CHURCHILL CONTROLS
www.churchill-controls.co.uk

Mega_Link

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 threefold. Firstly it identifies the optimal mast height and aerial choices for all of the various base-station and out-station locations. Secondly it confirms that adequate reception can be achieved to ensure that the system will operate at all times (even under adverse weather conditions). Thirdly it identifies any radio channels which are currently in use in the area, leading to selection of best radio channel(s), thus ensuring that the proposed system will not interfere with other users.

Outline

The common radio band allocated for de-regulated telemetry is designated MPT1329, and covers the frequency range 458.500 MHz…458.950 MHz. It defines channels at 12.5 kHz spacing, and accommodates a total of 34 channels, of which 10 are designated for special functions, leaving 24 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).

See Application Note AN026 for more guidance on channel frequency selection.

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. Alternatively, a ***Mega_Link*** can be used itself to scan through the channels in order to monitor and select the best open channel to use.

Two ***Mega_Link***s can then be used to prove the viability of the radio path by establishing a temporary two-way link sending messages back and forth between sites. The ***Mega_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 ***Mega_Link***'s used for this are totally standard, both in hardware and software.

After a system is installed during commissioning and any future maintenance and servicing, the RSSI reading can be easily monitored to determine the signal margin available.

1) Scanning to Determine the Best Available Channels for Use

A ***Mega_Link*** can be used to scan the radio spectrum to determine which channels are already occupied and therefore should be avoided and those channels which are empty of interference and are safe to used.

The joystick is used as follows:

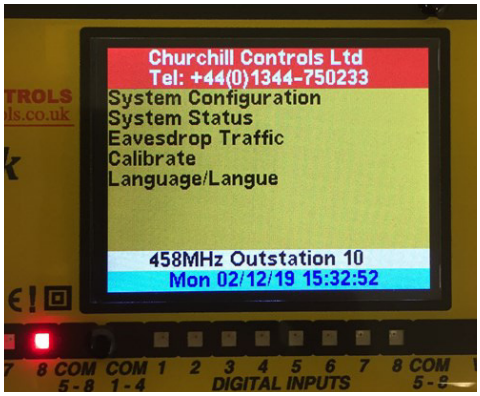
Up = move up

Down = move down

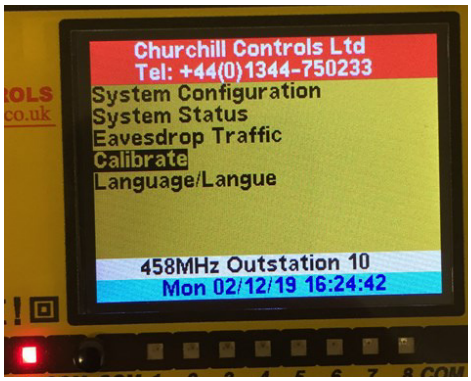
Right = select

Left = go back (multiple go backs will get back to home page)

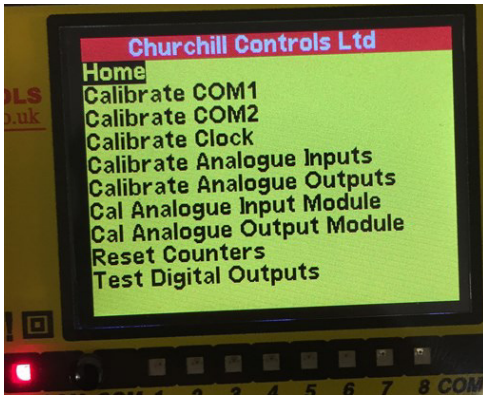
The homepage looks like this:



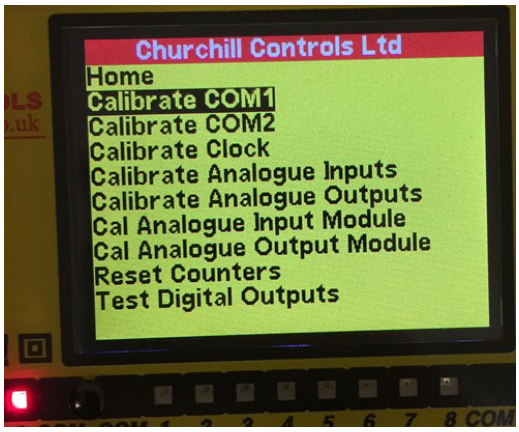
Down click a few times so that the highlighter bar is on "Calibrate" as follows:



