

Data_Link 2000

APPLICATION NOTE AN005

Radio Path Testing

Summary

Before installing any de-regulated radio telemetry system it is highly recommended that a Radio Path Survey is carried out. The purpose of this is twofold. Firstly it identifies which radio channels are currently in use in the area, thus ensuring that the proposed system will not interfere with other users. Secondly it confirms that adequate reception can be achieved to ensure that the system will operate at all times (even under adverse weather conditions).

Outline

The common radio band allocated for de-regulated telemetry is designated MPT1329, and covers the frequency range 458.500MHz...458.950MHz. It defines channels at 12.5KHz spacing, so accommodates a total of 36 channels, of which three are designated for special functions, leaving 33 usable channels. Being de-regulated, anyone is free to use any of these channels (provided their equipment is approved in accordance with the relevant specifications)

A conventional radio scanner can be used to identify which channels are already in use by sweeping across the band and noting which frequencies are occupied. However, some care is needed to ensure that equipment which transmits briefly at infrequent intervals is not missed.

Two battery-powered *Nano_Link*'s can then be used to prove the viability of the radio path by establishing a temporary two-way link between sites. The *Nano_Link* at one end can be configured to display the received signal strength in each direction, allowing the signal margin to be easily deduced by comparing the signal strength with the known receiver sensitivity.

The *Nano_Link*'s used for this are totally standard, both in hardware and software, requiring only the addition of an Alphanumeric Display Module (Churchill part number 7075-1) at the base-station. For convenience a dedicated Radio Path Test Set has both *Nano_Link*'s housed in polycarbonate enclosures, with the Display Module attached to the front cover of the base-station.

One *Nano_Link* is configured as a base-station, and the other as an outstation. Both units are identical, except for the display module attached to the base-station. Also the digital outputs at the outstation are linked to its digital inputs, thus echoing data back to the base-station.

The outstation is configured for address 1, and battery operation. Therefore the switches are as follows:

S1 = 10000000 S2 = xxxxx000

The base-station is configured in radio path test set mode, so the switches are set as follows:

S1 = 00000000 S2 = xxxxx011

Where 1 = on, 0 = off.

Switches marked xxxxx define the radio channel (in binary), and should be set the same on both units.

The outstation will stay in Sniff Mode (i.e. relative low power consumption) until the base-station interrogates it, when it will wake up and respond, increasing the power consumption. When the unit is put back into storage S1 should be set to 11111111 to minimise battery drain.

In radio path test set mode the base-station will be in its power-down state, but will check the pushbuttons on the Alphanumeric Display Module (ADM) every 15 seconds. If it detects the Enable pushbutton to be pressed it will activate and interrogate the outstation every 5 seconds. To save the inconvenience of holding down the pushbutton, a toggle switch is fitted to the ADM when used as part of a Radio Path Test Set.

While the base-station is active the ADM can be used to display the radio signal strength (RSSI) in each direction. If communications is lost the RSSI will drop to its minimum value of $-15\text{dB}\mu\text{V}$. As a further indication of correct operation, the base-station simulates varying digital input data, which should be received at the outstation and echoed back. The ADM should therefore show the base-station digital outputs following its inputs.

Aerials

It is not always practical to carry out the survey with the proposed aerial in the proposed location. For example, the site may be under construction, or the proposed type of aerial may not be available.

The survey should, however, be carried out with the nearest practical equivalent of the proposed aerial, sited as close as possible to the proposed location. If the results are at all marginal then the aerials should be considered carefully.

Channel Occupancy Survey

Before starting a test, channel occupancy should be tested using a conventional radio scanner such as the Icom IC-R10. The scanner should be set to sweep the band 458.500MHz...458.925MHz, with a channel spacing of 12.5KHz, and record all channels on which a carrier is detected. It should then be connected to the test aerial at each proposed location, and left running for at least 15 minutes. At the end of this test it will indicate all occupied channels, which should be recorded on the Radio Path Test Result Sheet.

