HIGH	Data Exchange	Req	1	00	
10606	Bit	SD2	1->103	DL	Data Exchange	Res	4	18 00 00 00	
10801	Bit	SD2	1->104	SRD_HIGH	Data Exchange	Req	1	00	
11117	Bit	SD2	1->105	SRD_HIGH	Data Exchange	Req	1	00	
11433	Bit	SD2	1->106	SRD_HIGH	Data Exchange	Req	1	00	
11748	Bit	SD2	1->107	SRD_HIGH	Data Exchange	Req	1	00	
12063	Bit	SD4	1->1	Token pass	Pass token				
12132	Bit	SD1	1->24	FDL Status		Req			
12401	Bit	SD4	1->1	Token pass	Pass token				
12470	Bit	SD1	1->25	FDL Status		Req			
12738	Bit	SD4	1->1	Token pass	Pass token				
12807	Bit	SD1	1->26	FDL Status		Req			
13075	Bit	SD4	1->1	Token pass	Pass token				
13144	Bit	SD1	1->27	FDL Status		Req			
13412	Bit	SD4	1->1	Token pass	Pass token				
13481	Bit	SD1	1->28	FDL Status		Req			
13749	Bit	SD4	1->1	Token pass	Pass token				
13818	Bit	SD1	1->29	FDL Status		Req			
14086	Bit	SD4	1->1	Token pass	Pass token				
14155	Bit	SD1	1->30	FDL Status		Req			



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This bus might have no problems / serious problems on a physical level – we need to investigate why these devices are not responding.

Repeated messages



Repeats indicate communication problems

FrameNr	Timestamp	Attention	Frame	Addr	Service	Msg type	Req/Res	SAPS	Dat
31453	14753175...		SD1	1->4	SRD_HIGH	Data Exchange	Req		
31454	14753490...		SD2	1<-4	DL	Data Exchange	Res	5	
31455	14753883...		SD1	1->3	SRD_HIGH	Data Exchange	Req		
31456	14754204...		SD2	1<-3	DL	Data Exchange	Res	5	
31457	14754597...		SD1	1->84	FDL Status		Req		
31458	14756710...		SD4	1->1	Token pass	Pass token			
31459	14756982...		SD1	1->6	SRD_HIGH	Data Exchange	Req		
31460	14757302...		SD2	1<-6	DL	Data Exchange	Res	5	
31461	14757695...		SD1	1->8	SRD_HIGH	Data Exchange	Req		
31462	14758010...		SD2	1<-8	DL	Data Exchange	Res	5	
31463	14758403...		SD1	1->7	SRD_HIGH	Data Exchange	Req		
31464	14758730...		SD2	1<-7	DL	Data Exchange	Res	5	
31465	14759123...		SD1	1->5	SRD_HIGH	Data Exchange	Req		
31466	14759444...		SD2	1<-5	DL	Data Exchange	Res	5	
31467	14759837...		SD1	1->4	SRD_HIGH	Data Exchange	Req		
31468	14760158...		SD2	1<-4	DL	Data Exchange	Res	5	
31469	14760551...		SD1	1->3	SRD_HIGH	Data Exchange	Req		
31470	14762664...	Repeat	SD1	1->3	SRD_HIGH	Data Exchange	Req		
31471	14764777...	Repeat	SD1	1->3	SRD_HIGH	Data Exchange	Req		
31472	14766890...	Repeat	SD1	1->3	SRD_HIGH	Data Exchange	Req		
31473	14769003...		SD1	1->85	FDL Status		Req		
31474	14771116...		SD4	1->1	Token pass	Pass token			
31475	14771388...		SD1	1->6	SRD_HIGH	Data Exchange	Req		
31476	14771709...		SD2	1<-6	DL	Data Exchange	Res	5	
31477	14772102...		SD1	1->8	SRD_HIGH	Data Exchange	Req		
31478	14772423...		SD2	1<-8	DL	Data Exchange	Res	5	
31479	14772816...		SD1	1->7	SRD_HIGH	Data Exchange	Req		
31480	14774929...	Repeat	SD1	1->7	SRD_HIGH	Data Exchange	Req		
31481	14775256...		SD2	1<-7	DL	Data Exchange	Res	5	
31482	14775649...		SD1	1->5	SRD_HIGH	Data Exchange	Req		
31483	14775970...		SD2	1<-5	DL	Data Exchange	Res	5	
31484	14776363...		SD1	1->4	SRD_HIGH	Data Exchange	Req		
31485	14776684...		SD2	1<-4	DL	Data Exchange	Res	5	
31486	14777077...		SD1	1->86	FDL Status		Req		
31487	14775190...		SD4	1->1	Token pass	Pass token			



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When a device does not respond to a masters request the message is resent. When we see this we know that the bus has problems even though it may not yet have failed!