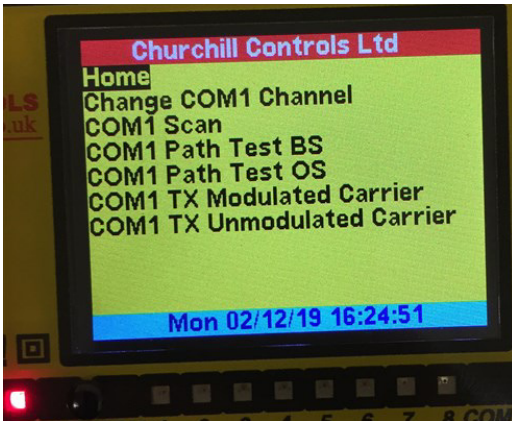
Click right to select the "Calibrate" sub-menu which looks like this:



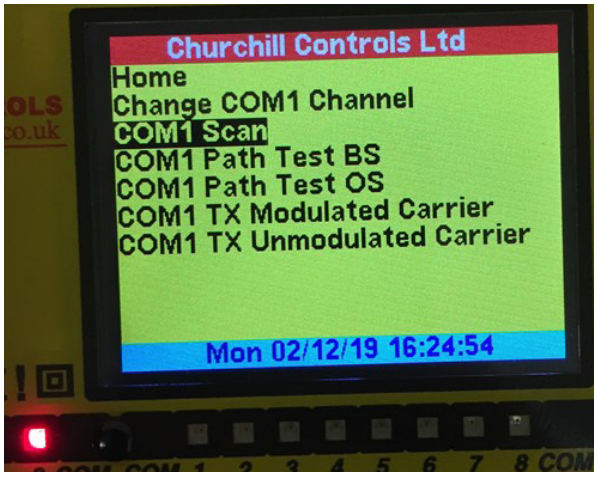
Down click once so that the highlighter bar is on "Calibrate COM1" as follows:



Click right to select the "Calibrate COM1" sub-sub-menu which looks like this:



Down click twice so that the highlighter bar is on "COM1 Scan" as follows:

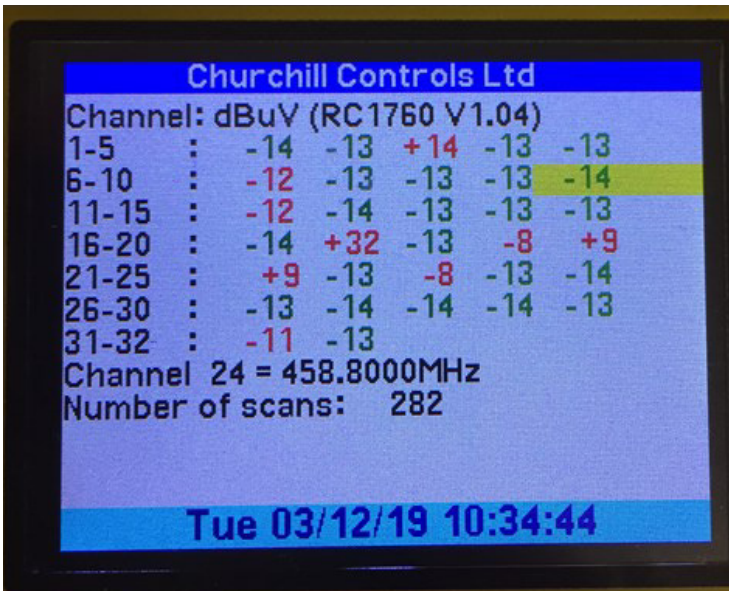


Click right to select the "COM1 Scan" function which looks like this:

Leave for a good few 10's of complete scan cycles.

Looking at this scan below shows an environment with a strong signal on channel 17 at +32dBµV and this should certainly be avoided.

The lower the figure the emptier the channel, so channel 10 with -14dBµV is a sensible choice to use.