Path Loss Survey

The outstation and base-station should be set to a radio channel which has been identified as unused. If testing a site where a base-station will be communicating with several outstations, install the test set outstation at the proposed base-station site. The test set base-station can then be taken to each outstation site to test the link, without the need to return to the base-station site.

The transmitter power should ideally be adjusted to compensate for any aerial gain to ensure the ERP doesn't exceed 500mW, or $134\text{dB}\mu\text{V}$. However, for short-duration tests with directional aerials it is acceptable to leave the transmitters at 500mW, since the Result Sheet will make allowance for this in calculating the expected margin for the proposed installation. There can be instances, therefore, where the path works in the survey, but would not work when the transmitter power is brought within the legal limits.

The Radio Path Test Result Sheet gives all necessary guidance on deriving the receive margin in each direction. The receiver sensitivity is better than $-10\text{dB}\mu\text{V}$, so the final line of the sheet shows the expected receive margin.

The margin should ideally be greater than 10dB, to allow for adverse conditions. For example, trees close to the aerials can attenuate the signal when in full leaf and wet.

Radio Path Survey - Results Sheet

Confidential? YES / NO			
Customer:		Tel:	Fax:
Address:	Project Name/Description:		
Contact:	Witness:	Date:	Ref:

LOCATION:	Base-station: (Local)			Outstation: (Remote)		
Test Channel:	Bearing to outstation:			Distance from base-station:		
	PROPOSED	SURVEY		PROPOSED	SURVEY	
Power Supply		-			-	
Equipment Type		<i>Nano_Link</i>			<i>Nano_Link</i>	
Aerial Type						
Feeder length			m			m
Aerial height above ground			m			m
Aerial pole length			m			m
Aerial brackets						
U bolts required						
TX Power		500	mW		500	mW
TX Power <i>(see table overleaf)</i>	134	134	dB μ V	127	134	dB μ V
+ Aerial Gain <i>(see table overleaf)</i>	0	0	dB	6	0	dB
- Feeder loss <i>(see table overleaf)</i>	-3	-2	dB	-2	-1	dB
ERP (134dB μ V max)	131	132	dB μ V	131	133	dB μ V
<i>Read from Test Set:</i>	Local RSSI	5	dB μ V	Remote RSSI	8	dB μ V
<i>Copied from corresponding box above:</i>	- Survey outstation ERP	-133	dB μ V	- Survey base station ERP	-132	dB μ V
	+ Proposed outstation ERP	131	dB μ V	+ Proposed base station ERP	131	dB μ V
	- Survey b/s aerial gain	0	dB	- Survey o/s aerial gain	0	dB
	+ Proposed b/s aerial gain	3	dB	+ Proposed o/s aerial gain	6	dB
	+ Survey b/s feeder loss	2	dB	+ Survey o/s feeder loss	1	dB
	- Proposed b/s feeder loss	-3	dB	- Proposed o/s feeder loss	-2	dB
<i>Adjust for radio receiver sensitivity:</i>	+ Proposed RX Sensitivity	10	dB μ V	+ Proposed RX Sensitivity	0	dB μ V
Proposed Receive Margin	Base-station:	15	dB	Outstation:	12	dB

Occupied Channels - 458.xxxxMHz (cross out those occupied)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
5000	5125	5250	5375	5500	5625	5750	5875	6000	6125	6250	6375	6500	6625	6750	6875
15	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
7000	7125	7250	7375	7500	7625	7750	7875	8000	8125	8500	8625	8750	8875	9125	9250

Weather during test:

Topographical features:

Notes:

I/O Requirements

Base-station	Outstation

Power Unit Conversion
(0dB μ V = 1 μ V into 50 Ω)

Power	dB μ V
1mW	107
2.5mW	111
5mW	114
10mW	117
25mW	121
50mW	124
100mW	127
250mW	131
500mW	134
1W	137

Aerial Gain

300mm whip	PUG/TNC	0 dB
Centre-fed dipole	CDF450	0 dB
End-fed dipole	ENF450	0 dB
4 element Yagi	UHF 4	7.5 dB
8 element Yagi	UHF 8	10 dB

Feeder Loss

Downlead cable	RG213	0.2 dB/metre
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