It is kind of like having a heart murmur... not immediately life threatening but could be a problem!

Illegal Messages



Illegal Messages

FrameNr	Timestamp	Attention	Frame	Addr	Service	Msg type	Req/Res	SAPS	Datalen	Dat
34266	6145925	Bit	SD1	1->101	FDL Status		Req			
34267	6146003	Bit	SD1	1-<101	Passive		Res			
34268	6146120	Bit	SD4	1->1	Token pass	Pass token				
34269	6146189	Bit	SD1	1->102	FDL Status		Req			
34270	6146267	Bit	SD1	1-<102	Passive		Res			
34271	6146384	Bit	SD4	1->1	Token pass	Pass token				
34272	6146453	Bit	SD1	1->103	FDL Status		Req			
34273	6146531	Bit	SD1	1-<103	Passive		Res			
34274	6146648	Bit	SD2	1->100	SRD_HIGH	Data Exchange	Req		1	00
34275	6146770	Bit	SD2	1-<100	DL	Data Exchange	Res		4	18
34276	6147002	Bit	Parity error	Ill...					1	FO
34277	6148530	Bit	SD4	1->1	Token pass	Pass token				
34278	6148599	Bit	SD1	1->104	FDL Status		Req			
34279	6148794	Bit	SD2	1->101	SRD_HIGH	Data Exchange	Req		1	00
34280	6148916	Bit	SD2	1-<101	DL	Data Exchange	Res		4	18
34281	6149110	Bit	SD2	1->102	SRD_HIGH	Data Exchange	Req		1	00
34282	6149232	Bit	SD2	1-<102	DL	Data Exchange	Res		4	18
34283	6149426	Bit	SD2	1->103	SRD_HIGH	Data Exchange	Req		1	00
34284	6149548	Bit	SD2	1-<103	DL	Data Exchange	Res		4	18
34285	6149742	Bit	SD2	1->104	SRD_HIGH	Data Exchange	Req		1	00
34286	6150058	Bit	SD2	1->105	SRD_HIGH	Data Exchange	Req		1	00
34287	20369035...	Parity error	Ill...						8	68
34288	20369135...	Wrong SD	Ill...						1	16
34289	20369350...		SD4	1->1	Token pass	Pass token				
34290	20369419...		Ill...						3	10
34291	20369688...		SD4	1->1	Token pass	Pass token				
34292	20369757...		Ill...						3	10
34293	20369806...	Parity error	Ill...						2	36
34294	20370025...		SD4	1->1	Token pass	Pass token				
34295	20370094...		Ill...						3	10
34296	20370140...	Wrong SD	Ill...						1	FE
34297	20370362...		SD4	1->1	Token pass	Pass token				
34298	20370431...		SD1	1->31	FDL Status		Req			
34299	20370699...		SD4	1->1	Token pass	Pass token				
34300	20370768...		Ill...						2	10
34301	20370830...	Parity error	Ill...						1	FC



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Definitely something not right!!