Perhaps take a photo for the records.

2) Path Test to Determine the RSSI Link Margin and Message Error Rate

A pair of ***Mega_Link*** can be used to set up a path test between two sites to determine the RSSI link margin and likely error rate as follows.

Firstly set up the outstation into path test mode and leave that running, then travel to the basestation and set-up that end of the path test link and observe the results.

1) Set Up Outstation into path test mode.

The joystick is used as follows:

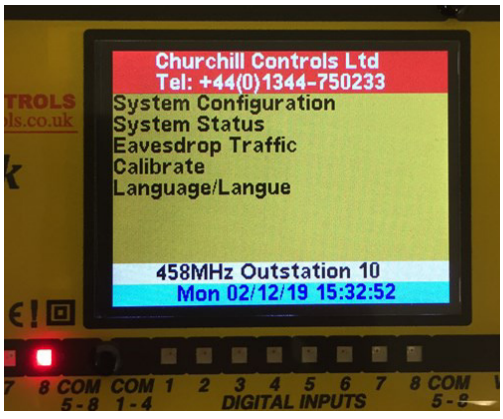
Up = move up

Down = move down

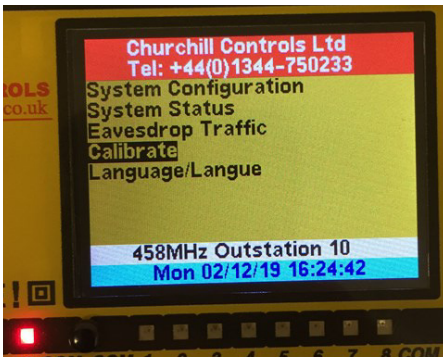
Right = select

Left = go back (multiple go backs will get to home page)

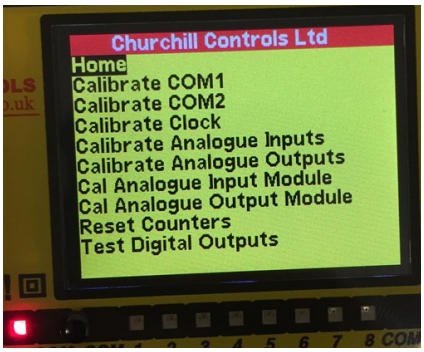
The homepage looks like this:



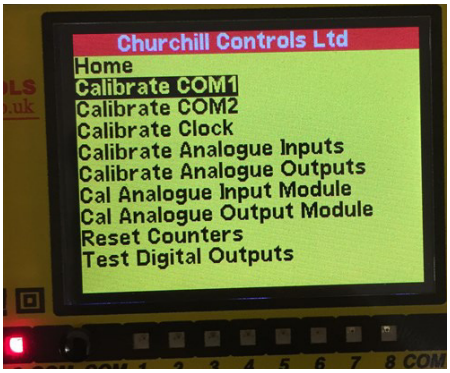
Down click a few times so that the highlighter bar is on "Calibrate" as follows:



Click right to select the "Calibrate" sub-menu which looks like this:

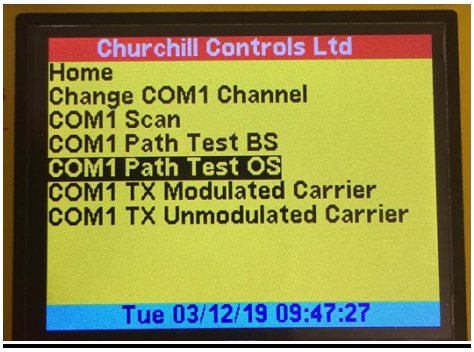


Down click once so that the highlighter bar is on "Calibrate COM1" as follows:

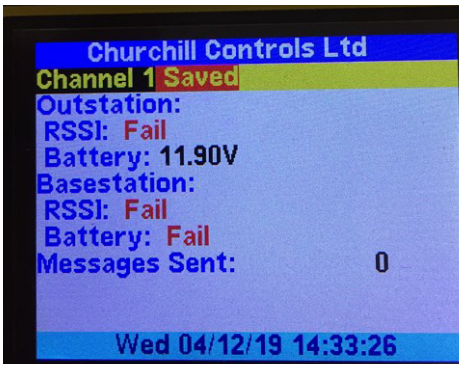


Click right to select the "Calibrate COM1" sub-sub-menu which looks like this:

Down click four times so that the highlighter bar is on "COM1 Path Test OS" as follows:



Click right to select the "COM1 Path Test OS" function at outstation and you should see the following screen waiting for a path test message to be received from basestation which has not yet been set up.



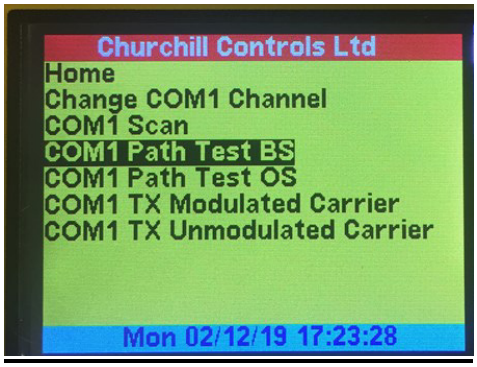
No messages have been sent because no poll message has been received yet.

Leave outstation running like this.

2) Set Up Basestation into path test mode.

With the outstation ***Mega_Link*** left running in COM1 Path Test OS mode, travel to the basestation site and switch-on and set up the basestation ***Mega_Link*** as follows.

Follow steps as for Outstation above but select and right click on the "COM1 Path Test BS" function.



At the basestation you should see a screen like this:

The above screen at basestation shows that 35 messages have been transmitted and received so far, none of them has failed to trigger a message to be received back. It also shows the RSSI for both the basestation to outstation and the return leg of outstation back to basestation. Readings of +2 and +6dBµV are marginal for reliable operation while a reading of +10dBµV, or greater, would be preferable for a safe margin due to the effects of potential atmospheric and environmental radio path variations.

3) Viewing the RSSI During Normal Operation Of a System

RSSI = Received Signal Strength Indication

The desired situation is to have a ***Mega_Link*** system which comprises of a Basestation which communicates with either a single Outstation or multiple Outstations with adequate signal levels plus some margin to allow for variations in atmospheric propagation and hence signal path attenuation losses at their worst condition throughout the year.

When a system has been installed (or just temporarily installed) and it is communicating then it is easy to use the display to show the RSSI at the Basestation and then each of the Outstations.

The typical receiver sensitivity level is -10dBµV, this means that it should receive a signal provided that it is of a level equal or greater than this. While a signal level of between -9 to 0dBµV would be received, there is very little safety margin for variations. A signal level of +10dBµV (or more) gives at least a 20dB margin and is a good figure to aim for in terms of balance between size of aerial and available margin.

The joystick is used as follows:

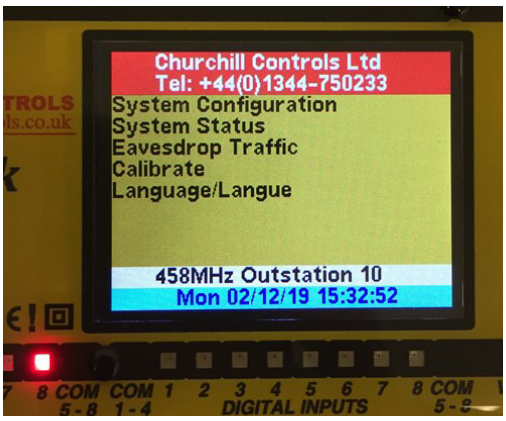
Up = move up

Down = move down

Right = select

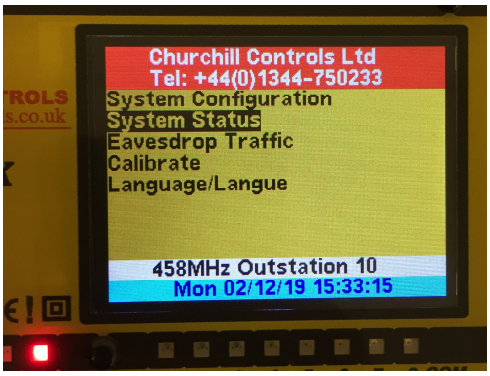
Left = go back (multiple go backs will get to home page)

The homepage looks like this:



Down click gets a highlighter bar as follows:

Click down to "System Status":



Click right to select the "System Status" sub-menu which looks like this:

Click down multiple times to highlight RSSI as follows:

Now click right to select "RSSI" .