Illegal Messages

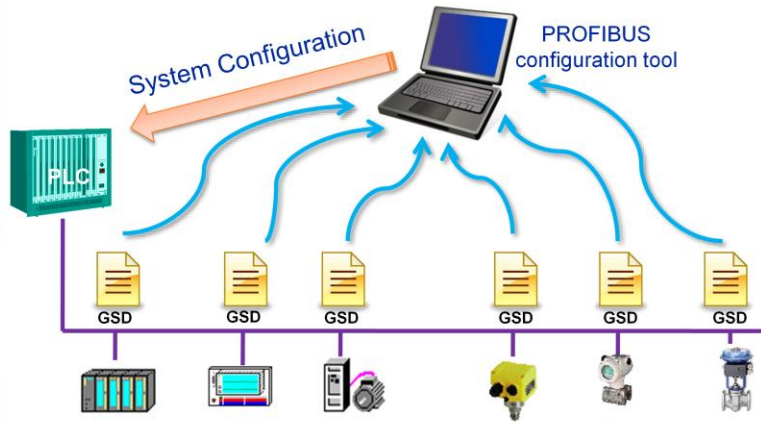


Illegal Messages – Duplicate address

5.63 ms	SD2	1->32	SRD_HIGH	Data Exchange	Req	2	00 00	
6.34 ms	SD2	1<-32	DL	Data Exchange	Res	6	00 00 2A CA :	
7.44 ms	Sync	SD2	1->66	SRD_HIGH	Get Diagnostics	Req	62->60	0
8.63 ms	SD4	1->1	Token pass	Pass token				
9.03 ms	SD1	1->79	FDL Status		Req			
9.92 ms	Sync	SD2	1->13	SRD_HIGH	Get Diagnostics	Req	62->60	0
10.62 ms	Parity error	Illegal				1	00	
10.69 ms	Parity error	Illegal				11	00 00 2A CA :	
11.34 ms	Parity error	Illegal				6	00 00 2A CA :	
11.69 ms	Parity error	Illegal				6	00 00 2A CA :	
12.05 ms	Parity error	Illegal				1	00	
12.13 ms	Framing error	Illegal				1	00	
12.43 ms	SD2	1->32	SRD_HIGH	Data Exchange	Req	2	00 00	
13.14 ms	SD2	1<-32	DL	Data Exchange	Res	6	00 00 2A BA :	
14.24 ms	Sync	SD2	1->66	SRD_HIGH	Get Diagnostics	Req	62->60	0
15.43 ms	SD4	1->1	Token pass	Pass token				
15.83 ms	SD1	1->80	FDL Status		Req			
16.72 ms	Sync	SD2	1->13	SRD_HIGH	Get Diagnostics	Req	62->60	0
16.73 ms	Parity error	Illegal				1	00	
16.79 ms	Parity error	Illegal				11	00 00 2A BA :	
17.43 ms	Parity error	Illegal				6	00 00 2A BA :	
17.79 ms	Parity error	Illegal				6	00 00 2A BA :	
18.15 ms	Parity error	Illegal				1	00	
18.23 ms	Framing error	Illegal				1	00	
18.53 ms	SD2	1->32	SRD_HIGH	Data Exchange	Req	2	00 00	
19.23 ms	SD2	1<-32	DL	Data Exchange	Res	6	00 00 2A CA :	
20.34 ms	Sync	SD2	1->66	SRD_HIGH	Get Diagnostics	Req	62->60	0
21.53 ms	SD4	1->1	Token pass	Pass token				
21.93 ms	SD1	1->81	FDL Status		Req			
22.82 ms	Sync	SD2	1->13	SRD_HIGH	Get Diagnostics	Req	62->60	0
23.52 ms	Parity error	Illegal				1	00	
23.59 ms	Parity error	Illegal				11	00 00 2A CA :	
24.23 ms	Parity error	Illegal				6	00 00 2A CA :	
24.59 ms	Parity error	Illegal				6	00 00 2A CA :	
24.94 ms	Parity error	Illegal				1	00	
25.03 ms	Framing error	Illegal				1	00	
29.37 ms	SD4	1->1	Token pass	Pass token				



Configurations Errors



Bad configuration



Devices not configured correctly


Addr	Service	Msg type	Req/Res	SAPS	Datalen	Data
1->32	SRD_HIGH	Get Diagnostics	Req	62->60	0	
1<-32	DL	Get Diagnostics	Res	62<-60	13	42 05 00 FF 02 54 07 00 00 00 00 00 00
		Short acknowledge	Res			
1->32	SRD_HIGH	Set Parameters	Req	62->61	12	98 01 23 0B 69 6A 00 00 00 00 00 00
		Short acknowledge	Res			
		Short acknowledge	Res			
1->32	SRD_HIGH	Check Config	Req	62->62	2	00 11
		Short acknowledge	Res			
1->32	SRD_HIGH	Get Diagnostics	Req	62->60	0	
1<-32	DL	Get Diagnostics	Res	62<-60	13	42 05 00 FF 02 54 07 00 00 00 00 00 00
1->32	SRD_HIGH	Get Diagnostics	Req	62->60	0	
1<-32	DL	Get Diagnostics	Res	62<-60	13	42 05 00 FF 02 54 07 00 00 00 00 00 00
		Short acknowledge	Res			
1->32	SRD_HIGH	Set Parameters	Req	62->61	12	98 01 23 0B 69 6A 00 00 00 00 00 00
		Short acknowledge	Res			
		Short acknowledge	Res			
1->32	SRD_HIGH	Check Config	Req	62->62	2	00 11
		Short acknowledge	Res			
1->32	SRD_HIGH	Get Diagnostics	Req	62->60	0	
1<-32	DL	Get Diagnostics	Res	62<-60	13	42 05 00 FF 02 54 07 00 00 00 00 00 00
1->32	SRD_HIGH	Get Diagnostics	Req	62->60	0	
1<-32	DL	Get Diagnostics	Res	62<-60	13	42 05 00 FF 02 54 07 00 00 00 00 00 00
		Short acknowledge	Res			
1->32	SRD_HIGH	Set Parameters	Req	62->61	12	98 01 23 0B 69 6A 00 00 00 00 00 00
		Short acknowledge	Res			
		Short acknowledge	Res			
1->32	SRD_HIGH	Check Config	Req	62->62	2	00 11
		Short acknowledge	Res			
1->32	SRD_HIGH	Get Diagnostics	Req	62->60	0	
1<-32	DL	Get Diagnostics	Res	62<-60	13	42 05 00 FF 02 54 07 00 00 00 00 00 00
1->32	SRD_HIGH	Get Diagnostics	Req	62->60	0	
1<-32	DL	Get Diagnostics	Res	62<-60	13	42 05 00 FF 02 54 07 00 00 00 00 00 00
		Short acknowledge	Res			
1->32	SRD_HIGH	Set Parameters	Req	62->61	12	98 01 23 0B 69 6A 00 00 00 00 00 00
		Short acknowledge	Res			



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Preparation

There is a lot that you can do while your system is running to prepare to deal with any potential problems.


Don't:

“Ignore it and hope it never gives problems!”

“If there is a problem we will get the system integrator in”


“We will replace things till it works again”

Many of the hours that you spend in a downtime situation could have been spared by correct preparation up-front!



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There are some un-helpful attitudes out there and you are going to laugh... probably because you know someone (and maybe it is you)

“Ignore it and hope it never gives problems!”

This is a bad idea because if something does happen you will be completely unprepared – you will not know where you can get help or where to start with sorting out the problem.

“If there is a problem we will get the system integrator in”

They probably know as much as you... it is weird we will arrive on site and they have already rewired the panel with different connectors and decided to throw away the active terminators because they give more trouble than they are worth...

“We will replace things till it works again”

The most common troubleshooting strategy out there! Replace things even if we are not sure that they are faulty until the system is working again.

Training



Train your people!

- Technology can never work without people.
- People are intimidated by things they don't understand
 - Installation decisions are hampered
 - Maintenance takes longer
- The benefits of many technologies are nullified if operated by under qualified staff.
 - Bad installation
 - Poor Maintenance
 - Extended Troubleshooting and down time
- Internationally accredited training is available
- We NEED to foster an environment of training!



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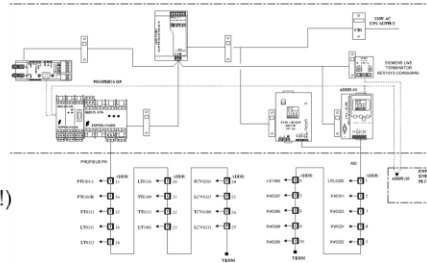
We have a bad attitude to training in this country – perhaps it has been caused by poor training institutions? Pay peanuts – get monkeys.

Very few of the candidates we have on our training courses sit and sleep and the few that do usually fail.

Importance of good network diagrams...

This cannot be stressed enough!

- ✓ Order of devices
- ✓ Locations of devices
- ✓ Addresses of devices
- ✓ Type of devices
- ✓ Termination points
- ✓ Cable lengths
- ✓ Access points (PG plugs!)
- ✓ Simple to follow!!



Matching cable labelling scheme!

Good drawing make troubleshooting **MUCH** simpler!

Familiarity with the network:

- ✓ Walk the network
- ✓ Know what is connected
- ✓ Know what it does
- ✓ Know how to replace devices and set the address correctly!
- ✓ Have the configuration files on hand
- ✓ Have the device manuals on hand



Regular Health Checks

Digital systems either work or don't work – no in between

Do you know the state of your network?

Regular health checks are a great way to ensure that your network is in good shape.

- ✓ Every 6 months to 1 year
- ✓ After any upgrades / changes
- ✓ Before major system changes



THE END



Thank you for your attention!

Questions?



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