For a Basestation you should see the screen below:

This is saying that the RSSI at the Basestation when receiving from Outstation 10 is +12dBµV.

The values on the screen will update each time that the scan happens (usually every 10 seconds).

If there are multiple outstations then the display will update as each one is scanned through in order.

For an Outstation you should see the screen below:

This is saying that the RSSI at the Outstation when receiving from the Basestation 0 is +13dBµV

As discussed earlier a reading of greater than +10dBµV is recommended for a system to have an adequate link margin.

Record Keeping

A radio path test is only relevant if it is carried out at exactly the location at which the equipment is to be installed, and there are no subsequent changes in the vicinity.

To ensure the validity of the test, therefore, it is important to ensure it is carried out at the required location and to record the location and the site conditions. This requires:

a) Confirmation from the customer that the tests have been carried out from the required locations. The customer should therefore sign the attached report

b) Identifying the location of each site using a 10-digit National Grid reference obtained from a GPS receiver

c) Attaching photographs to the end of the report to show the location of the aerials, (ideally with some fixed reference points in the background), and the state of the surrounding area

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 ***Mega_Link***'s built-in channel scan function. This will sweep the channels 1 to 31 within the band 458.500 MHz…458.950 MHz, with a channel spacing of 12.5 kHz, 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 134dBµV. 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 –10dBµV, 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.

CHURCHILL CONTROLS
www.churchill-controls.co.uk

Radio Path Survey - Results Sheet

Confidential? **YES / NO**		Surveyed by:	
Customer:		Tel:	Fax:
Address:		Project Name/Description:	
Witness Name:	Witness Signature:	Date:	Ref:

System Name	Base-station Name			Outstation Name		
	Grid Reference:			**Grid Reference:**		
Radio Channel	**Bearing to o/s:**			**Distance from b/s:**		
	PROPOSED	**SURVEY**		**PROPOSED**	**SURVEY**	
Power Supply		-			-	
Equipment Type		***Nano_Link***			***Nano_Link***	
Aerial Type	yagi	end fed		yagi	end fed	
Feeder length	20	10	m	12	10	m
Aerial height above ground	8	8	m	8	8	m
Aerial pole length	4	8	m	4	8	m
Aerial brackets						
U bolts required						
TX Power (mW)	60	500	mW	60	500	mW
TX Power (dBµV) *(see table overleaf)*	124	134	dBµV	124	134	dBµV
+ Aerial Gain *(see table overleaf)*	10	0	dB	10	0	dB
- Feeder loss *(see table overleaf)*	-4	-2	dB	-2.4	-2	dB
ERP (134dBµV max)	130	132	dBµV	131.6	132	dBµV
Read from Test Set:	Local RSSI	1.6		Remote RSSI	2.6	dBµV
Calculation:	- Survey o/s ERP	-132	dBµV	- Survey b/s ERP	-132	dBµV
	+ Proposed o/s ERP	131.6	dBµV	+ Proposed b/s ERP	130	dBµV
	- Survey b/s aerial gain	0	dB	- Survey o/s aerial gain	0	dB
	+ Proposed b/s aerial gain	10	dB	+ Proposed o/s aerial gain	10	dB
	+ Survey b/s feeder loss	2	dB	+ Survey o/s feeder loss	2	dB
	- Proposed b/s feeder loss	-4	dB	- Proposed o/s feeder loss	-2.4	dB
Adjust for radio receiver sensitivity:	- Proposed RX Sensitivity	-10	dBµV	- Proposed RX Sensitivity	-10	dBµV
Proposed Receive Margin	**Base-station:**	**19.2**	**dB**	**Outstation:**	**20.2**	**dB**

Occupied Channels - 458.xxxxMHz (cross out those occupied) - Avoid channels in RED

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	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 (0dBµV = 1µV into 50Ω)

Power	dBµV
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

ATTACH PHOTOGRAPHS TO FOLLOWING PAGE: