LINK RESEARCH

LINK XP

LINK RESEARCH

User Manual

Link Research Ltd. 23 Watford Metro Centre, Dwight Road, Watford, Hertfordshire, WD18 9XA, England. Tel: +44 (0) 1923 244 233
Registered in London No. 2074604 Web: www.linkres.co.uk Fax: +44 (0) 1923 241 357

LINK RESEARCH

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1. Firmware Versions Supported by this Manual

The following firmware versions are supported by this manual:

- L1101/1102/1104/1106 Version 7d2
- L2102/2104 Version 1e4
- Link Infra Red Version 1.2

The latest firmware versions and details of how to download them can be found on the Link Research web site:

www.linkres.co.uk

2. About this manual

This manual is divided into 3 sections:

- Section 1 – **Getting started and basic operation**. This will enable Users to set up the system and get it running. A trouble-shooting guide is included.
- Section 2 – **More advanced operation**. This section gives detailed coverage of how to change and store profiles including uploading/downloading files from a PC.
- Section 3 – **Technical reference.** This section is intended mainly for support engineers and covers the system's technical specifications, remote control protocol and software upgrades.

3. Introduction

The Link Research LinkXP wireless camera system is the first of a new generation of high performance, low delay encoders incorporating an up convertor and transmitter in an extremely compact clip-on unit for easy camera mounting. Designed for use with the S band (1.7 to 2.7GHz) the transmitter uses the extremely rugged COFDM modulation scheme with 2000 carriers where end-to-end system delay can be as low as 50mS. The encoder/transmitter unit has very low power consumption, less than 18W and can be powered directly from the camera or from an alternative battery source.

On the receive side, a variety of antennas can be used to feed a compact down convertor providing a UHF output signal for the diversity demodulator which can accept up to 4 inputs.

The system is very simple to set up using Link's control software (supplied with the system) allowing rapid change of frequency and system reconfiguration. In addition, the unit can be controlled by the hand-held infra-red (IR) controller, L9020, via the front panel buttons or an RS232 interface using the supplied cable.

The internal design of all units in the system is extremely compact using state-of-the-art components and software giving a number of major advantages for the User.

- The low component count leaves few parts to go wrong giving very high system reliability.
- All units in the system have been designed as part of an integrated family ensuring the very best interoperability.
- The design is so flexible that the LinkXP wireless camera system gives Customers the best future proofed product on the market today.

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- Low power consumption ensures long operating times from each battery before a change is needed.
- The very cool running temperature and careful component choice lead to a product that is designed not to fail.

Link aim to make product backup second-to-none. Link has extensive manufacturing experience as well as full servicing capability of both it's own and many other manufacturers' products. The full Link product range is stocked leading to short lead times and fast field support from the factory in Watford.

Always refer to the Link Research website, www.linkres.co.uk, for the latest information. A customer section, password protected, is available in the Support Area. Please contact Link Research to gain access to this area that gives access to the latest product news, software upgrades etc..

4. Warranty and support

In all support requirements or in case of unit failure please contact Link directly (contact details at the front of this manual). Always refer to the Link web site for firmware upgrades, interoperability and support in general.

4.1 Standard warranty cover

The LinkXP system is fully covered for parts and labour in case of failure for one year from date of despatch from Link Research Ltd.

In addition an advance replacement service is included for the first year, see below.

Extended warranty and advance replacement are available beyond the first year; contact Link for details.

4.2 Repair procedure

If the unit has failed please contact Link to be given a RAN number (Return Authorisation Number). Wherever possible please give a full description of the problem leading to the failure.

Return the complete system to Link Research at the address given, preferably in the original packaging and enclosing a full fault report wherever possible. The unit will be repaired and returned as soon as possible. Repair times should be short but if you must have a replacement unit immediately then you can take advantage of our advance replacement service.

4.3 Advance replacement service

On request, once the fault has been discussed with a Link technician and a RAN number allocated, Link will despatch a temporary replacement unit within 24 hours of your call. The replacement unit must be returned on receipt of your repaired unit complete with the original packaging.

N.B. For repairs and advance replacement units, shipping costs will be borne by Link for the outward leg only.

For out-of-the box failures, occurring within the first 14 days from delivery, Link will pay agreed transport costs in both directions.

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5 Safety, compliance and approvals

5.1 Safe Operating Procedures

The product must be earthed.
Ensure that the power requirements meet the LinkXP specification.
Operate within the environmental limits of the product and ensure there is adequate ventilation. Allow at least 40mm free air-space at each side of the equipment.
Do not subject the equipment to splashing or dripping liquids.
Only authorised trained personnel should open the product. There are no functions that required the User to gain access to the interior of the product.

5.2 Safety

This equipment has been designed to meet the requirements of the following:-

EN60950	European Safety of information technology equipment including business equipment.
IEC 60950	International Safety of information technology equipment including business equipment.
UL 1950USA	Safety of information technology equipment including business equipment.

The equipment has been designed to meet the following:-

EN 55022	European	Emission Standard equipment-class A.
EN 55103-2	European	Generic Immunity Standard.
FCC	USA	Conducted and radiated emission limits For a Class A digital device
ETSI EN301 - 489 - 3		For Radio Equipment in the range of 1GHz to 40GHz.

5.3 Radio

ETSI EN300 - 440 -1	For Radio Equipment in the range of 1 GHz to 40GHz

5.4 CE Marking

The CE mark is affixed to the LinkXP and the EC Declaration of Conformity and Technical File is available on request.

5.5 CE Compliance Note

This is a Class A product. In a domestic environment this product may cause radio interference in which case the User may be required to take adequate measures.

5.6 FCC Compliance Note

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This unit has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful radiation when the equipment is used in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful radio interference. Operation of this equipment in a residential area is likely to cause harmful interference in which case the User will be required to correct the interference at his own expense.

5.7 Other Compliance Notes

Antistatic precautions should be observed when connecting leads to the rear panel connectors.

Nominal lead length used for EMC checks was less than 3 metres.

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Section 1 - Getting Started and Basic Operation

1.1 Getting Started - The Transmitter

1.1.1 Which model do I have?

Four models of camera-mounted transmitter are available with the following model numbers and frequency ranges. A colour-coded band on the N-type antenna connector denotes which frequency band the transmitter will cover.

Model number	Frequency coverage	Colour Code
L1101	1.9GHz to 2.2GHz	Black
L1102	2.1GHz to 2.3GHz	Green
L1104	2.3GHz to 2.5GHz	Red
L1106	2.5GHz to 2.7GHz	Blue

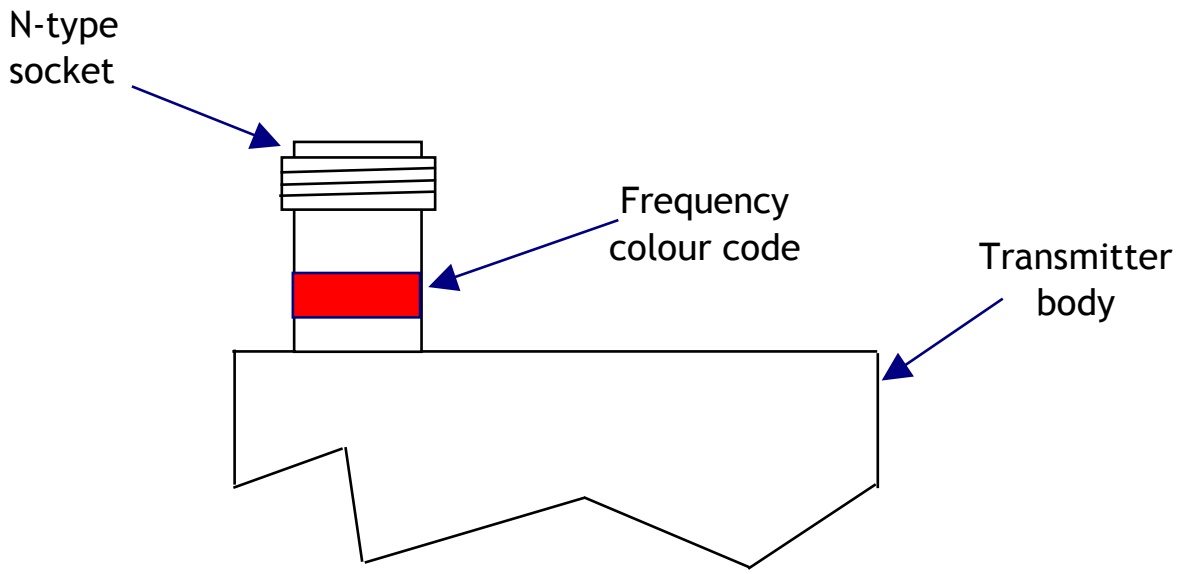

Figure 1- frequency band marking on the transmitter

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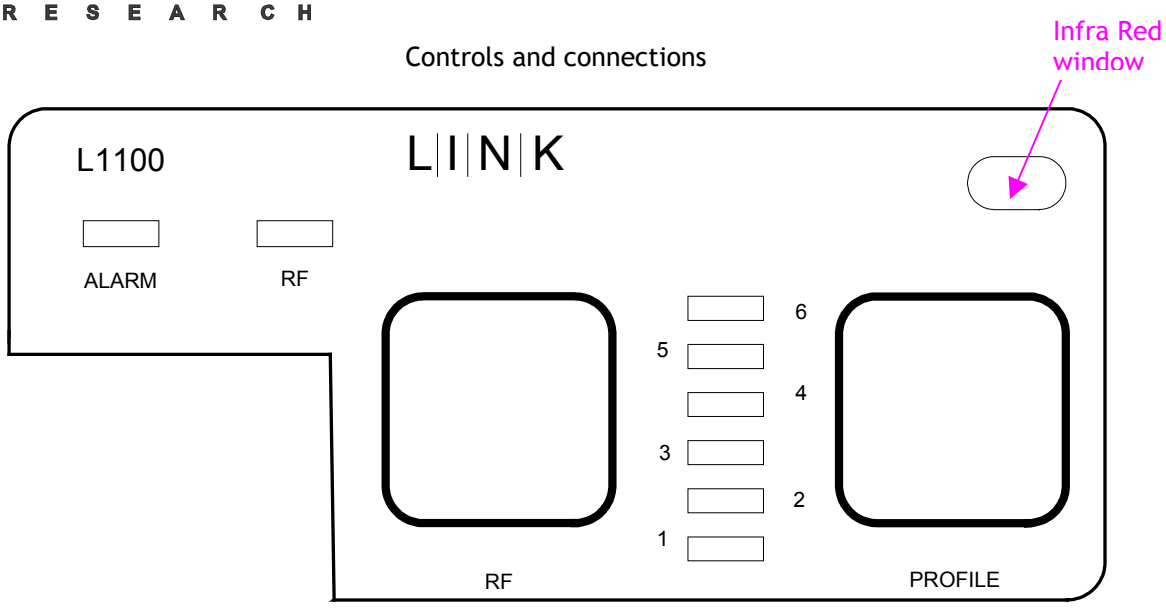

Figure 2 - L110x controls and displays

Control/Display	Function
Profile	Selects one of six stored configurations. Each press steps the selection forward one profile.
RF	Pressing this turns the RF output on or off
Yellow LEDs 1 to 6	The LED that is lit indicates which of the six stored profiles is selected.
Green RF	When lit, the RF output is enabled.
Red ALARM	When lit an alarm state has been detected.
All profile LEDs flashing on and off	Indicates the battery voltage is low and has fallen below the threshold.

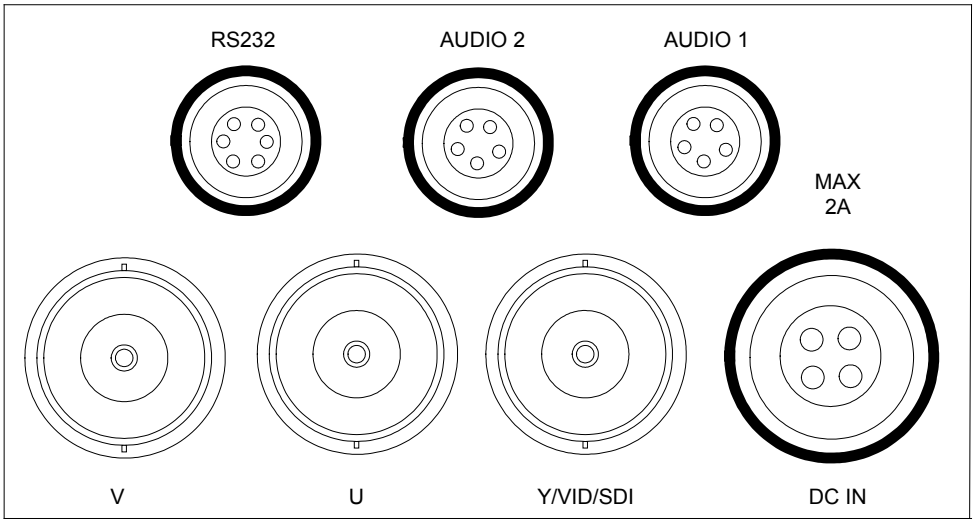

Figure 3 - L110x connections

Connector type	Legend	Description
Lemo 4 pin DC in	DC IN	DC input connector pin 1 -ve pin 4 +ve

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		Input voltage range 16VDC to 10.5VDC
Lemo 5 pin	AUDIO 1	Audio 1 input, 1 stereo pair or 2 mono channels
Lemo 5 pin	AUDIO 2	Audio 2 input, 1 stereo pair or 2 mono channels
Lemo 6 pin	RS232	RS232 data input, firmware upgrade port and control port
BNC	Y/VID/SDI	Video input for composite, SDI or luminance component depending on input selection.
BNC	U	U component video input
BNC	V	V component video input
N type	ANT	Antenna connection

1.1.3 Fitting the battery and camera adaptor plates

The transmitter is designed to take a wide range of battery adaptor plates. These can be obtained from Link Research of directly from the battery manufacturer.

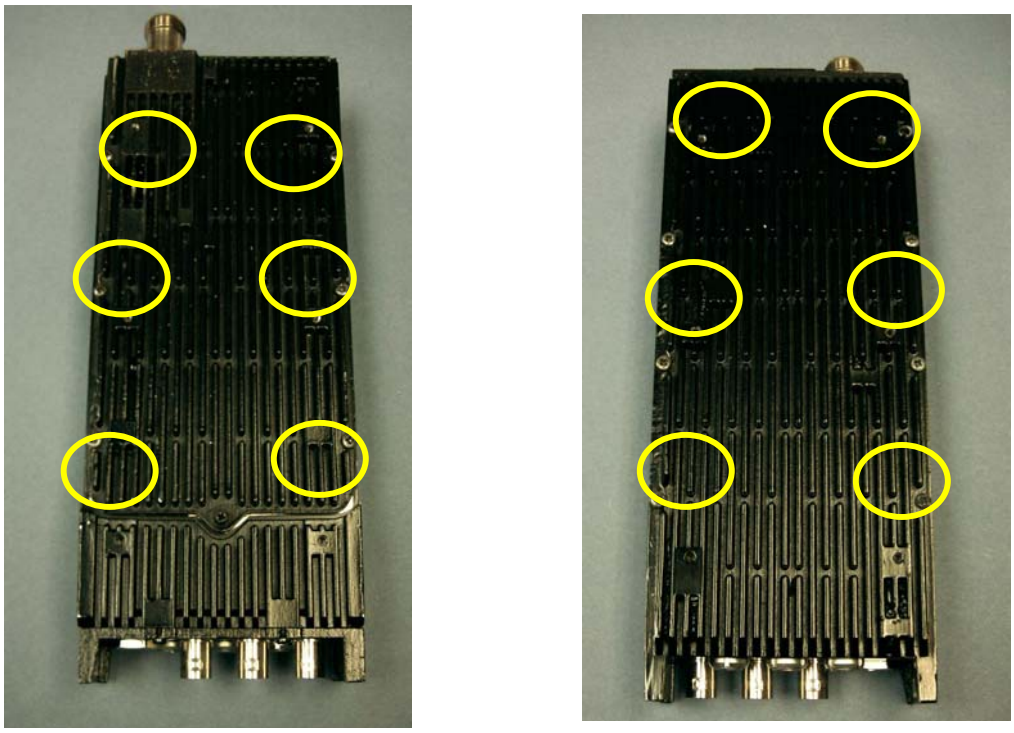

Figure 4 - Position of threaded holes for mounting battery plates.

On both faces of the transmitter, six threaded mounting points are provided (M3 thread 6mm depth). Standoffs at least 6mm long should be used to space the mounting plate from the transmitter body so that adequate cooling is provided. It is recommended that the screws be fitted using a screw locking compound as well as shake proof washers to prevent accidental loosening.

1.1.4 Fitting the antenna

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The antenna is fitted by screwing the N-type connector on the base of the antenna onto the N-type socket on the top of the casing. Make sure the antenna is fully screwed down onto the socket. **Do not over tighten; use hand pressure only.**

N.B. Damage caused to the casing by incorrect fitting of the antenna is not covered by the warranty.

Several different types of antenna can be used. See section 2.1 on Antennas.

1.2 Getting Started – The L3010 Down convertor

1.2.1 Controls and connections

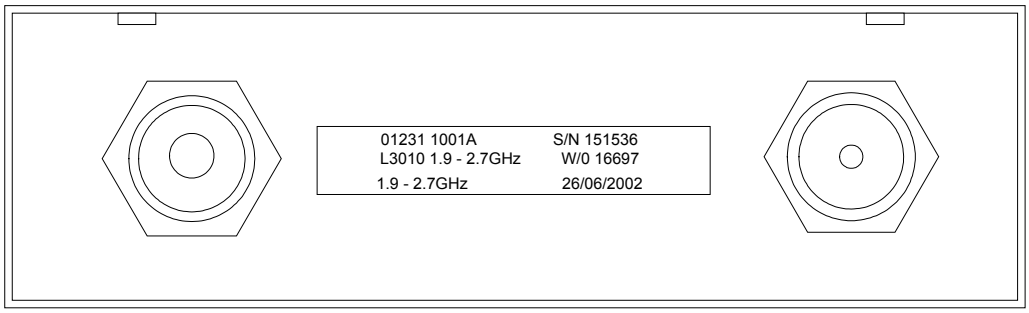

Figure 5 – L3010 connections

Two connections are provided on the lower side of the unit as shown in the table below.

Connector type	Legend	Description
F-type 75Ω threaded socket	Not marked	UHF intermediate frequency out to receiver Power input to down convertor from receiver 22kHz signalling tone for down convertor control from receiver
N-type 50Ω threaded socket	Not marked	SHF input from antenna

The 22kHz tone is used to control the down convertor gain to compensate for signal losses in the cable length between the down convertor and the receiver.

1.2.2 Mounting the L3010

The L3010 down convertor should be mounted so that the two connectors are facing downwards. This will help to prevent water ingress. In areas of very heavy rainfall the L3010 should be mounted inside a waterproof protective cover.

The L3010 must be mounted as close to the receive antenna as possible with a maximum cable length between antenna and down convertor of 1 metre.

For temporary installations, cable ties can be threaded through the holes in the corners of the casing and then tied to any convenient point. It is worth remembering that although

the L3010 is very light, the support must be capable of taking the combined weight of the L3010 and the drop cable to the receiver unless this is independently supported.

For permanent installations, the L3010 can be mounted directly onto a flat surface using screws through the casing holes in each corner. For mast mounting, a flat plate can be made up on which the L3010 is mounted. The plate is then fixed to the mast using U-bolts or tie wraps.

1.3 Getting Started – The L2102 Receiver

1.3.1 Controls and connections

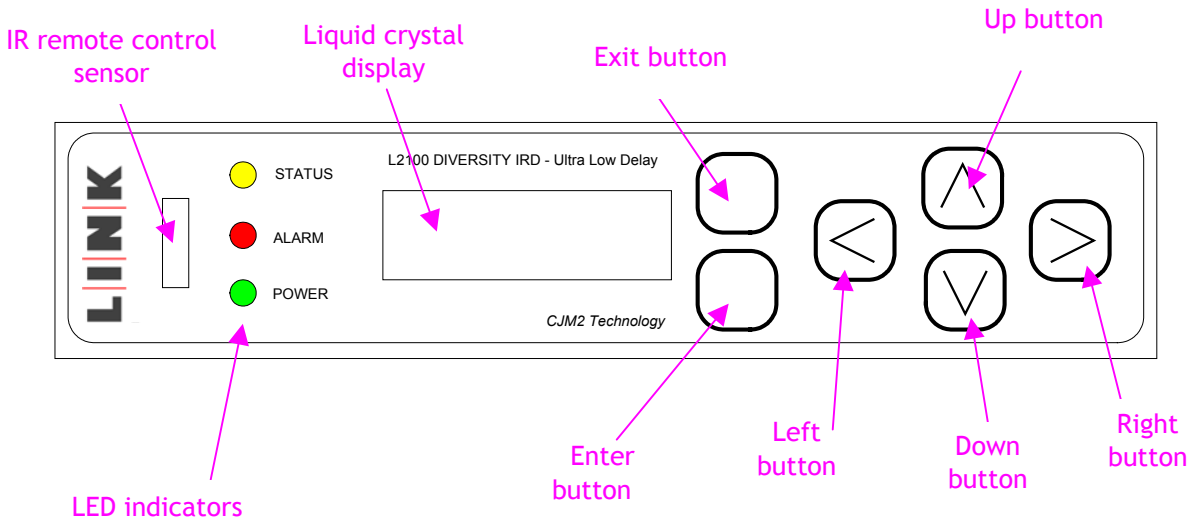

Figure 6 – Controls and displays

Control/Display	Function
Enter button	Allows downward navigation of the menu system Stores system parameters after they have been set
Exit button	Allows upward navigation of the menu system Cancels any parameter changes made restoring the previously stored value
Up button	Allows upward navigation in a sub menu.
Down button	Allows downward navigation in a sub menu.
Left button	Returns the user to a higher-level menu and allows movement to the left when changing parameters within a menu setting.
Right button	Allows movement to the right when changing parameters within a menu setting.
LCD window	Displays menu settings and system status
IR window	Allows receiver set-up using remote infra red controller
Status LED (yellow)	When lit, the receiver is locked to a signal.
Alarm LED (red)	When lit, an alarm has been detected. For details enter the alarm menu.
Power LED (green)	When lit, power is applied to the receiver.

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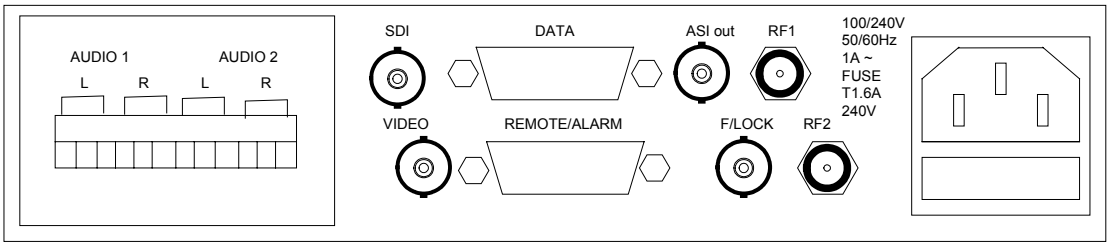

Figure 7 – Rear panel connections

Connector type	Legend	Description
F-type 75Ω threaded socket	RF1 & RF2 (RF3 & RF4 on L2104)	RF input from L3010 down convertor Power output for L3010 22kHz tone output for control of L3010
9-way D-sub socket	Remote/Alarm	RS232 remote control port Alarm signalling
9-way D-sub socket	Data	Data output from receiver
BNC 75Ω bayonet socket	Video	Video output
BNC 75Ω bayonet socket	Frame lock	Delays the output signal by up to 40ms to lock the video frames to an external reference. **NB – colour sub carrier is not locked.**
BNC 75Ω bayonet socket	SDI	SDI output.
Proprieatary	Audio	Two audio stereo pairs or 4 mono channels outputs or 2 digital audio outputs
IEC socket*	Mains 110 –220VAC	Mains power input
4-way XLR panel mounted plug*	DC in	DC power input 9VDC – 32VDC

* Standard configuration is for IEC mains input. The DC input is optional and replaces the IEC socket.

1.4 Getting Started – Plugging up the System

1.4.1 Setting the down convertor gain

Normally, the down convertor gain is controlled from the receiver using a 22Khz tone. If this is not available, then the gain will need to be set manually. To do this it is necessary to open the down convertor casing by removing the two screws along the top edge.

Once the cover is lifted off, all the switches are freely accessible.

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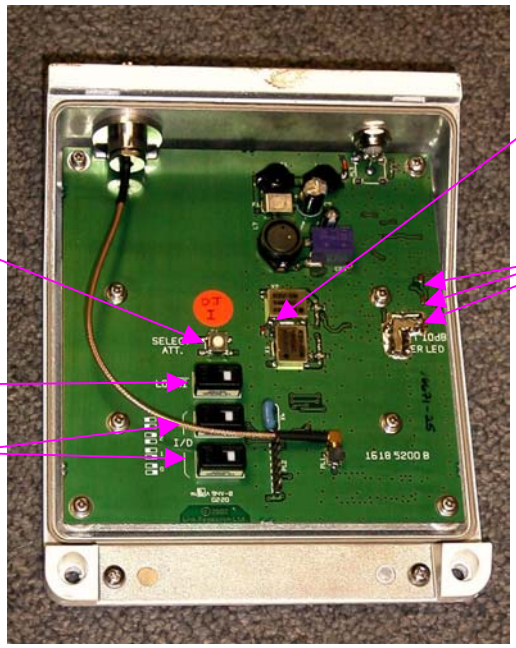

Figure 8 – switches and LEDs inside down convertor

Switch settings are as follows:

Switch	Default setting	Description
Gain setting switch S1	Last setting	Changes the down convertor gain to compensate for losses in the cable to the receiver.
Hi/Lo switch S2	Hi (when lit)	Selects local oscillator to be used by the system.
ID switch S3 and S4	User selectable	See chart below for setting details

The down convertor identity is selected by setting the switches as follows:

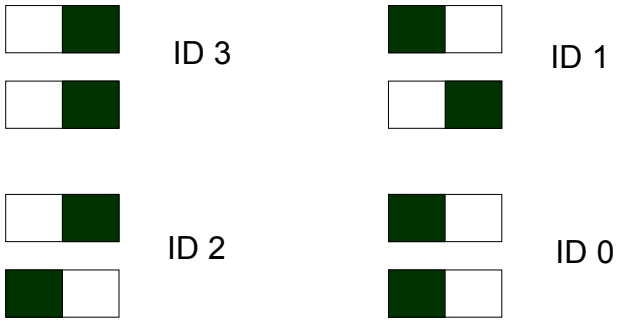

Figure 9 – Down convertor ID switch settings

ID0 should be set for RF1 input, ID1 set for RF2 input, ID2 set for RF3 input and ID3 set for RF4 input.

1.4.2 Non-diversity system

This is the simplest system and the receive side only requires 1 antenna and down convertor to make it work. The performance over short distances will be good, but not as good as a 2

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channel diversity system. For outdoor installations where only a small area has to be covered, non-diversity is ideal.

Generally the antenna should be placed as high as possible and in the clear (see section xx on antennas for more information).

Connect the receive side as shown in the diagram below. Take care to keep all cables away from potential sources of interference and/or damage (see section xx on cables for more information).

NB When connecting up the cables the receiver **must not** be powered up. If the LNB power is active whilst cables are being connected, it is easy to make a short circuit. It is very unlikely that any damage will be done because the LNB power supply is short circuit protected, but it is better to be safe than sorry!

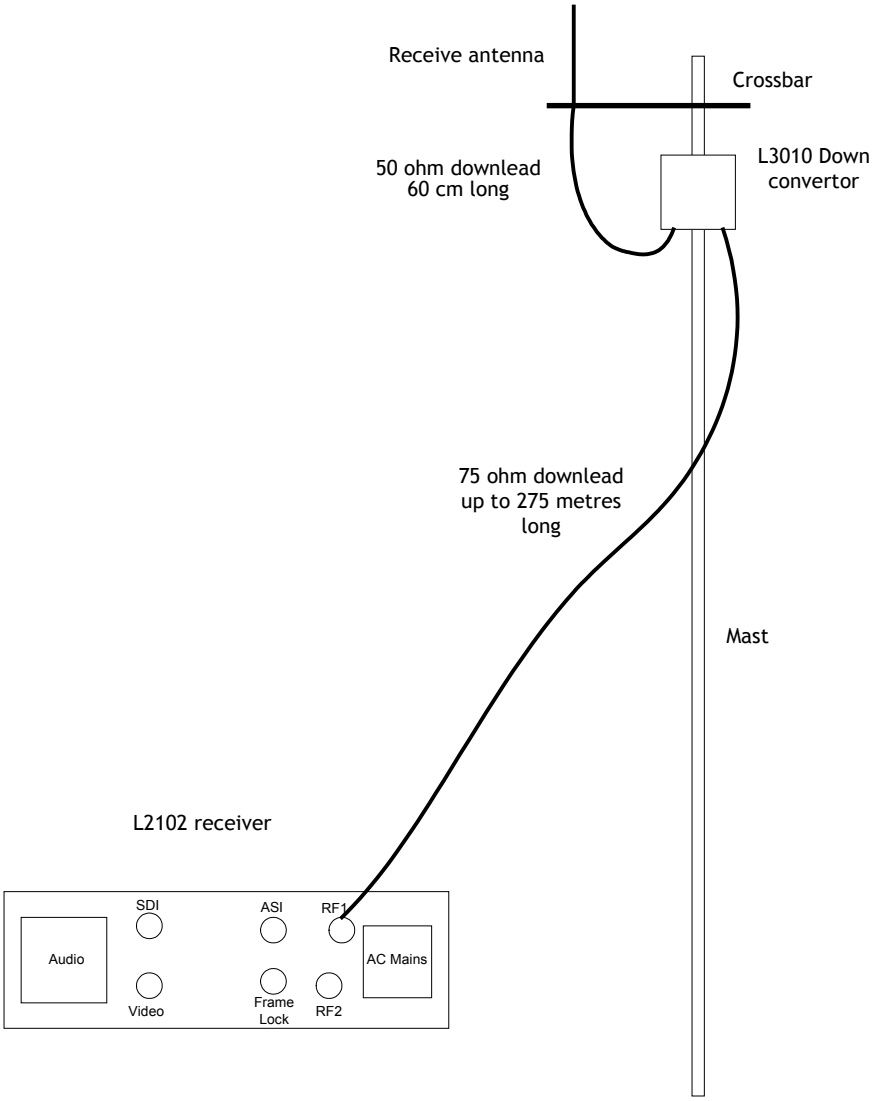

Figure 10 – Non-diversity system

Outputs from the receiver can be taken from SDI out or video out or both and audio from the mulitway connector block. If required, Frame Lock can be connected to synchronise the output with other equipment.

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1.4.3 Diversity system

This is a much more robust system giving better performance than non-diversity especially when the installation is indoors. The transmission range is not increased very much, but performance near the margins of the transmission area is much more robust and RF "black holes" are eliminated.

Generally the antennas should be placed as high as possible and in the clear (see section xx on antennas for more information). The antenna spacing is not critical and can be anything from 10cm to several metres. A little experimentation may be needed to find the optimum spacing in a particular environment.

Connect the receive side as shown in the diagram below. Take care to keep all cables away from potential sources of interference and/or damage (see section xx on cables for more information).

NB When connecting up the cables the receiver **must not** be powered up. If the LNB power is active whilst cables are being connected, it is easy to make a short circuit

Connect the receive side as follows:

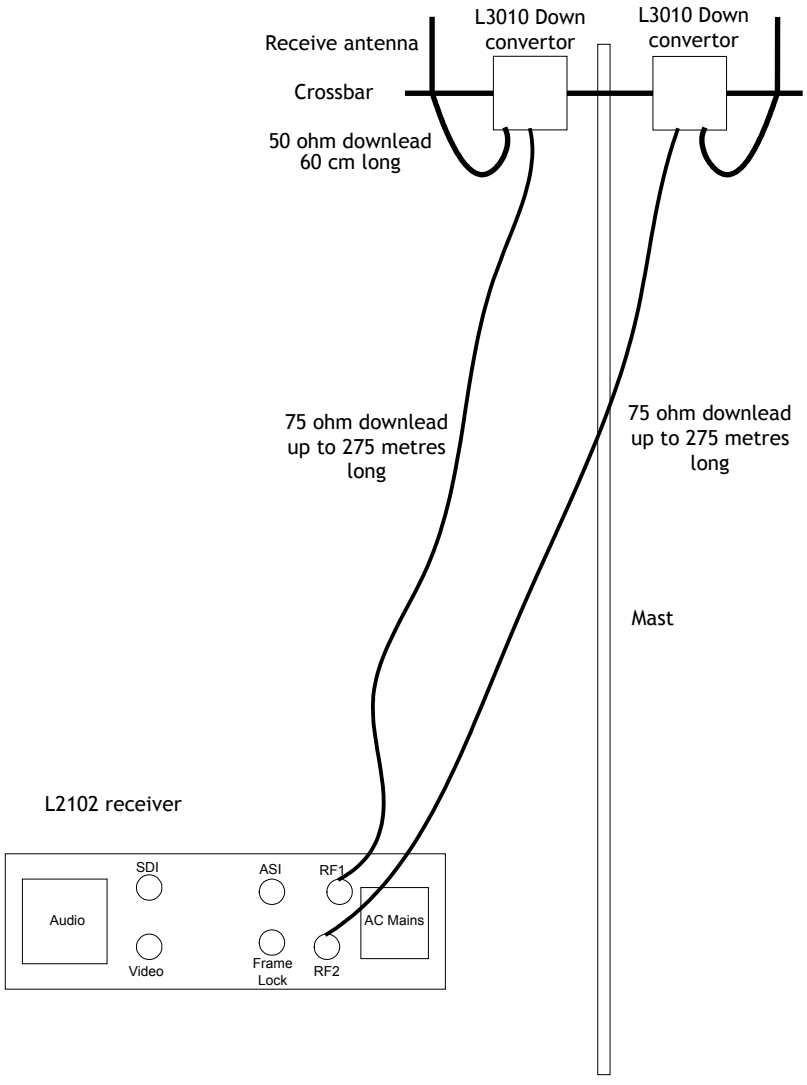

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Figure 11 – Diversity system

Outputs from the receiver can be taken from SDI out or video out or both and audio from the mulitway connector block. If required, a synchronising signal can be input to Frame Lock to synchronise the output with other equipment.

1.4.4 Turning on the transmitter

There is no ON/OFF switch. The transmitter will turn on automatically when connected to a battery providing the battery voltage is at least 11.0V. At voltages below 10.9V the transmitter will not switch on because of the protection circuits. Once the transmitter is switched on, it will continue operating until the battery voltage has fallen to 9.0V when the unit will switch off. The operator will have warning of a low battery condition because the LEDs on the control panel start flashing.

1.4.5 Selecting a profile

The transmitter is supplied with 6 predefined profiles stored in the following locations:

- Location 1 – rugged 625 lines with YUV input
- Location 2 – high quality 625 lines with YUV input
- Location 3 – rugged 625 lines with PAL input
- Location 4 – rugged 625 lines with SDI input
- Location 5 – rugged 525 lines with NTSC input
- Location 6 – high quality 525 lines with YUV input

The rugged profiles use high levels of protection so the video and audio bit rates are relatively low, around 5.5Mb/s, but the signal path is less affected by noise and interference.

The high quality profiles use a greater video and audio bandwidth, around 11Mb/s, with lower level of protection. The signal path is therefore slightly more susceptible to noise and interference. When using a diversity system, little performance difference will be seen between the rugged and high quality profiles.

To select a profile, simply press the Profile button until the LED adjacent to the required memory location is lit. Each button press will increment the memory locations by one until 6 is reached. The next press will select location 1.

Full details of the profile settings are given in Section 3 – Technical Reference.

1.4.6 Turning the RF on and off

Press the RF button once. The RF indicator LED lights when RF is being transmitted.

When RF is being transmitted pressing the RF button will stop the transmission and the RF indicator LED will go out.

NB Changing the profile when the transmitter is radiating RF will turn the RF off. To continue transmitting, press the RF button. The RF indicator LED will illuminate.

1.5 Changing the transmitter output frequency

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1.5.1 Toggling the unit between RS232 and Infra Red mode

The control interface can be set to either RS232 or Infra Red. To switch from one mode to the other, power down the transmitter, hold down the RF button, and power up the transmitter again. Keep the RF button held down until all the LEDs are on. The transmitter will have changed its control mode.

To set the transmitter back to the original mode, repeat the procedure outlined in the paragraph above.

1.5.2 Using Link Control (diagnostic) software

As supplied, the transmitter output frequency is set to the centre of the band. If it is necessary to change this, the Link control software is needed. See Section 3, Technical Reference, Loading Link Control Software onto a PC for details of how to set the software up.

Also required is the Data/Remote lead (supplied with the unit), a 9-way D-sub female/female adaptor and a straight serial cable (minimum connection pin 2 to pin 2, pin 3 to pin 3 and pin 5 to pin 5).

Set up the equipment a shown in the diagram below.

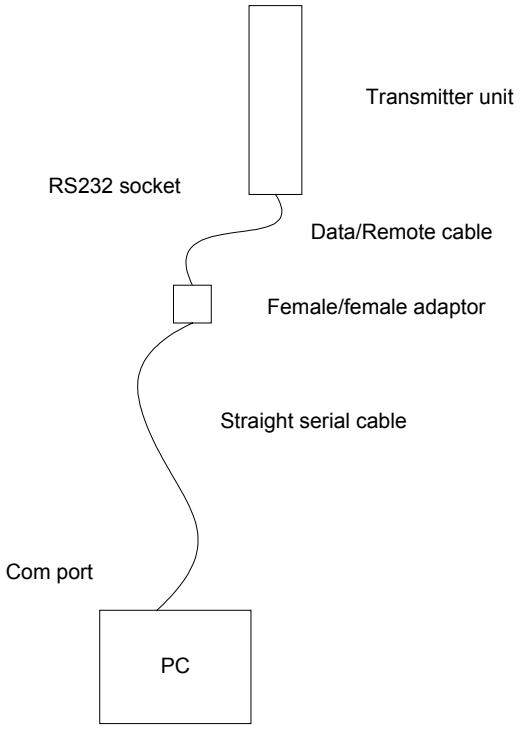

Figure 12 – Connections for changing transmitter frequency

Make sure the computer COM port is correctly configured as shown below.

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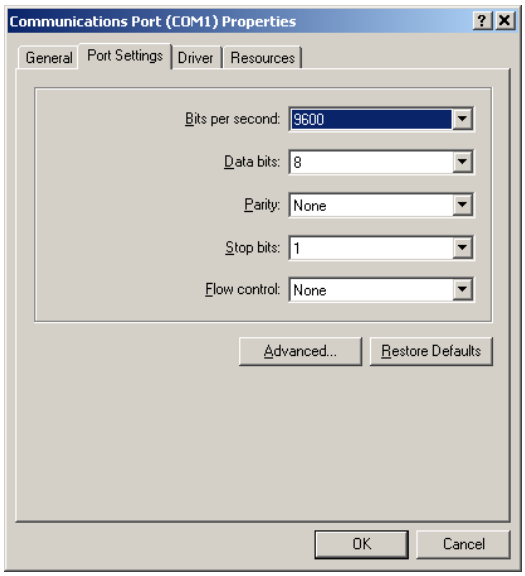

Figure 13 – Com port settings

Turn on the transmitter unit and select the profile whose transmit frequency you want to change. Open the Link Control software and a screen like that shown below will be displayed.

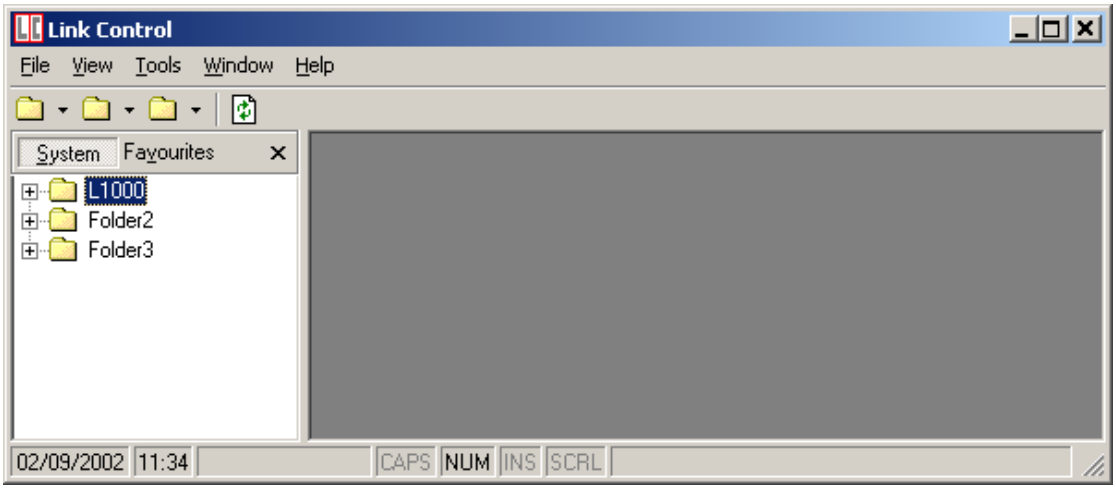

Figure 14 – Top-level screen for Link Control Software

Double click the L1000 folder to open:

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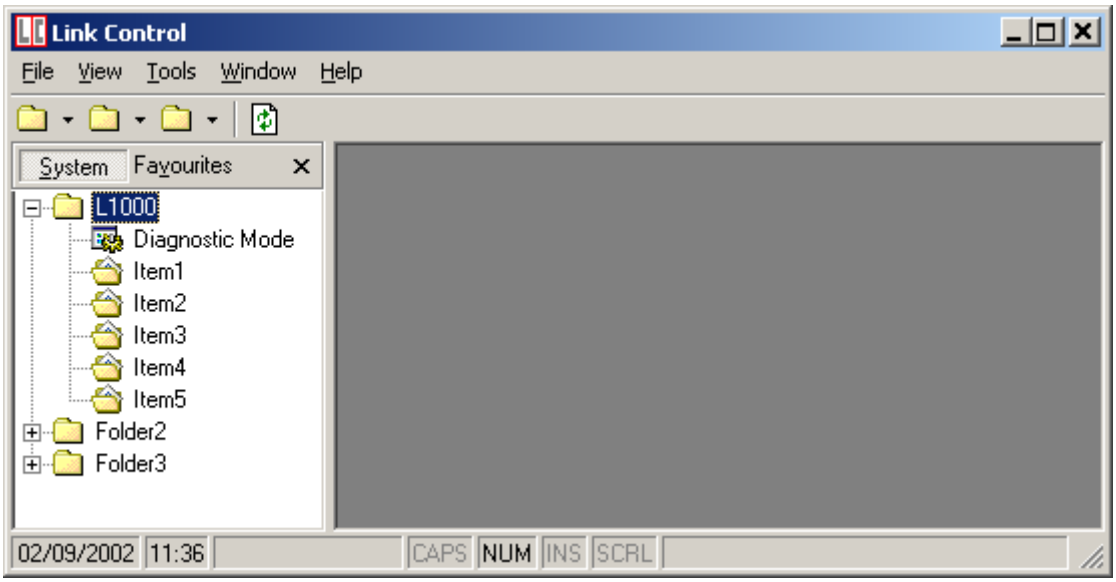

Figure 15 – L1000 folder opened

Now double click Diagnostic mode and the control interface will open as shown in the diagram below. Set the COM port parameters as required.

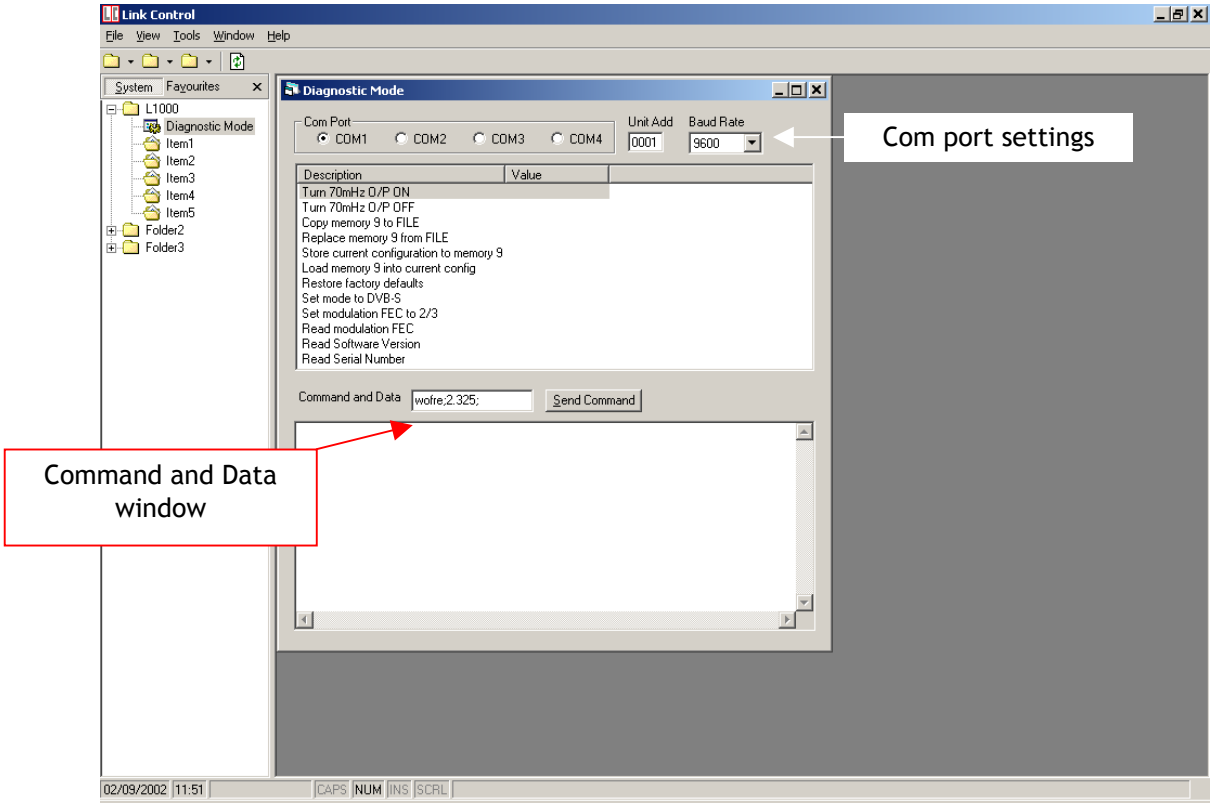

Figure 16 – control interface window – 2.325GHz is the frequency being set

In the command and data window, enter the following command:

`wofre;x.xxx;`

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where x.xxx is the required transmit frequency in GHz and then click the Send Command button. The new frequency is now stored in the memory and can be checked by sending the command:

```
rofre;;
```

This will read back the transmit frequency.

N.B. – Do not turn off the transmitter or the new frequency will be lost. It must now be stored in the profile setting.

To store the frequency as part of the profile data, type the following command in the Command and Data window:

```
wdsto;x;
```

In this command, x is the profile number (1 to 6) that the data will be stored in. Once this has been successfully completed, the transmitter can be powered down. When it is powered up again, it will use the new frequency setting.

For full details of the remote control protocol, see Section 3 Technical Reference Remote Control Protocol.

1.5.3 Using the Link Control Software option

This uses a graphic user interface, GUI, allowing the User to set a number of related parameters and then apply them to the transmitter with one mouse click. The software requires a licence key to be issued by Link Research before it will operate. See the Instruction Manual for the Link Control Software Option for full details of how to install the software, obtain a licence key and operate the software.

The PC is connected to the transmitter as shown in Figure 12 above. Once the Link Control software is running, select the Control folder to run the application. See the Software Instruction manual for full details.

N.B. – Do not turn off the transmitter or the new frequency will be lost. It must now be stored in the profile setting. Select the **Memory** option from the list and enter the appropriate settings before saving them.

1.5.4 Using the infra red, IR, interface

The transmitter must be set to infra red mode before the Compaq can "talk to" the IR port. See section 1.5.1 above for detail so of how to change the control interface mode.

Turn the Compaq on and from the Start menu, select the LinkIR option and tap with the stylus. The screen will change to something like that shown below.

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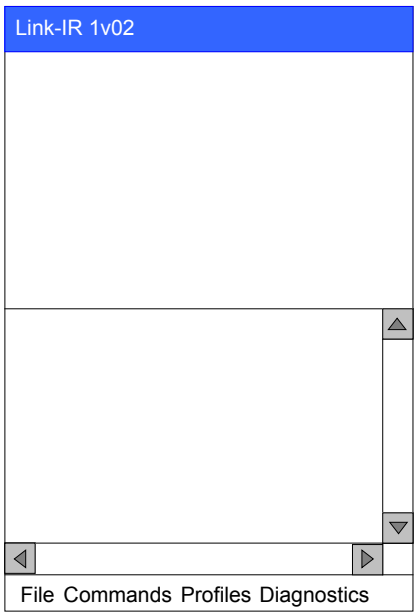

Figure 17 – Compaq pocket PC

Figure 17 – Top level screen of Link-IR software

Hold the Palm about 30cm away from the L110x transmitter so that there is a clear path between the two devices. Using the stylus, tap the file option (bottom left of the screen) and a sub menu will open looking something like that shown below.

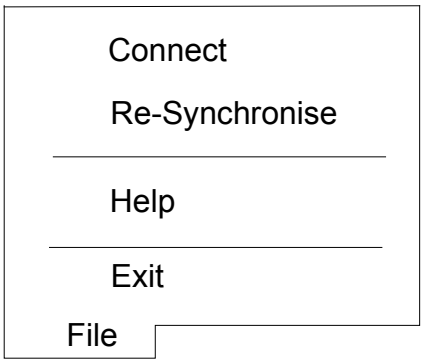

Figure 18 – File menu options

Select "connect" from the options and communication will be set up between the two devices. Once communication is established, the screen will change to look something like that shown below. Providing the path between the two devices is not lost, the units will continue to exchange data. Should the path become lost, selecting Re-synchronise will re-establish the communication link.

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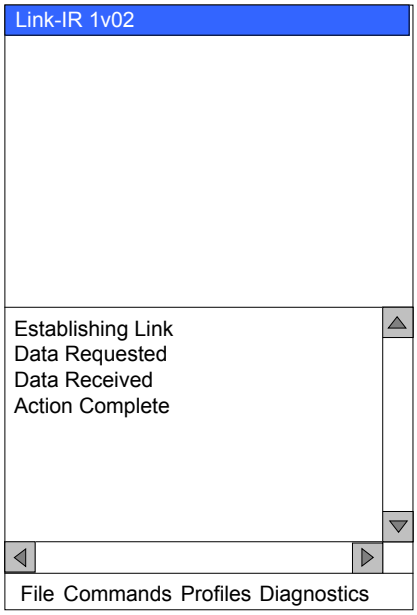

Figure 19 – IR communications established

To change the transmitter frequency, select the Commands option at the bottom of the screen and a sub menu will open with the following options.

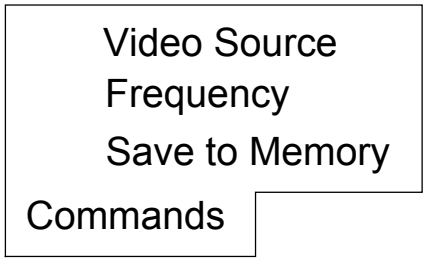

Figure 20 – Commands sub menu

From the options, select Frequency and the iPAQ will interrogate the transmitter and display the currently set frequency. The screen will look something like the illustration below.

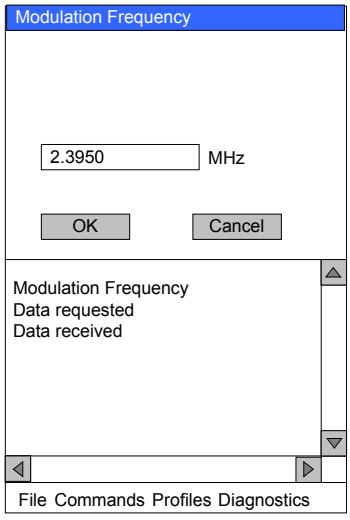

Figure 21 – Frequency menu

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To change the frequency, tap the keyboard icon at the bottom right of the screen and a QWERTY keyboard will be displayed. Type in the required frequency which will be displayed in the box at the top of the screen. To close the keyboard, tap the icon at the bottom right. To set the frequency into the transmitter tap the OK box and wait until the display shows "Action completed". If the screen shows "Timed Out Action not completed" it will be necessary to go to the file menu and select "Re-synchronise" to re-establish communication between the two devices.

N.B. - Do not turn off the transmitter or the new frequency will be lost. It must now be stored in a profile setting.

To store the modified profile in memory, select the Commands menu and a sub menu will open containing three items as shown below.

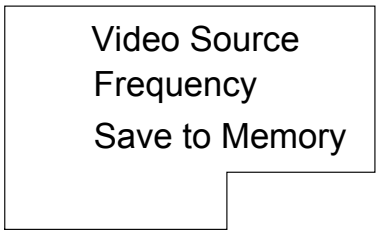

Figure 22 - Profiles sub menu

Select Save to Memory and enter the profile number (1 - 6) by using the keyboard (icon on bottom right corner) and then click OK.

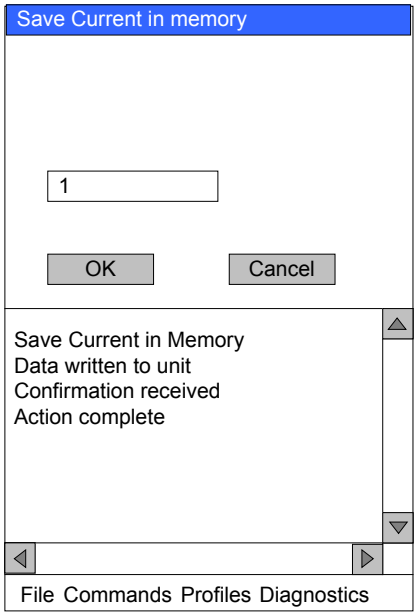

Figure 23 - saving the current settings to a memory location

If the action is successful, the screen will look like that shown in figure 23 above.

1.6 Turning on and setting up the receiver

There is no ON/OFF switch, so plugging in the power cable will turn the receiver on. **NB; connect the antenna cable(s) and L3010(s) before turning the unit on.**

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Once the unit has booted up, the display screen will look something like the illustration below.

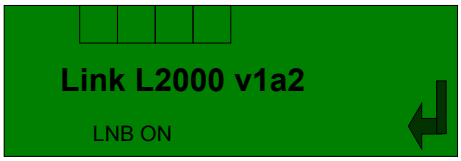

Figure 24 - top-level menu screen just after boot up

If a valid input signal is present, the amber STATUS indicator will light: if there is no valid input signal, the red ALARM indicator will be lit.

To enter the menu system, press the button nearest the bottom right corner of the display. The display will now look something like the illustration below.

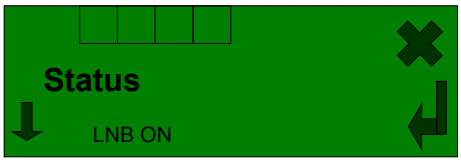

Figure 25 - Status menu top level

Press the down arrow until the down **unit** menu is shown and press enter to select it. Press the down arrow until the down convertor type menu is displayed. The display will look something like that shown below.

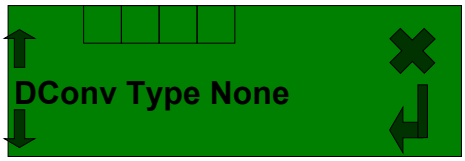

Figure 26- down convertor type menu

Pressing the enter key, , allows access to the following options:

- L3010
- L3010MK2
- Other
- None

Select according to the type of down covertor to be used with the system. Once selected and confirmed with the enter key, , the display will change to indicate the type selected.

Now go back up the menu until the diversity setting menu is displayed.

Figure 27 - Diversity setting menu

Pressing the enter key, , provides a sub menu with the following options:

- Diversity
- Dual Diversity
- Remux
- Single

To select the required option, press the enter key, , when the option name is displayed in the window. Then press the exit key, , to return to the upper level.

If a down convertor other than an L3010 has been selected, it will be necessary to go to the down convertor local oscillator set up page. The display should look something like the illustration below.

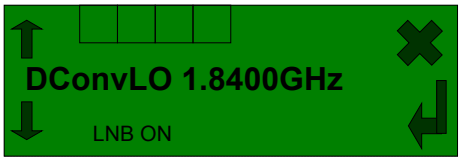

Figure 28 - Down-convertor status screen(shown for L3010)

To change the local oscillator setting, press the enter key and change to the new value. Press the enter key again to store the new setting and then press the escape key to return to the **Demodulator 1** menu.

NB. It is not possible to use down convertors of mixed manufacture in a diversity system.

Next, the **Input Frequency** must be set. At the Demodulator 1 menu, press enter and the Input Frequency page will be shown and will look something like the illustration below.

Figure 29 - Frequency changing display

To change the frequency, use the right button to move the block cursor over the number to be changed and then use the up or down arrows to scroll through the numbers until the required number appears. To accept and start using the changes, press the enter key . To reject the changes and go back to the top of the frequency menu, press the escape key .

If the unit is working in Diversity mode, it is not necessary to make settings for Demodulator 2 as these are automatically carried forward from the Demodulator 1 menu.

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Next, use the down arrow key to select the LNB power menu. The display will look something like the illustration below.

Figure 30 – LNB Power Screen

Pressing enter allows two selections to be made:

- Yes
- No

Select the required status by pressing enter, , and the display will be updated to indicate the status.

The unit should now be locked to the incoming signal. If it is not, go back and check the settings made above.

Next go to the **Decoder** menu.

The screen will look something like the illustration below.

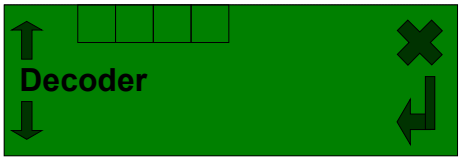

Figure 31 - Decoder screen

Use the down arrow key until a list of available services is displayed and select the required service. Press the enter key to confirm the selection.

Now go to the Audio A menu where the current status will be shown and may look something like the illustration below.

Figure 32 - Channel A audio status

In the illustration above the status is analogue. To change this to digital, press the enter button, , select digital and confirm the selection by pressing enter again.

Channel B audio is set up in the say way from the Baudio O/P menu.

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If the signal being received is scrambled, it will be necessary to set up the descrambling menu. To do this select the descrambling menu (6 down arrow presses from Status) and a screen like the illustration below will be shown.

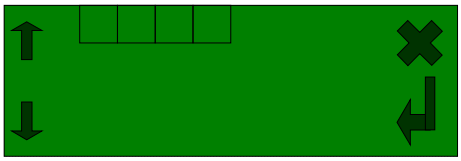
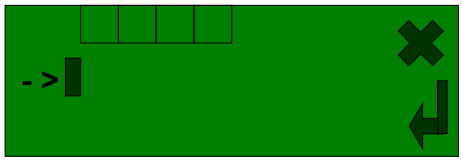


Figure 33 – Descrambling screen

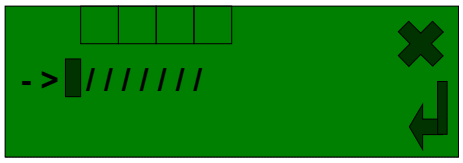
By using the up or down arrow the following options are available:

- Descrambling Off
- EBS Key "

If EBS Key " is selected one of the following screens will be displayed:



Screen when no previous EBS key has been entered



Screen when a previous EBS key has been entered

Figure 34 – EBS key change screens

The EBS key is an 8 digit hexadecimal number. To enter it, use the up arrow to scroll through the numbers 1 – 9 and letters A – F. Once the required character has been selected, use the right arrow key to move the cursor to the next position. Repeat the selection process until the next character is shown. Once the complete key is displayed, press the enter key, , to store this in memory.

NB. It is possible to select characters outside the range of 1 – 9 and A – F, but such a selection will be rejected when the enter key is pressed.

Once the receiver is set up, go to the Status menu and press enter, , and a screen like the illustration below will be displayed.

Figure 35 – Signal strength status display

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The bar graphs give an indication of the relative signal qulaity received at each antenna. In operation it is quite normal that the bar graphs fluctuate wildly.

If the receiver is to be powered off, the settings will be retained in the current memory. When powered up again, it will use these settings unless another memory is recalled to the current memory. It is therefore good practice to save the set up to one of the nine memories so that it can be recalled easily. To do this, enter the Memory menu (one down from Status). The top-level screen will look something like the illustration below:

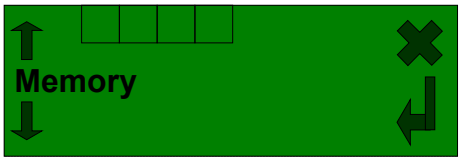

Figure 36 – Memory menu top level

Press the enter key and the screen display will change:

Figure 37 - Store config screen

Press the enter key and the screen will change again to:

Figure 38 – Second level of storing a configuration

Pressing the down arrow scrolls through the numbers 1 – 9 and the up arrow 9 – 1. Once the desired memory is selected, press the enter key and all the settings will be stored for easy recall.

To recall a previously stored configuration, go to the Memory menu, press enter and then use the down arrow to select the Load config option. The screen will look something like the illustration below:

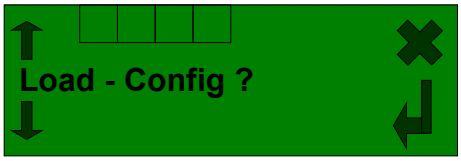

Figure 39 – The load config screen

Press enter and the display will change to something like the illustration below:

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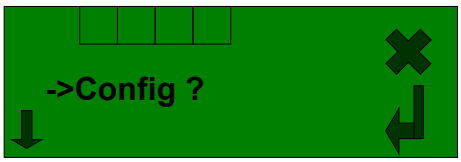

Figure 40 - Configuration selection screen

By using the down arrow, memory locations from 1 – 9 can be selected. Using the up arrow allows memory location selection from 9 – 1. Once the desired memory has been selected, pressing,  , will store the setup data in that location.

1.7 Connecting the camera

The method of connecting the camera video output to the transmitter unit will vary according to the make and model of the camera. Some cameras will require custom built harnesses like that shown below. Others will be able to use short lengths of BNC to BNC coax for the video.

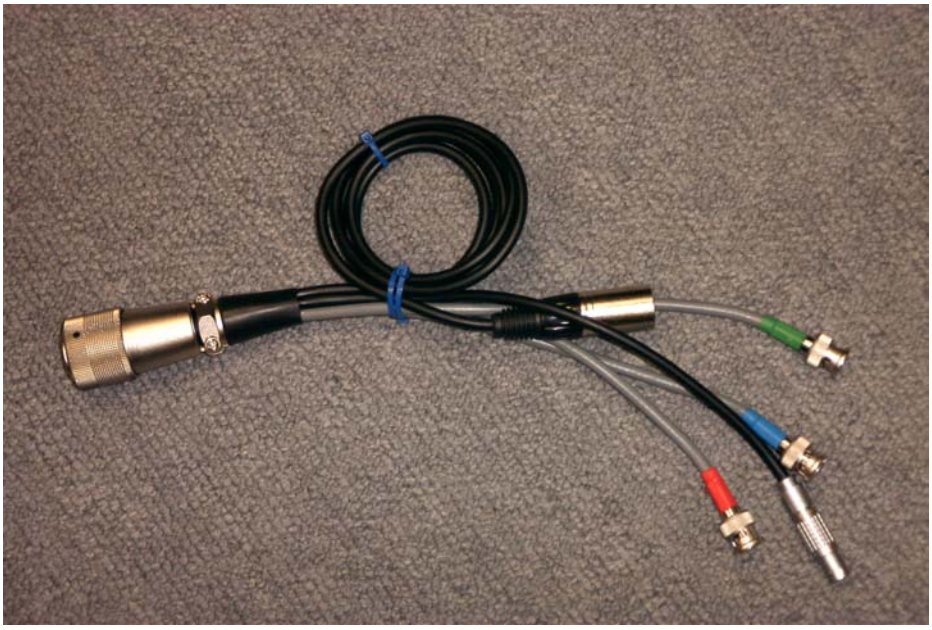

Figure 42 - Input harness for triax connector

The audio will require a special connection no matter what the make of camera because the audio input to the transmitter is via a 5-pin Lemo connector. A lead must be made up as follows using the two supplied connectors:

Pin 1 L+, pin 2 L-, pin 3 ground, pin 4 R+, and pin 5 R-

Further details of the audio interface are given in the technical specifications in Annex 1.

Power is taken either directly from the battery or from an auxiliary power connector on the camera. A power input lead is supplied, but will require the correct termination for the camera to be put on the other end. On the supplied lead, red is +ve and black ground (-ve).

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Section 2 - More Advanced Operation

2.1 Antennas

A good understanding of how antennas work and their limitations is necessary to maximise the performance of the LinkXP Wireless Camera System. LinkXP uses the COFDM modulation method that has a big advantage of being immune to multipath propagation. As a result the antenna requirments are very different to those for analogue systems which rely heavily on directional antennas to get good performance. The following section gives some good background information with some practical examples of antenna setup.

2.1.1 The transmit antenna

One of the greatest advantages of using the Link XP Wireless Camera System is that it gives the cameraman complete freedom to move without little restriction. He cannot necessarily predict from moment to moment which way the camera will be pointing or where he will be standing. On the other hand, the receiver antenna(s) is static so a good path between the two at all times is required. This demands that the transmit antenna has omni directional capabilities and a reasonable horizontal angle to cope with different camera attitudes as it is pointed up or down. Such an antenna will have a doughnut type radiation pattern around the antenna as shown in the diagram below.

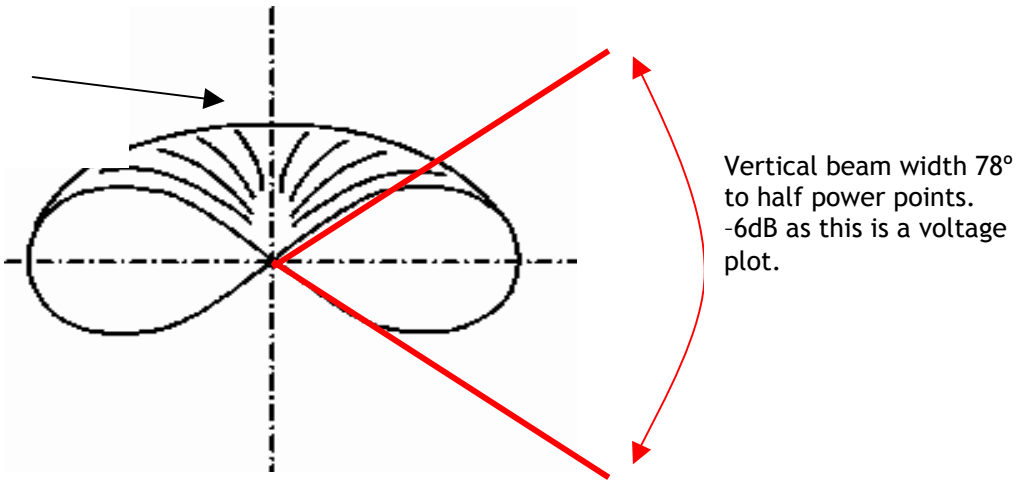

Figure 43 - Ideal radiation pattern for transmit antenna.

It makes little sense to use an antenna with gain as the transmit antenna unless the transmit path is fixed or will only vary by one or two degrees. Antennas with gain do not have amplifiers; they are completely passive, but fold the radiated power into a narrow beam. Thus the power density is concentrated and has the effect of allowing the signal to travel further before it becomes so weak that it is lost in the general noise floor. As can be seen from the diagram below, the narrower the beam width, the greater the gain.

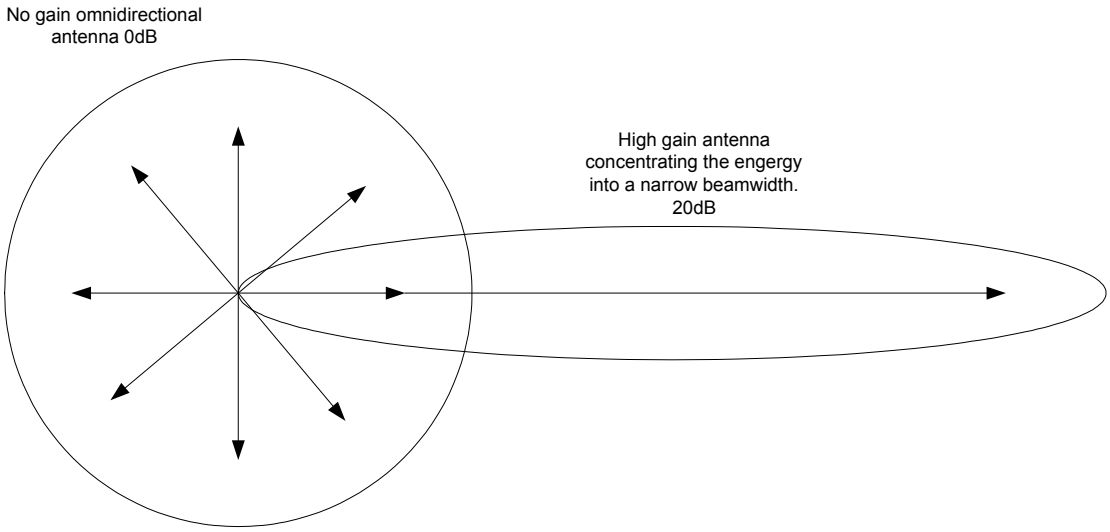

Figure 44 – radiated energy and antenna gain

2.1.2 The receive antenna

The requirements for the receive antenna are rather difficult. Normally these antennas will be located on the edge of the area of activity and will "look" inwards. It is therefore advantageous if their performance can take advantage of this by only taking signals from their "front". In analogue systems this can be done by building Yagi arrays or using horn type antennas that are very directional and give good performance because they reduce the effect of multiple path signals by eliminating them. If the transmitter is moving, there must be an operator to steer the receive antenna so that it tracks the transmitter accurately. Any mismatch between the paths will result in complete signal loss or partial break-up of the picture if the signal is on the beam margin. In reality, there are probably several hundred reflected signals that result in nulls in the received signals.

In a digital system, especially a system using COFDM, much of the performance gain comes from using multipart reception. As a result there is no need for an operator to track the transmitter: a fixed antenna works as well because the receiver uses the multipart or reflected propagation to rebuild the signal.

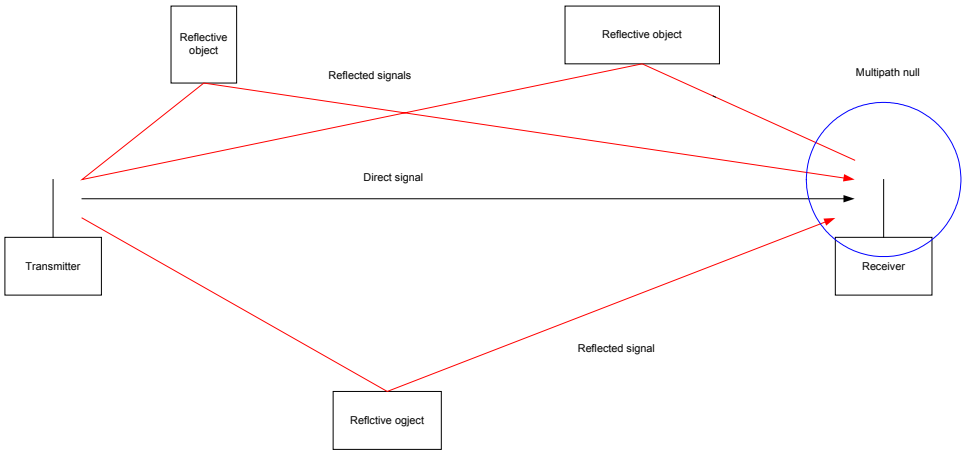

Figure 45 – multipath signals and the null zone

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The vertical beamwidth of the receive antenna still needs to be fairly high and for a football or sports stadium, 80º will be very effective. If this can be combined with a horizontal beamwidth of around 107º this would suit most applications. Such an antenna would be described as having +6dBi gain. The polar diagrams of such an antenna are shown below.

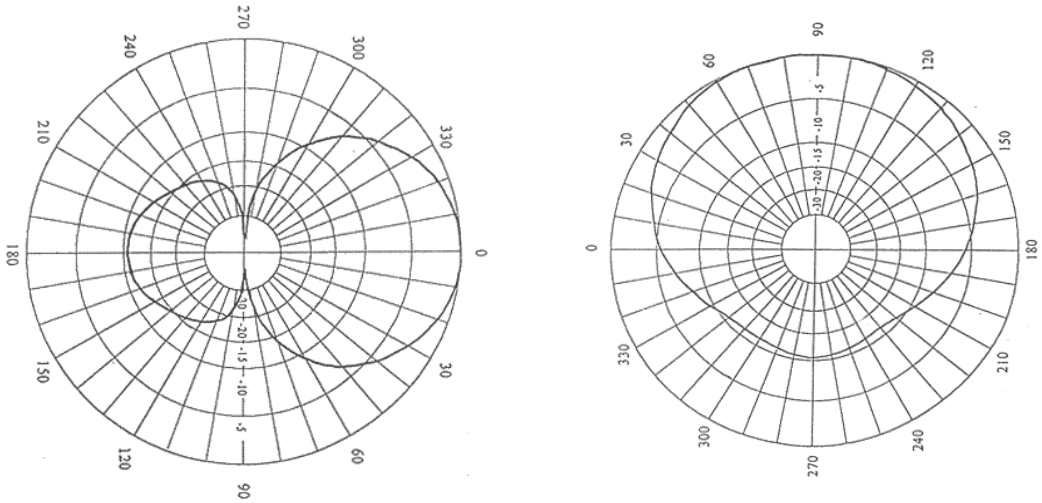

Figure 46 - Polar plots for ideal receive antenna with +6dBi Vertical on the left and horizontal on the right

One such antenna should give good coverage of a sports stadium if mounted as shown in the diagram below;

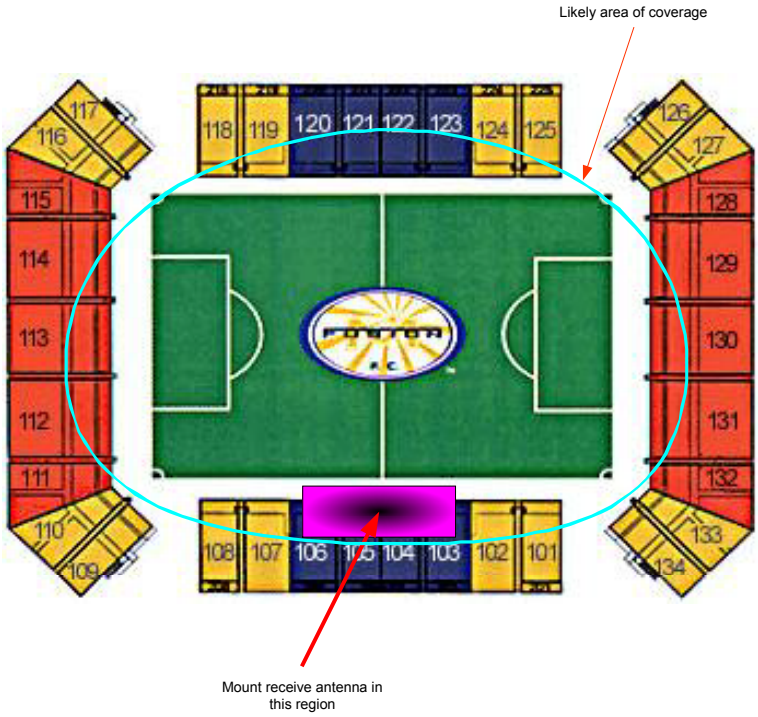

Figure 47 – mounting a single antenna in a stadium

Mounted in this way, the antenna will be able to "see" virtually all the stadium except perhaps the two corners nearest to it.

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2.1.3 Diversity antennas

Using diversity antennas, considerable performance gains can be made in a number of ways. The classical deployment of diversity antennas requires two antennas to be mounted 11 x ¼λ apart. For a transmitter operating at 2.5GHz the theoretical spacing is around 33cm, but equally good results can be obtained with spacing up to 1 metre. If it proves difficult to arrange this, greater spacing can be used with very good effect.

Using the example shown in figure xx above, the two antennas would be mounted side-by-side near the centre line and high up in the stadium structure.

Diversity reception is not just confined to two antennas. By using a Link 2104 receiver, up to 4 antennas can be used and the receiver will take the best signal to build its output. This has considerable advantages if the camera is required to track players' progress from the dressing room down the tunnel and out onto the pitch. By placing antennas in the dressing room, half way down the tunnel and in the normal positions for covering the pitch, excellent results can be achieved.

Figure 48 – Link L3010 with complimentary directional antenna mounted on the front

2.1.4 LinkXP and other Manufacturers' antennas

The LinkXP wireless camera system will work with antennas of non-Link manufacture, but as many of these are based on lossy printed circuit elements and thin coaxial cable, performance may be disappointing.

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2.1.5 Mounting antennas

Four general rules should be applied to all antenna installations:

- Mount antennae as high as possible. A couple of metres can make a considerable difference.
- Keep antennae in the clear especially the transmit antenna. The human body is 80% water and is a good RF attenuator so the antenna should be above head height to be most effective. Although COFDM relies on reflections, the receive antenna needs enough clear space to be able to "see" the different radiation paths.
- Test a number of different locations. On the day of the live transmission, the RF characteristics of the environment may have changed significantly e.g. a stadium with a capacity crowd is very different to when it is empty.
- Use only good quality cables and keep them as short as possible so that maximum signal is available.

It is most likely that LinkXP will be used in temporary locations so jubilee clips, cable tie wraps, gaffer tape etc are likely to be used. So long as the antennae are held firmly and vertically, they should work well.

2.1.6 A some practical examples

Example 1

The requirement was for coverage of a rugby final in a national stadium. The Director wanted the following:

- Coverage of the pitch for all the match action and the pre-match entertainment
- Pictures of the teams in the changing rooms before the match, during the interval and after the game
- Pictures of the teams leaving the dressing rooms and running down the tunnel onto the pitch. (The tunnel was about 100 metres long and underneath the main stand).
- Touchline cover of the match and close-ups of interesting incidents
- Close-ups of the celebrities in the main stand
- On pitch post match celebrations and interviews

It was decided to use 3 antennae to give coverage of the event. No permanent cabling was available so cables had to be run in specially in a very limited time. Antennae were mounted vertically on microphone stands about 1.7metres above ground level giving good horizontal omni directional coverage. Locations of the antennae were as follows:

- One near the corner flag
- One near the tunnel entrance adjacent to the pitch
- One at the end of the tunnel near the changing rooms

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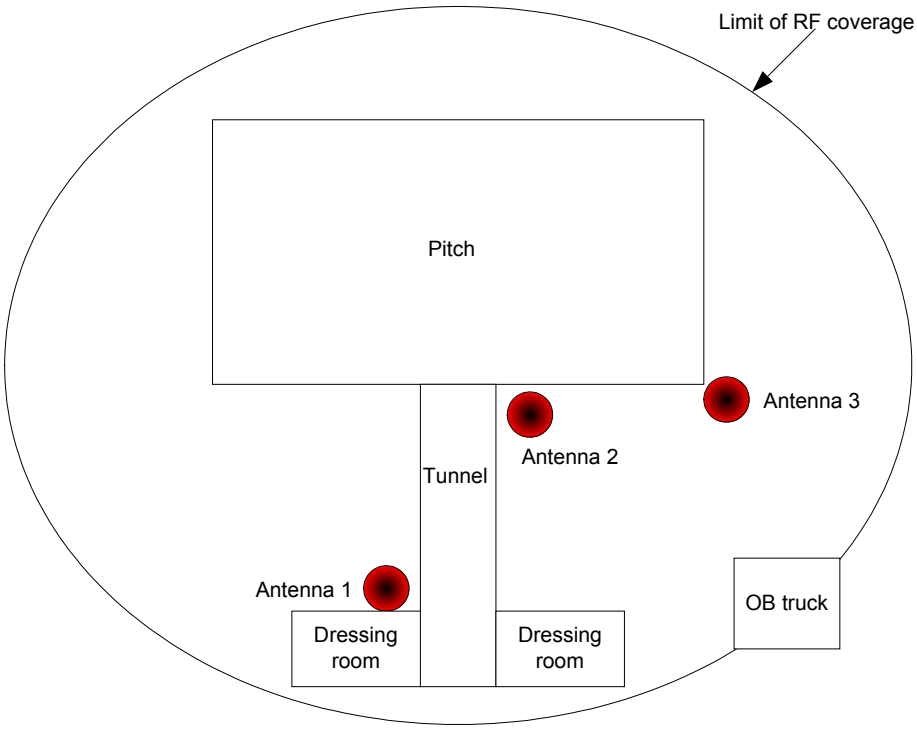

Figure 49 – Coverage at Stadium Australia

During the broadcast QPSK modulation was used for coverage in the tunnel and changing rooms using Antenna 1 and Antenna 2 for diversity. During the match the modulation was switched to 16QAM using Antenna 2 and Antenna 3 in diversity. For the post match interviews, the video input was changed from YUV to SDI with embedded sound.

Post match debrief found the following points of interest:

- Antennae need to be mounted as high as possible and would have given a bigger area of RF coverage.
- Temporary antenna mountings need to be away from potential crowd tampering
- Cables from down convertors to receiver can be up to 300 metres if using the correct type of cable
- The distance between antennae is not critical for diversity reception.
- It is a great advantage to be able to try out a number of alternative antenna locations to determine optimum performance positions

Example 2

The requirement was for coverage of a major international yachting event. The Director wanted the following:

- Coverage of start and finish of races
- Close-ups of individual boats during races
- General shots around the marina
- Interviews with celebrities in boats and in the clubhouse

Some programme material was filmed and edited during the day, but the majority of the material was to be used for live national broadcast during sports programmes.

The event was covered by an OB truck parked on the quayside with a marina in front of it. The marina was protected by a harbour wall separating the mooring area from the racing

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area. To the rear was an open space flanked by a built up area of boathouses, warehouses and general buildings. Very few line-of-sight propagation paths existed.

The two antennae were mounted on a crossbar on the top of a 7-metre pump up mast. Initially they were left hanging below the bar so that they were in free space. However, it was found that the wind disturbed them too much so they were firmly fixed onto the crossbar alongside other existing antennae.

The cameraman was based in a small rigid inflatable dingy and moved freely around the water both in and out of the marina. Live coverage of racing was reliably achieved at distances of up to 1½km. Interviews were held both inside and outside the clubhouse.

Figure 50 – Link directional antennas in diversity rig

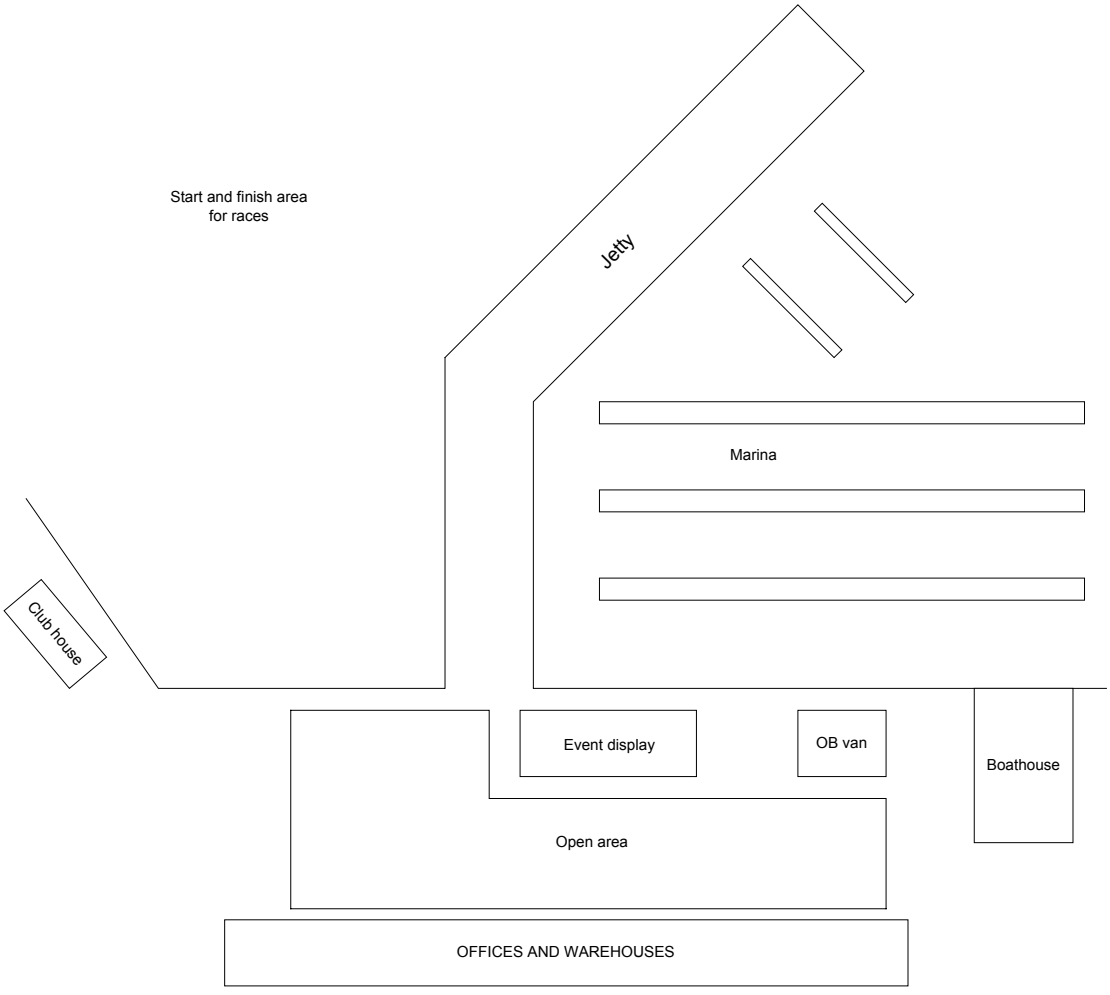

Figure 51 – Layout of harbour area for yachting event

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Figure 52 – Link omnidirectional receive antenna mounted on L3010 down convertor

2.2 Cables

2.2.1 Why should I be concerned about cables?

The LinkXP wireless camera system uses very low power transmissions with a maximum effective radiated power of around 100mW. To make the most of this, it is vital that the correct cable types are used and that they are treated with respect. A damaged cable of the correct type may give inferior performance to good cable of the wrong type and both will provide less than acceptable results.

2.2.2 Cable impedances

Two different cable impedances are used in the LinkXP wireless camera system. All the higher frequencies, measured in GHz, use 50Ω nominal impedance cable. These are the cables directly connected to the antennae; from the transmitter to the transmit antenna and from the receiving antenna to the down convertor.

The second cable impedance that is used is 75Ω for the cable used between the down convertor and the receiver and the receiver output to the monitor or other display device. If the wrong cable is used, there will be an impedance mismatch that will result in the generation of standing waves on the cable and consequent loss of power.

2.2.3 Cable losses

Besides the characteristic impedance, cables are measured on the losses they incur as the signal passes along them. Therefore the lower the cable losses, the greater the cable length that can be used. To get the best performance from the LinkXP wireless camera

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system, only low loss cables must be used. Whilst these are more expensive than lossy cable, the performance gain is worth the extra cost.

Low loss cables generally have a foam dielectric whereas more lossy cables have a solid dielectric. Also low loss cables usually have more copper in their conductors than lossy cables.

The cable from the down convertor to the receiver is the most critical in terms of loss because this is normally required to be 10s of metres long. The maximum loss that can be tolerated on this cable length is 43dB. To find out what this equates to in the real world, look up the attenuation per 10 metres at 900MHz in the manufacture's data tables. Dividing this figure into 43dB will give the maximum cable length in 10s of metres.

2.2.4 Cable types

Ideally the receive antenna should be mounted directly on the down convertor (see figure xx). Where this is not possible, the shortest length of cable should be used to minimise the losses. A low loss heliax such as Andrew type LDF450 should be used. This is a ½" thick cable using foam dielectric and solid copper outer. Other similar low loss thick cable can be used.

For the cable between the down convertor and the receiver, a low loss foam dielectric such as Comscope RG59 or RG11 should be used. Using these cables will allow a 200 metre run with RG59 and 300 metres with RG11.

Where the output from the receiver is SDI and cable lengths of greater than 5 metres are to be used a line driver will be required to equalise the signal on the cable. This will allow cable lengths of up to 300 metres to be used. A suitable line driver is the AGA video type D5DA as shown in the illustration below.

Figure 53 – AJA video line driver type D5DA

Only use cables whose electrical characteristics and type numbers are known. Other cables may give poor performance at best.

2.2.5 Care of cables

Using the correct type of cable is still no guarantee of success if the cables are not given the care and respect they require. The worst enemy of coaxial cables is moisture. Any ingress of moisture will physically degrade the cable causing corrosion that will change the cable's characteristic impedance. All terminations must therefore be sealed against water penetration and any cable whose outer sheath is damaged should be thrown away. For any cable that is used outside, it is advisable to fit waterproof boots to the terminations to prevent water getting into the cable dielectric.

When not in use, cables should be coiled on drums or in a figure-of-eight to equalise the stresses on the cable construction and terminations should be capped to prevent damage to the connector as well as moisture ingress.

When installing cables either permanently or temporarily two simple rules should be followed:

- Do not place pressure on the cable (cable ties too tight or heavy objects holding it down) as this deforms the dielectric causing a change in characteristic impedance leading to standing waves being generated over the cable length.
- Do not bend cable round too tight a radius at corners. General rule of thumb is that the minimum radius of the bend should not be less than 6 times the diameter of the cable. For example an RG59 having a nominal diameter of 6mm should not be formed into a radius of less than 36mm.

2.3 The Receiver

2.3.1 The Receiver Menu Structure

The diagram below shows the function of the front panel controls and displays necessary to operate the receiver.

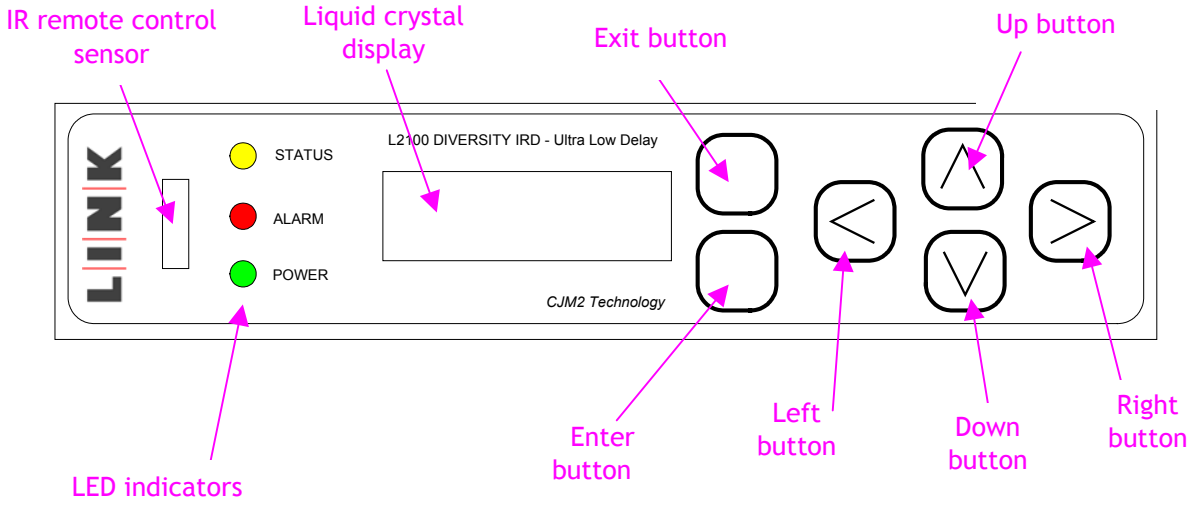

Figure 54 - Controls and displays

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The receiver menu structure is described in the following table. Entries in **bold** are factory default settings.

Menu section	Available options	Sub Options	Comments
Status	None	None	A bar graph display is used to show relative received signal strengths at the antenna inputs to the receiver. Rapid fluctuations in level are quite normal and should give no cause for concern.
Memory	Store – Config ?	Config 1	Stores current settings to memory location 1
		Config 2	Stores current settings to memory location 2
		Config 3	Stores current settings to memory location 3
		Config 4	Stores current settings to memory location 4
		Config 5	Stores current settings to memory location 5
		Config 6	Stores current settings to memory location 6
		Config 7	Stores current settings to memory location 7
		Config 8	Stores current settings to memory location 8
		Config 9	Stores current settings to memory location 9
	Load – Config ?	Config 1	Loads stored settings from memory location 1 and makes them active.
		Config 2	Loads stored settings from memory location 2 and makes them active.
		Config 3	Loads stored settings from memory location 3 and makes them active.
		Config 4	Loads stored settings from memory location 4 and makes them active.
		Config 5	Loads stored settings from memory location 5 and makes them active.
		Config 6	Loads stored settings from memory location 6 and makes them active.
		Config 7	Loads stored settings from memory location 7 and makes them active.
		Config 8	Loads stored settings from memory location 8 and makes them active.
		Config 9	Loads stored settings from memory location 9 and makes them active.
	Default Restore No	No	Does not change the currently active settings.
		Yes	Restores currently active settings to factory defaults
	Last config no	None	Displays the number of the last active configuration used
Demodulator 1*	IPFreq 0.0000GHz	None	The transmit frequency of the camera transmitter is entered here. Note that although tuning steps of 100kHz can be entered on the screen, when the enter key is pressed the tuner locks to the nearest 125kHz step.

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	DconvLO 0.0000GHz	None	The down convertor local oscillator frequency is entered here. For L3010 enter 1.84GHz for high band switching (down conversion range of 2.310GHz - 2.700GHz to 470MHz - 860MHz) and 1.48GHz for low band switching (down conversion range of 1.950GHz - 2.340GHz to 470MHz - 860MHz). Other manufacturers may use a different frequency: see supporting documentations.
Demodulator 1*	Width ???	8MHz	Channel bandwidth. Must be entered from the front panel.
		7MHz	
		6MHz	
	Guard ???	None	Automatically picked up from the incoming signal. When this happens it is an indication that the receiver is locked to an incoming signal, although other faults may prevent pictures and sound being presented.
	Lock ??	No	Automatically detected: the receiver is not locked to any incoming RF signal and an alarm will be shown in the top right corner of the display.
		Yes	Automatically detected: the receiver is locked to an incoming RF signal.
	Modulation ???	None	Automatically detected from the incoming RF signal.
	Carrier ???	None	Automatically detected from the incoming RF signal.
	FEC Rate ???	None	Automatically detected from the incoming RF signal.
	Polarity ???	Normal	Automatically detected from the incoming RF signal.
		Inverted	
	SNR 0.0000dBm	None	Signal to noise ratio. Automatically detected from the incoming RF signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.
	MER 0.0000dBm	None	Modulation error rate. Automatically detected from the incoming RF signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.
	PreBER 0000.0000e	None	Pre viterbi error rate. Automatically detected from the incoming RF signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.
	PostBER 0000.0000	None	Post viterbi error rate. Automatically detected from the error corrected signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.

	Pkt errors 0.0000	None	Packet errors detected. Automatically detected from the error corrected signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.
Demodulator 2*	IPFreq 0.0000GHz	None	The transmit frequency of the camera transmitter is entered here. Note that although tuning steps of 100kHz can be entered on the screen, when the enter key is pressed the tuner locks to the nearest 125kHz step.
	DconvLO 0.0000GHz	None	The down convertor local oscillator frequency is entered here. For L3010 enter 1.84GHz for high band switching (down conversion range of 2.310GHz to 2.700GHz to 470MHz to 860MHz) and 1.48GHz for low band switching (down conversion range of 1.950GHz to 2.340GHz to 470MHz to 860MHz). Other manufacturers may use a different frequency: see supporting documentations.
	Width ???	8MHz	Channel width. Must be entered from the front panel.
		7MHz	
		6MHz	
	Guard ???	None	Automatically picked up from the incoming signal. When this happens it is an indication that the receiver is locked to an incoming signal, although other faults may prevent pictures and sound being presented.
	Lock ??	No	Automatically detected: the receiver is not locked to any incoming RF signal and an alarm will be shown in the top right corner of the display.
		Yes	Automatically detected: the receiver is locked to an incoming RF signal.
	Modulation ???		Automatically detected from the incoming RF signal.
	Carrier ???		Automatically detected from the incoming RF signal.
	FEC Rate ???		Automatically detected from the incoming RF signal.
	Polarity ???	Normal	Automatically detected from the incoming RF signal.
		Inverted	
	SNR 0.0000dBm	None	Signal to noise ratio. Automatically detected from the incoming RF signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.
	MER 0.0000dBm	None	Modulation error rate. Automatically detected from the incoming RF signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.

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			Pre viterbi error rate. Automatically detected from the incoming RF signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.
	PostBER 0000.0000	None	Post viterbi error rate. Automatically detected from the error corrected signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.
	Pkt errors 0.0000	None	Packet errors detected. Automatically detected from the error corrected signal. The reading shown is an instantaneous measurement taken at the time the return button is pressed. To update the reading, the menu must be exited and entered again.
Decoder	Service	None	Shows the service name of the service to which the receiver is currently locked.
	Default Service xx	None	Allows selection of a service from a list of services that the receiver can see. Use the up and down arrows to scroll through the list and press enter to select.
	625 Video PAL	YUV	Selects component output for 625-line video standard.
		PAL	Selects composite PAL encoded video output for 625 line video standard.
	525 Video NTSC	YUV	Selects component output for 525-line video standard.
		NTSC	Selects composite NTSC encoded video with 12½ IRE pedestal on black level for 525-line standard.
		NTSC No Ped	Selects composite NTSC encoded video without any pedestal on black level for 525 line standard.
	Aaudio O/P	Ana	Channel A audio output is set to analogue.
		Dig	Channel A audio output is set to digital.
	Baudio O/P	Ana	Channel B audio output is set to analogue.
		Dig	Channel B audio output is set to digital.
	Aud DID 767	None	Allows the audio data identifier for embedded audio to be changed.
	Genlock	Off	The unit is in free running mode and not locked to any external source.
		On	The unit's output video is frame locked to an external source. **NB - the colour sub carrier is not locked.** If genlock is set to on and no genlock input is detected a genlock alarm will be shown on the top right of the display screen.
	Offset 5000pix	None	Allows delay or advance of the frame lock in the range of 0 – 9999 pixels. 5000 is the centre of the range. 1 pixel = approx 74.63 nano seconds.
	Locked	None	Shows when the receiver is locked to a valid input signal.

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Multiplexer	ASI OP	188 byte	ASI output will be in packets of 188 bytes (no Reed Solomon error correction added).
		204 byte	ASI output will be in packets of 204 bytes (Reed Solomon error correction added).
	Bitrate	None	This sets the overall bit rate for the receiver. The figure set must be large enough to accommodate the stream passing through. If it is set too low, the buffer will fill, and error message will be generated and the output will be broken. It does not matter the bit rate set is too large. This setting should be used to limit the ASI output bit rate where the output signal is being fed to other equipment that requires a limited bit rate.
Descrambling	Descrambling EBS	On	Sets EBS scrambling on so the receiver can descramble a scrambled stream providing the correct key has been entered.
		Off	The receiver can only receive streams sent in the clear.
	EBS Key	None	Enables entry of an 8 digit hexadecimal key. The left and right arrows allow scrolling to the right or left in the number. The up and down arrows allow scrolling through the values (1 – 9 and A – F).
Unit	Mode	Diversity	In this mode all available inputs are scanned to provide a continuous high quality output. The diversity algorithm selects the best input signal.
		Dual Diversity	Inputs 1 & 2 and 3 & 4 are treated as separate diversity inputs with the two signals being multiplexed together.
	Dconv Type	None	No down convertor is used in the system. The 70MHz output from an encoder can be directly input to the receiver.
		L3010	For when L3010(s) are used.
		L3010 Mk2	For when L3010 Mk2 is used and allows control of the down convertor parameters, gain, address and Hi/Lo selection, from the receiver.
		Other	For when a down convertor not manufactured by Link is used.
	LNB Power	On	Power is supplied via the down leads to the down convertor.
		Off	No power is supplied to the down convertor. This mode should only be used when the input to the receiver is taken directly from the output of an encoder.
	Frequency offset	Auto	L3010 Mk2 down convertors automatically introduce an 8 MHz offset between down convertor output frequencies so that there is no leakage between the two channels if one antenna becomes disconnected.
		None	For use with older L3010 down convertors that cannot be controlled from the receiver. Can also be used if the automatic offset brings in adjacent channel or other interference.

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		-16MHz -8MHz 8MHz 16MHz	Allows manual setting of the offset between the two down convertors in 8MHz steps (to a maximum of 16MHz). This can be used when adjacent channel or other interference falls on the auto setting.
	Address ?	None	This is the address of the unit as used by the remote control protocol.
	Baudrate 9600	None	Sets the baud rate for the data stream and remote control interface.
	Interface		
	LCD Contrast	None	Allows changing of the contrast (brightness) of the display. Adjustable in 8 steps.
	Lock		
	Soft version	None	Displays the version of the current firmware.
	FPGA version	None	Displays the version of the current FPGA code.
	SerNum ????????	None	Displays the electronic serial number of the unit.
	Lcod	None	Allows entry of a unique hexadecimal string so that the unit's features can be upgraded or downgraded. The hex string will be issued by Link providing the correct conditions (payment) are satisfied.
	Attenuation	40dB Cable Att	Introduces 40dB of attenuation to the down convertor output. Should be used with very short cables to avoid overloading the receiver front end.
		30dB Cable Att	Introduces 30dB of attenuation to the down convertor output. If the picture output is blocky, try adding more attenuation to avoid receiver overload.
		20dB Cable Att	Introduces 20dB of attenuation to the down convertor output. If the picture output is blocky, try adding more attenuation to avoid receiver overload.
		10dB Cable Att	Introduces 10dB of attenuation to the down convertor output. If the picture output is blocky, try adding more attenuation to avoid receiver overload.

* Note if ASI input cards are fitted (instead of RF tuners), the Demod menus are replaced by ASI input menus. These have only one item, which is lock.

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Section 3 - Technical Reference

3.1 Remote Control Protocol

Introduction

This document describes the remote control protocol interface of the L1000 low delay encoder C100 PCB and LinkXP wireless camera system C102 PCB.

The physical interface is RS232 but this can be converted to RS 485 with an external adapter where multiple units are controlled over one RS 485 bus.

Normal operation involves sending a packet from the control device (normally a PC) to the L1000/C100/C102. If the packet satisfies an address integrity check, then the L1000/C100/C102 will action the command and send a reply.

For compatibility with modems an ASCII style protocol is used.

Physical Interface

The PCB connector is wired (in the L1000/C100 unit for example) to an external nine pin male RS232 connector using the following pins.

- Pin 2 Receive data into L1000/C100
- Pin 3 Transmit data from L1000/C100
- Pin 5 0V
- Pin 7 Tri-state control line from Encoder for use with external RS485 convertor.

For the LinkXP system, a six-way Lemo connector is used wired as follows:

- Input at baud rates of 9k6 baud or 11520 baud
- Protocol – standard Link 1000 ASCII protocol
- Data input Pin 1 TX, pin 2 RX, pin 3 ground
- Control input pin 4 TX, pin 5 RX, pin 3 ground

When connecting the Encoder directly to a PC with a 9 pin RS232 connector, a three-wire cable only should be used with direct connection of pins 2 & 3 & 5.

Ports are set for 8 bits, No parity, 1 stop bit. Baud rate is normally 9600 but 115,200 will also be allowed for manufacturers use.

Packet Strlucture

Sending (from PC)

ASCII	**Value**	
STX	02h	Start byte
0-9	30h-39h	4 byte unit address. In range 0-9999
R	20h-7Eh	1 byte command type. R read, W write or M miscellaneous
I	20h-7E	1 byte indicator of internal data block. I, V-video, O-modulator, A-Audio a, B-Audio b channel, G, E, Z
ABC	20h-7Eh	Command –three byte mnemonic

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;	3Bh	Separator
PQR	20h-7EhData –Optional, variable length	
;	3Bh	Separator
X	20h-7EhSum Check	
ETX	03h	End byte

Reply (from L1000/C100/C102)

ASCII	**Value**	
STX	02h	Start byte
0-9	30h-39h4 byte unit address. In range 0-9999	
Z	20h-7Eh	Status BYTE
PQR	20h-7EhData –Optional, variable length	
;	3Bh	Separator
X	20h-7EhSum Check	
ETX	03h	End byte

Notes-

1) The Sum check byte is the summation of all bytes in the packet, not including the start and end bytes. Higher order bytes are ignored and the final byte result is modified to prevent ASCII control characters being sent. Bit 7 (highest) is forced high.
2) Status byte will indicate command performed OK, or indicate an error.

ASCII	**Meaning**
1	All OK
E	General error, Command could not be actioned

Note: Typically E will be returned if the message is formatted incorrectly (separators in wrong place) or if commands are in upper case, or if commands do not match against the allowed list of commands, or if the checksum is wrong.

3) Addresses in the range 0001 to 9998 are for general use. Address 0000 is reserved and 9999 is a broadcast address. i.e. any Encoder will reply to this address. Its reply will contain its own specific address.
4) All data in the LinkXP system is stored as one of 5 data types, Double, String, List, Integer or HexInteger. The data type dictates the contents of the data section of the reply.

   List – 2-byte reply. Reply represents index into original choice list. E.g. Reply 02 indicates entry 2 in original list.

   Double - variable length. Reply always contains decimal point and 4 decimal places. Can have 1 to 3 digits before decimal.

   Integer - 6byte reply. integer value with stuffed with preceding zeros. e.g. GOP reply 000012 = GOP length 12

   String - Variable length. Reply is string excluding null terminator

   HexInteger – 8byte Hex reply

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Command List

Description	Type	Block	Command	Data Sent	Data Type

Type 'o' Output Modulation set up messages QPSK and OFDM share certain parameters

Set Modulation IF output	r/w	o	out	1 byte, 0= OFF, 1= ON, 2=Carrier Only (DVB-S), 3=Carrier Low (DVB-S)	List
Set QPSK symbol rate	r/w	o	sym	Set symbol rate in Msym, decimal point allowed.	Double
Set OFDM Guard Interval	r/w	o	gua	1 byte, 0= 1/32, 1= 1/16, 2= 1/8, 3= ¼	List
Set OFDM Modulation Mode	r/w	o	mod	1 byte, 0= QPSK, 1 = 16-QAM, 2 - 64-QAM	List
Set modulation FEC	r/w	o	fec	1 byte,0 = ½, 1 = 2/3, 2 = ¾, 3 = 5/6, 4 = 7/8	List
Set modulation Polarity	r/w	o	pol	1 byte, 0= Norm, 1= Inv	List
Set OFDM Bandwidth	r/w	o	wid	1 byte 0 = 6MHz, 1 = 7MHz, 2 = 8MHz	List
Set modulation output Level	r/w	o	lev	Set output level in dB number equates to -ve value	Integer
Set modulation Frequency	r/w	o	fre	Set Frequency in MHz, decimal point allowed.	Double
Set modulation roll off factor in DVB-S only	r/w	o	rol	1 byte. 0 = 35% (0.35) 1 = 25% (0.25)	List

Type 'm' messages are for multiplexer commands

Set ASI Mode	r/w	m	asi	1 byte, 0= OFF, 1= 188 byte, 2 = 204 byte	List
Set ASI Bitrate	r/w	m	bit	Bitrate in Mb/s decimal point included	Double
Set SI Service Name	r/w	m	ser	Service Name String	String
Set SI Network Name	r/w	m	net	Network Name String	String
Set PMT Pid	r/w	m	pmt	4 byte decimal PID 32 - 8190	Integer

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Set PCR Pid	r/w	m	pcr	4 byte decimal PID 32 – 8190	Integer
Enable local service	r/w	m	loc	1 byte, 0 = off, 1 = On (remux must be On for this message to operate)	List
Set program ID	r/w	m	pro	Any integer value other than 0 and <65535	Integer

Type 'z' messages are for scrambler commands

Scrambling	r/w	z	scr	1 byte, 0= Off, 1 = EBS (CJM2), 2 = BISS-1, 3 = BISS-E	List
EBS key	w	z	ebs	EBS Encryption Key	8-digit hex string
BISS-1 key	w	z	key	BISS-1 Session word	12-digit hex string
BISS-E key	w	z	esw	BISS-E Encrypted session word	16-digit hex0 string

Type 'v' messages are for video input commands

Video Input	r/w	v	inp	1 byte 0 = Bars 625, 1 = Bars 525, 2 = SDI 625, 3 = SDI 525, 4 = PAL, 5 = NTSC, 6 = NTSC No Pedestal, 7 = PAL-M, 8 – PAL-N, 9 = YUV 625*, 10 = YUV 525*	List
Bars on input video loss	r/w	v	bar	0 = Blank, 1 = Bars + Ident	List
Auto line standard detection (SDI only)	r/w	v	aut	0 = Off, 1 = On	List
Audio DID	r/w	v	aud	4 byte decimal DID	Integer
Frame Rate	r	v	fra	1 byte, 0= 25Hz, 1 = 29.97Hz	List
Video Locked	r	v	loc	1 byte, 0= No, 1= Yes	List

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Type 'e' messages are for encoder commands

Encoder On	r/w	e	enc	1 byte, 0= OFF, 1= ON, 2 = On only when video I/P locked	List
Encoder Profile	r/w	e	pro	1 byte, 0= MP@ML 1 = 422P@ML	List
Encoder Bitrate Auto	r/w	e	aut	1 byte, 0= OFF, 1= ON	List
Encoder Bitrate	r/w	e	bit	Bitrate in Mb/s include decimal point	Double
Encoder Mode	r/w	e	mod	1 byte, 0= standard 1 = low delay	List
Encoder Horizontal Resolution	r/w	e	hor	1 byte, 0= 720 1 = 704	List
Encoder Aspect Ratio	r/w	e	asp	1 byte, 0= 4:3 1 = 16:9	List
Encoder GOP Length	r/w	e	gop	1 byte, length	Integer
Encoder video PID	r/w	e	pid	4 byte, Decimal 32 - 8190	Integer
Encoder Vertical Blanking	r/w	e	vbi	0 = OFF, 1 = ON	Integer

Type 'a' messages are for audio 'A' commands

Audio A Standard	r/w	a	sta	1 byte, 0= OFF, 1= MPEG	List
Audio A Input	r/w	a	inp	1 byte, 0= test tone, 1 = Analogue, 2 = SDI Emb 1, 3 = AES-EBU*	List
Audio A Bitrate	r/w	a	bit	1 byte, 0= 128Kbs, 1= 160Kbs, 2= 192Kbs, 3= 224Kbs, 4= 256Kbs, 5= 320Kbs, 6= 384Kbs	List
Audio A Mode	r/w	a	mod	1 byte, 0= stereo, 1= dual mono	List
Audio A Language	r/w	a	lan	1 byte, 0= eng, 1= spa, 2 = ger, 3 = fre	List

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Audio A PID	R/w	a	pid	4 byte PID 32 – 8190	Integer
Audio A AES/Emb Locked	R	a	loc	1 byte, 0= No, 1= Yes	List

Type 'b' messages are for audio 'B' commands

Audio B Standard	R/w	b	sta	1 byte, 0= OFF, 1= MPEG	List
Audio B Input	R/w	b	inp	1 byte, 0= test tone, 1 = Analogue, 2 = SDI Emb 2, 3 = AES-EBU*	List
Audio B Bitrate	R/w	b	bit	1 byte, 0= 128Kbs, 1= 160Kbs, 2= 192Kbs, 3= 224Kbs, 4= 256Kbs, 5= 320Kbs, 6= 384Kbs	List
Audio B Mode	R/w	b	mod	1 byte, 0= stereo, 1= dual mono	List
Audio B Language	R/w	b	lan	1 byte, 0= eng, 1= spa, 2 = ger, 3 = fre	List
Audio B PID	r/w	b	pid	4 byte, 0= OFF, 1= ON 32 – 8190	Integer
Audio B AES/Emb Locked	r	B	loc	1 byte, 0= No, 1= Yes	List

Type 'g' messages are for unit level commands

Unit Mode	r/w	g	mod	1 byte, 0= ASI, 1 = DVB-T, 2 = DVB-S	List
Unit Address	r/w	g	add	4 byte Unit Address 0000 – 9999 see above	Integer
Unit Baudrate	r/w	g	bau	1 byte, 0= 115200, 1 = 9600	List
L1000/C100 Interface Selection – RS232 remote or Infra Red Remote	r/w	g	int	1 byte, 0= RS232, 1 = Infra Red	List
Unit LCD Contrast	r/w	g	lcd	1 byte 0 = dark 15 = bright	Integer
Unit Front Panel Lock	r/w	g	loc	1 byte, 0= OFF, 1= ON	List
420 DTS offset	r/w	g	420	Important = default should be 10ms	Integer

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422 DTS offset	r/w	g	422	Important default should be 90ms	Integer
Disable Dual Prime predictions in encoder	r/w	g	dis	0=Enable, 1=Disable	List
Software Version	r	g	sof	software version number	String
Option Card Type	r	g	opt	0=Not fitted, 1=IQ Output, 2=ASI/AES-EBU	List
FPGA Version	r	g	fpg	fpga version number	Integer
Serial Number	r	g	ser	Hex based serial number	HexInt
License Code	W	g	lco	License number for software facilities	12-digit hex string
BISS Injected ID	W	g	bis	BISS-E Injected Identifier	14-digit hex string

Type 'd' messages are for memory configuration commands

Store Current Configuration to Memory	w	d	sto	1 byte, Config Address 1 to 9	Integer
Load Configuration from Memory into current	w	d	loa	1 byte, Config Address 1 to 9	Integer
Restore Default Build	w	d	def	1 byte, 0 = No 1 = Yes	List
Read number of last config loaded	r	v	las	4 byte, Config Address	Integer (V6a)
Calibrate Video or TCXO	w	c	cal	1 or 4 byte, v = calibrate video xNNN = calibrate TCXO	List NNN : 0-255

Type 't' messages are for configuring RS232 data pipe commands

Data On/Off	r/w	t	dat	1 byte, 0= OFF, 1= ON	List
Input Data Baudrate	r/w	t	bau	1 byte 0 = 1200 baud 1 = 2400 baud 2 = 4800 baud 3 = 9600 baud 4 = 19200 baud 5 = 38400 baud	List

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Data PID	r/w	t	pid	4 byte PID 32 – 8190	Integer

Type 'x' messages are for configuring Remux commands

Remux Input Source	r/w	x	inp	1 byte, 0 = OFF, 1 = SDI Connector, 2 = AUX Connector*	List
Read input transport rate in Mb/s	r	x	inc	Value in Mb/s	Double
Remux status – describes if remux active	r	x	act	1 byte 0 = Not Active (indicates error if remux enabled) 1 = Active	List

Type '0-9' messages are for uploading/downloading complete configurations

Get config from unit	r	0-9	get	Hex data separated with ':'	Long string
Put config into unit	w	0-9	put	Hex data separated with ':'	Long string

* = Requires Option Module

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3.2 Technical Specifications

Specifications subject to change without notice.
For the latest version go to the Link Research web site.

Introduction

The LinkXP wireless camera system is built from the following products:

Transmit side – standard models

- A camera mounted encoder/transmitter of four models with frequency coverage as shown:
  - L1101 covering 1.95GHz to 2.2GHz
  - L1102 covering 2.1GHz to 2.3GHz
  - L1104 covering 2.3GHz to 2.5GHz
  - L1106 covering 2.5GHz to 2.7GHz
- Additional frequency ranges can be provided for orders of 10 or more units. Contact Link Research for further details.

Receive side

- An S band to UHF down-convertor model L3010 feeding a UHF signal to one of the following 4 products
- An ultra low delay diversity integrated receiver decoder model L2102
- A Diversity demodulator models:
  - L2002 two channel
  - L2004 four channel

System Parameters

End-to-end Delay

- 40mS or 1 frame (as measured by the BBC)

Cable types

- Transmitter to transmit antenna RG8 50Ω foam polyethylene dielectric (if required)
- Receive antenna to down-convertor RG8 50Ω foam polyethylene dielectric
- Down-convertor to receiver/decoder RG11 or RG59 75Ω foam polyethylene dielectric

NB – cable lengths have not been specified, as this will be dependent on the signal attenuation of the cable and/or the gain setting of the down convertor.

L110x Encoder/transmitter

Physical

- 234 x 84 x 44mm without antenna fitted
- 1.05kg weight
- Black stove enamelled finish
- Housing - splash proof machined aluminium casing

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Mounting

The front and back faces of the transmitter body have six 3mm threaded mounting holes on which can be mounted a variety of standard battery mountings.

Environmental

- Ambient 0°C to 40°C

Power

- 11.5V DC to 16V DC supplied from standard camera battery. Once started the unit will work down to 9.0VDC (low battery warning).

Power Consumption

- 18 Watts typically (depending on power setting)

Top Panel Controls and Indicators

A small control panel having two push buttons is mounted on the top of the transmitter having the following functions:

- Profile – pressing this button allows selection of one of 6 preset configurations
- RF – pressing this button toggles between RF on and RF off

Three indicators have the following functions:

- Alarm – a red LED that shows fault status when lit
- RF – a green LED that shows RF is being radiated when lit
- Profile – 6 yellow LEDs that when lit, indicates the active profile selected. The profiles are also numbered from 1 – 6.
- Flashing LED indicates low battery voltage

Lower Panel Connectors

Seven connectors provide the following interfaces:

- RS232 Control – 6 pin Limo connector
- Audio 1 – 5 pin Lemo connector
- Audio 2 – 5 pin Lemo connector
- DC input – 4 pin Lemo connector
- V video component input– 75Ω BNC connector
- U video component input– 75Ω BNC connector
- Y, composite video, SDI input – 75Ω BNC connector

Video Inputs

- SDI Video Input,
- Serial Digital with embedded audio.
- ITU-R BT.656 Part 3, bit serial interface 4:2:2 YC_BC_R. (UK/EC) ANSI/SMPTE 259M level C – 270Mb/s.
- Component video input
- 525/625 component (USA).

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- Composite video input
- 1 Vpp – NTSC with and without pedestal or PAL I.
- Return Loss >30dB at 6MHz

Audio Inputs

- Audio 1 and Audio 2
  - >20kΩ input impedance
  - One stereo pair or two mono channels
  - Pin 1 L+, pin 2 L-, pin 3 ground, pin 4 R+, pin 5 R-
  - Frequency response 50Hz to 15kHz <0.1dB
  - Frequency response 20Hz to 20kHz <0.5dB
  - +18dB clipping level

RS232 Input

- Input at baud rates of 9k6 baud or 11520 baud
- Protocol – standard Link 1000 ASCII protocol
- Data input Pin 1 TX, pin 2 RX, pin 3 ground
- Control input pin 4 TX, pin 5 RX, pin 3 ground

DC Input

- Pin 1 –ve, pin 4 +ve
- Pins 2 and 3 not connected

Transmitter Output Power

- Between 10mW and 100mW into 50Ω

Modulation Method

- Coded Orthogonal Frequency Division Multiplex (COFDM)
  - 64QAM, 16QAM, QPSK
  - FEC $^{1}/_{2}$, $^{2}/_{3}$, $^{5}/_{6}$, $^{3}/_{4}$, $^{7}/_{8}$
  - Guard interval ¼, $^{1}/_{8}$, $^{1}/_{16}$, $^{1}/_{32}$
  - 2000 carriers (1705 active carriers)
  - 6Mhz, 7MHz or 8MHz bandwidth selectable

Spurious Emissions

- –30dBm or better

In-band Tones

- –40dB or better with respect to OFDM level

Shoulder Height

- –36dB or better with respect to OFDM level

Frequency Stability

- 2.5ppm or better

Tuning Step Size

- 125kHz

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Phase Noise

- Better than –80dBc/Hz at 10kHz

Encoder performance

- Modes
  - MP@ML (4:2:0)
  - 422P@ML (4:2:2)
- Bit rate
  - MP@ML 1.5mbits/s to 15mbits/s dictated by channel and setting
  - 422P@ML 3.0mbits/s to 50mbits/s dictated by channel and setting
- Horizontal resolution 720 or 704
- Vertical resolution
  - 480 lines in 525 line (NTSC)
  - 576 lines in 625 (PAL)
- Frame rates
  - NTSC 29.97
  - PAL 25
- Delay mode and GOP length
  - Standard delay mode GOP = 12 (PAL) 15 NTSC
- Audio
  - Two analogue input channels
  - Each channel can be configured as a stereo pair or dual mono
  - Input impedance 20kΩ
  - Sampling rate 48kHz
  - Coding method MPEG layer 1 (ISO/IEC 13818-3, ISO/MPEG 11172.3) and MPEG layer 2 (MUSICAM)
  - Minimum audio bit rate of 128kbits per channel, 384kbits stereo
  - Video and audio synchronisation better than +10ms to –30ms. Typically <5ms

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L3010 Down-convertor

Physical

- 130 x 170 x 40mm without antenna fitted
- 0.83kg weight
- White stove enamelled finish
- Housing – water resistant 2-piece die cast aluminium casing

Mounting

Four holes for direct mounting to a flat surface or flat adaptor plate for universal pole mounting brackets.

NB To ensure the unit is water resistant it must be mounted with the input and output connectors facing down.

Environmental

- -20°C to +55°C

Power

- Input range 10VDC to 30VDC supplied via coaxial cable from receiver/decoder
- Power consumption approximately 3.5W excluding cable loss

Lower Panel Connectors

- N-type 50Ω input for connection to antenna either directly or by short drop lead
- F-type 75Ω output for connection to receiver/decoder

Input

- 1.95GHz to 2.70GHz frequency range
- <3.5dB noise figure

Output

- 470MHz to 860MHz frequency range
- Switchable in two bands
    - High band from 2.31GHz to 2.70GHz
    - Low band from 1.95GHz to 2.34GHz
    - Offset from centre frequency ±16MHz in two steps of 8MHz

Input Signal Level

- Minimum level –80dBm

Output Level

- Up to +17dBm at P1dB dependent on setting

Spurious Outputs

- Better than –30dBm (1µW) with no input signal
- Output must be correctly terminated in 75Ω

Inband Tones

- –40dB or better with respect to peak OFDM signal level

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Frequency Stability

- Better than 10ppm

Phase Noise

- Better than –80dBc/Hz at 10kHz offset from carrier

Down Conversion Factor

- High band 1.84GHz
- Low band 1.48GHz

Down Conversion Gain

- +45dB
- three switchable steps of attenuation each of 10dB
    - Manual switching inside unit
    - Remote switching using 22kHz tone from receiver/decoder

L2102 Ultra Low Delay Integrated Receiver/Decoder

Physical

- 210 x 227 x 44mm
- Small form 1RU ½ 19" rack width
- 1.7kg weight
- Black spray painted steel enclosure

Mounting

- Free standing
- Two units rack mounted side by side with optional bridging kit
- Single unit rack mounted with 10.5" 1RU mount option

Environmental

- Ambient 0ºC to +70ºC

Power

- AC input option 100VAC to 240VAC 50Hz to 60Hz
- DC input option 11VDC to 32VDC (-ve chassis earth)

Power Consumption

- 12 watts plus down convertor requirements

Front Panel Controls and Indicators

- 6 Push buttons with the following menu control functions
    - 4 buttons to the right of the unit with functions of move left, right, up and down in the menu structure
    - 2 buttons to the right of the display screen, upper button cancels/moves up a menu level; lower button opens and executes a selection
- 55mm x 20mm liquid crystal display (LCD) showing menu items, status and alarms
- 3 light emitting diodes (LED) showing status
    - Power – green – when lit power is applied
    - Alarm – red – when lit an alarm raised (details on the LCD)
    - Status – yellow – when lit a valid input signal is present

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Rear Panel Connectors

- RF1 and RF2 inputs
  - 75Ω F connector
  - Diversity input, antenna 1 to RF 1 and antenna 2 to RF2
  - UHF input 470MHz to 860MHz
  - +24VDC output to power up convertor limited to 400mA per connector
  - Short circuit protected
- Frame lock input
  - 75Ω BNC connector
- ASI out
  - 75Ω BNC connector
- SDI out
  - 75Ω BNC connector
  - Serial digital video with embedded audio
- Video out
  - 75Ω BNC connector
  - Composite video out 1V pp
  - PAL or NTSC
- Data
  - 9 way D-sub connector
  - RS232 data output
  - Baud rates of 9K6, 19K2, 38K4
  - Firmware download port
- Remote/Alarm
  - 9 way D-sub connector
  - Alarm output
  - Remote control port

Audio

- Proprietary connector block with screw clamp and strain relief bracket
  - Pin 1 Audio 1 L+
  - Pin 2 Audio 1 L-
  - Pin 3 Audio 1 L ground
  - Pin 4 Audio 1 R+
  - Pin 5 Audio 1 R-
  - Pin 6 Audio 1 R ground
  - Pin 7 Audio 2 L+
  - Pin 8 Audio 2 L-
  - Pin 9 Audio 2 L ground
  - Pin 10 Audio 2 R+
  - Pin 11 Audio 2 R-
  - Pin 12 Audio 2 R ground

Video Outputs

- Serial Digital Interface (SDI)
  - SDI with two stereo channels of embedded audio
  - SMPTE 259M, Rec ITU-R BT.656.3
- Composite Video
  - NTSC (with and without pedestal) or PAL I
  - REC. ITU-R BT.470-4
  - Signal to noise ratio >56dB
- ASI out
  - DVB ASI Burst and Byte mode
- Component video
  - YUV 625/525

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Video Inputs

- Frame Lock
  - Composite Black and Burst input for timing reference
  - Frame store added
  - Delay increased by 0 – 40mS

Analogue Audio Output

- Two stereo pairs or 4 mono channels
  - MPEG layer 1 and layer 2
  - Bit rates 32 to 448kbits/sec
  - 48kHz sampling
  - Clip level 18dBm
  - THD < 0.1%
  - 20Hz to 18kHz ±0.25dB
  - Crosstalk >60dB minimum
  - Signal to noise ratio >66dB RMS

Input Signal Level

- Receiver sense limit –80dBm
- Receiver overload limit –20dBm

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L2002 & L2004 Diversity Demodulator

Physical

- 210 x 227 x 44mm
- Small form 1RU ½ 19" rack width
- 1.7kg weight

Mounting

- Free standing
- Two units rack mounted side by side with optional bridging kit
- Single unit rack mounted with 10.5" 1RU mount option

Environmental

- Ambient 0ºC to +40ºC

Power

- AC input option 100VAC to 240VAC 50Hz to 60Hz
- DC input option 10VDC to 32VDC (-ve chassis earth)

Power Consumption

- 12 watts plus down convertor requirements

Front Panel Controls and Indicators

- 6 Push buttons with the following menu control functions
  - 4 buttons to the right of the unit with functions of move left, right, up and down in the menu structure
  - 2 buttons to the right of the display screen, upper button cancels/moves up a menu level; lower button opens and executes a selection
- 55mm x 20mm liquid crystal display (LCD) showing menu items, status and alarms
- 3 light emitting diodes (LED) showing status
  - Power – green – when lit power is applied
  - Alarm – red – when lit an alarm raised (details on the LCD)
  - Status – yellow – when lit a valid input signal is present

Rear Panel Connectors

- RF1, RF2, RF3 and RF4 (RF3 and RF4 not fitted to L2002)
  - 75Ω F connector
  - Diversity input, antenna 1 to RF 1 and antenna 2 to RF2 (L2002)
  - Diversity input antenna 3 to RF 3 and antenna 4 to RF4 (L2004 only)
  - UHF input 470MHz to 860MHz
  - +24VDC output to power up convertor limited to 400mA per connector
  - Short circuit protected
- ASI1 and ASI2 out
  - 75Ω BNC connector
  - Two independent outputs
- Data
  - 9 way D-sub connector
  - RS232 data output
  - Baud rates of 9K6, 19K2, 38K4
  - Firmware download port

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- Remote/Alarm
  - 9 way D-sub connector
  - Alarm output
  - Remote control port

Video Outputs/Inputs

- DVB ASI Burst and Byte mode

Input Signal Level

- Receiver sense limit –80dBm
- Receiver overload limit –20dBm

3.3 Default Profile Settings for L110x

The following tables give the default settings for all parameters that can be stored in a profile. There are 12 profiles altogether, but only 6 can be stored in the memories of an L110x transmitter.

Standard profile names are:

- WCT-RG-625-SDI-2.395.lpf
- WCT-RG-525-YUV-2.395.lpf
- WCT-RG-525-NTSC-2.395.lpf
- WCT-HQ-625-SDI-2.395.lpf
- WCT-HQ-525-YUV-2.395.lpf
- WCT-HQ-525-NTSC-2.395.lpf
- WCT-RG-625-PAL-2.395.lpf
- WCT-RG-625-YUV-2.395.lpf
- WCT-RG-525-SDI-2.395.lpf
- WCT-HQ-625-YUV-2.395.lpf
- WCT-HQ-625-PAL-2.395.lpf
- WCT-HQ-525-SDI-2.395.lpf

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Block	Parameter	WCT-RG-625-SDI-2.395	WCT-RG-525-YUV-2.395
Modulator	Output*	Off	Off
	Modulation mode	QPSK	QPSK
	Guard interval	1/16	1/16
	FEC	½	½
	Polarity	Normal	Normal
	Bandwidth	8MHz	8MHz
	Level	-2dBm	-2dBm
	Transmit frequency	2.3950GHz	2.3950GHz
Multiplexor	ASI output	Off	Off
	Local service	On	On
	Bitrate	5.8547Mbits/sec	5.8547Mbits/sec
	Service name	Service 01	Service 01
	Network name	Net 1	Net 1
	Programme ID	1	1
	PMT PID	32	32
	PCR PID	8190	8190
Scrambling	Scrambling	Off	Off
Video source	Input	SDI (625)	YUV (525)
	Bars video fail	Off	Off
	Auto line standard	Off	Off
	Audio DID	767	767
Video encoder	Encode	On	On
	Profile	4:2:2	4:2:2
	Auto rate	On	On
	Bit rate	5.3921Mbits/sec	5.3921Mbits/sec
	Mode	Low delay	Low delay
	Horizontal resolution	720	720
	Aspect ratio	4:3	4:3
	GOP length	12	15
	PID	300	300
Audio A	Standard	MPEG-2	MPEG-2
	Input	Analogue	Analogue
	Bit rate	224kb/s	224kb/s
	Mode	Stereo	Stereo
	Language	English	English
	PID	200	200
Audio B	Standard	Off	Off
	Input	Analogue	Analogue
	Bit rate	320kb/s	320kb/s
	Mode	Stereo	Stereo
	Language	Spanish	Spanish
	PID	201	201
Data	Data	Off	Off
	Baudrate	9600	9600
	PID	100	100
Remux	Input source	Off	Off
Unit	Mode	DVB-T	DVB-T

* If the RF output is set to on when the profile is saved to memory, it will be saved as ON.

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Block	Parameter	WCT-RG-525-NTSC-2.395	WCT-HQ-625-SDI-2.395
Modulator	Output*	Off	Off
	Modulation mode	QPSK	16-QAM
	Guard interval	1/16	1/16
	FEC	½	½
	Polarity	Normal	Normal
	Bandwidth	8MHz	8MHz
	Level	-2dBm	-2dBm
	Transmit frequency	2.3950GHz	2.3950GHz
Multiplexor	ASI output	Off	Off
	Local service	On	On
	Bitrate	5.8547Mbits/sec	11.7093Mbits/sec
	Service name	Service 01	Service 01
	Network name	Net 1	Net 1
	Programme ID	1	1
	PMT PID	32	32
	PCR PID	8190	8190
Scrambling	Scrambling	Off	Off
Video source	Input	NTSC	SDI (625)
	Bars video fail	Off	Off
	Auto line standard	Off	Off
	Audio DID	767	767
Video encoder	Encode	On	On
	Profile	4:2:2	4:2:2
	Auto rate	On	On
	Bit rate	5.3921Mbits/sec	11.1222Mbits/sec
	Mode	Low delay	Low delay
	Horizontal resolution	720	720
	Aspect ratio	4:3	4:3
	GOP length	15	12
	PID	300	300
Audio A	Standard	MPEG-2	MPEG-2
	Input	Analogue	Analogue
	Bit rate	224kb/s	224kb/s
	Mode	Stereo	Stereo
	Language	English	English
	PID	200	200
Audio B	Standard	Off	Off
	Input	Analogue	Analogue
	Bit rate	320kb/s	320kb/s
	Mode	Stereo	Stereo
	Language	Spanish	Spanish
	PID	201	201
Data	Data	Off	Off
	Baudrate	9600	9600
	PID	100	100
Remux	Input source	Off	Off
Unit	Mode	DVB-T	DVB-T

* If the RF output is set to on when the profile is saved to memory, it will be saved as ON.

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Block	Parameter	WCT-HQ-525-YUV-2.395	WCT-RG-525-NTSC-2.395
Modulator	Output*	Off	Off
	Modulation mode	16-QAM	16-QAM
	Guard interval	1/16	1/16
	FEC	½	½
	Polarity	Normal	Normal
	Bandwidth	8MHz	8MHz
	Level	-2dBm	-2dBm
	Transmit frequency	2.3950GHz	2.3950GHz
Multiplexor	ASI output	Off	Off
	Local service	On	On
	Bitrate	11.7093Mbits/sec	11.7093Mbits/sec
	Service name	Service 01	Service 01
	Network name	Net 1	Net 1
	Programme ID	1	1
	PMT PID	32	32
	PCR PID	8190	8190
Scrambling	Scrambling	Off	Off
Video source	Input	YUV (525)	NTSC
	Bars video fail	Off	Off
	Auto line standard	Off	Off
	Audio DID	767	767
Video encoder	Encode	On	On
	Profile	4:2:2	4:2:2
	Auto rate	On	On
	Bit rate	11.1222Mbits/sec	11.1222Mbits/sec
	Mode	Low delay	Low delay
	Horizontal resolution	720	720
	Aspect ratio	4:3	4:3
	GOP length	15	15
	PID	300	300
Audio A	Standard	MPEG-2	MPEG-2
	Input	Analogue	Analogue
	Bit rate	224kb/s	224kb/s
	Mode	Stereo	Stereo
	Language	English	English
	PID	200	200
Audio B	Standard	Off	Off
	Input	Analogue	Analogue
	Bit rate	320kb/s	320kb/s
	Mode	Stereo	Stereo
	Language	Spanish	Spanish
	PID	201	201
Data	Data	Off	Off
	Baudrate	9600	9600
	PID	100	100
Remux	Input source	Off	Off
Unit	Mode	DVB-T	DVB-T

* If the RF output is set to on when the profile is saved to memory, it will be saved as ON.

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Block	Parameter	WCT-RG-625-YUV-2.395	WCT-RG-625-PAL-2.395
Modulator	Output*	Off	Off
	Modulation mode	QPSK	QPSK
	Guard interval	1/16	1/16
	FEC	½	½
	Polarity	Normal	Normal
	Bandwidth	8MHz	8MHz
	Level	-2dBm	-2dBm
	Transmit frequency	2.3950GHz	2.3950GHz
Multiplexor	ASI output	Off	Off
	Local service	On	On
	Bitrate	5,8547Mbits/sec	5,8547Mbits/sec
	Service name	Service 01	Service 01
	Network name	Net 1	Net 1
	Programme ID	1	1
	PMT PID	32	32
	PCR PID	8190	8190
Scrambling	Scrambling	Off	Off
Video source	Input	YUV (625)	PAL
	Bars video fail	Off	Off
	Auto line standard	Off	Off
	Audio DID	767	767
Video encoder	Encode	On	On
	Profile	4:2:2	4:2:2
	Auto rate	On	On
	Bit rate	5.3921Mbits/sec	5.3921Mbits/sec
	Mode	Low delay	Low delay
	Horizontal resolution	720	720
	Aspect ratio	4:3	4:3
	GOP length	12	12
	PID	300	300
Audio A	Standard	MPEG-2	MPEG-2
	Input	Analogue	Analogue
	Bit rate	224kb/s	224kb/s
	Mode	Stereo	Stereo
	Language	English	English
	PID	200	200
Audio B	Standard	Off	Off
	Input	Analogue	Analogue
	Bit rate	320kb/s	320kb/s
	Mode	Stereo	Stereo
	Language	Spanish	Spanish
	PID	201	201
Data	Data	Off	Off
	Baudrate	9600	9600
	PID	100	100
Remux	Input source	Off	Off
Unit	Mode	DVB-T	DVB-T

* If the RF output is set to on when the profile is saved to memory, it will be saved as ON.

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Block	Parameter	WCT-RG-525-SDI-2.395	WCT-HQ-625-YUV-2.395
Modulator	Output*	Off	Off
	Modulation mode	QPSK	16-QAM
	Guard interval	1/16	1/16
	FEC	½	½
	Polarity	Normal	Normal
	Bandwidth	8MHz	8MHz
	Level	-2dBm	-2dBm
	Transmit frequency	2.3950GHz	2.3950GHz
Multiplexor	ASI output	Off	Off
	Local service	On	On
	Bitrate	5,8547Mbits/sec	11.7093Mbits/sec
	Service name	Service 01	Service 01
	Network name	Net 1	Net 1
	Programme ID	1	1
	PMT PID	32	32
	PCR PID	8190	8190
Scrambling	Scrambling	Off	Off
Video source	Input	SDI (525)	YUV (625)
	Bars video fail	Off	Off
	Auto line standard	Off	Off
	Audio DID	767	767
Video encoder	Encode	On	On
	Profile	4:2:2	4:2:2
	Auto rate	On	On
	Bit rate	5.3921Mbits/sec	11.1222Mbits/sec
	Mode	Low delay	Low delay
	Horizontal resolution	720	720
	Aspect ratio	4:3	4:3
	GOP length	15	12
	PID	300	300
Audio A	Standard	MPEG-2	MPEG-2
	Input	Analogue	Analogue
	Bit rate	224kb/s	224kb/s
	Mode	Stereo	Stereo
	Language	English	English
	PID	200	200
Audio B	Standard	Off	Off
	Input	Analogue	Analogue
	Bit rate	320kb/s	320kb/s
	Mode	Stereo	Stereo
	Language	Spanish	Spanish
	PID	201	201
Data	Data	Off	Off
	Baudrate	9600	9600
	PID	100	100
Remux	Input source	Off	Off
Unit	Mode	DVB-T	DVB-T

* If the RF output is set to on when the profile is saved to memory, it will be saved as ON.

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Block	Parameter	WCT-HQ-625-PAL-2.395	WCT-HQ-525-SDI-2.395
Modulator	Output*	Off	Off
	Modulation mode	16-QAM	16-QAM
	Guard interval	1/16	1/16
	FEC	½	½
	Polarity	Normal	Normal
	Bandwidth	8MHz	8MHz
	Level	-2dBm	-2dBm
	Transmit frequency	2.3950GHz	2.3950GHz
Multiplexor	ASI output	Off	Off
	Local service	On	On
	Bitrate	11.7093Mbits/sec	11.7093Mbits/sec
	Service name	Service 01	Service 01
	Network name	Net 1	Net 1
	Programme ID	1	1
	PMT PID	32	32
	PCR PID	8190	8190
Scrambling	Scrambling	Off	Off
Video source	Input	PAL	SDI (525)
	Bars video fail	Off	Off
	Auto line standard	Off	Off
	Audio DID	767	767
Video encoder	Encode	On	On
	Profile	4:2:2	4:2:2
	Auto rate	On	On
	Bit rate	11.1222Mbits/sec	11.1222Mbits/sec
	Mode	Low delay	Low delay
	Horizontal resolution	720	720
	Aspect ratio	4:3	4:3
	GOP length	12	15
	PID	300	300
Audio A	Standard	MPEG-2	MPEG-2
	Input	Analogue	Analogue
	Bit rate	224kb/s	224kb/s
	Mode	Stereo	Stereo
	Language	English	English
	PID	200	200
Audio B	Standard	Off	Off
	Input	Analogue	Analogue
	Bit rate	320kb/s	320kb/s
	Mode	Stereo	Stereo
	Language	Spanish	Spanish
	PID	201	201
Data	Data	Off	Off
	Baudrate	9600	9600
	PID	100	100
Remux	Input source	Off	Off
Unit	Mode	DVB-T	DVB-T

* If the RF output is set to on when the profile is saved to memory, it will be saved as ON.

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3.4 Loading Link Control Software onto a PC.

To save or restore customised profiles for the camera transmitter, a simple proprietary utility called "Link Control" is needed. This can be found on the L1000 Encoder/Modulator Support CD or can be obtained by contacting Customer Support at Link Research.

Load the CD into the drive and go to My Computer. Clicking on the CD icon will bring up a window as shown below.

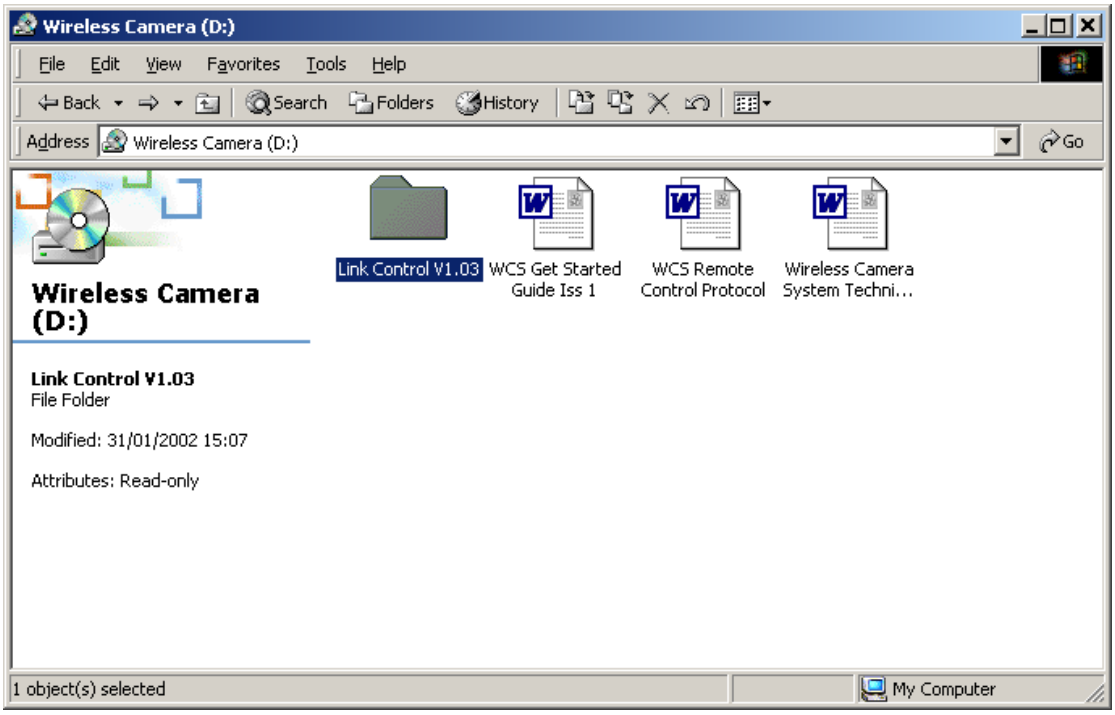

Figure xx – Link Support CD contents

Open the Link Control Software file to reveal the installation utility and the compressed data files. Double clicking on the SET UP icon will launch the automatic install wizard. Unless there are good reasons not to, accept all the defaults presented.

N.B. All open programmes must be closed before installation.
It is not necessary to unzip the data files; the install programme does this automatically.

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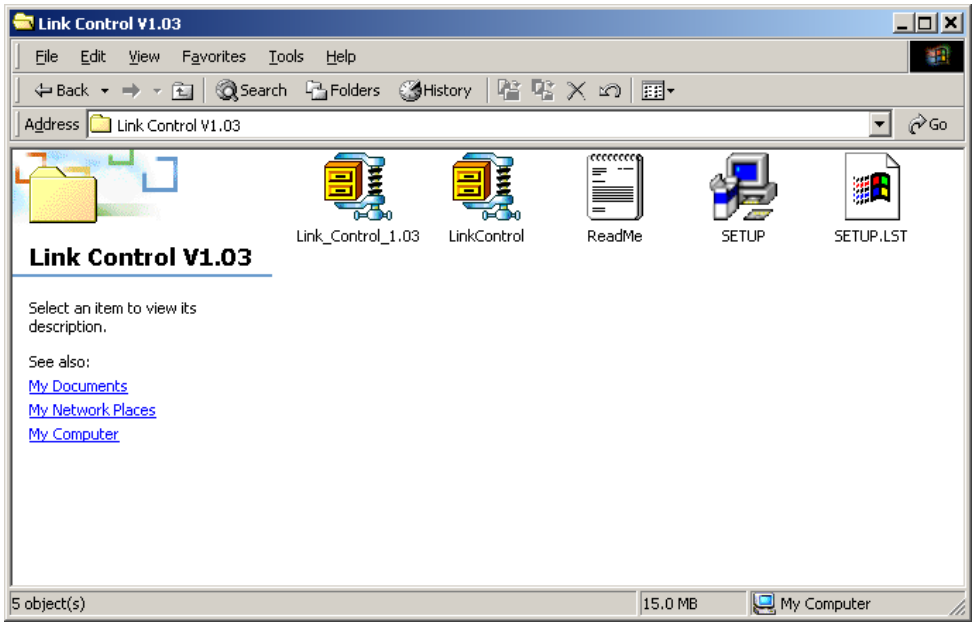

Figure xx – Link Control Software set up screen

If the installation defaults were kept, the software will have been installed in the Programme Files as follows:

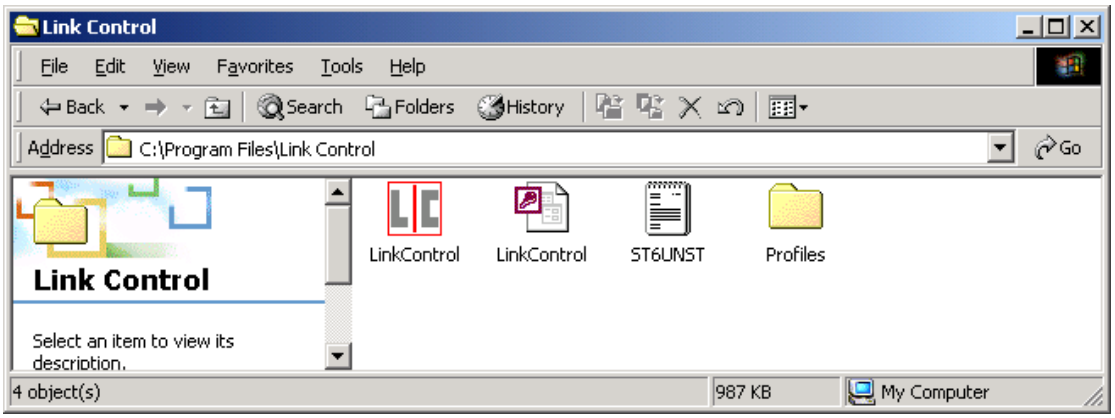

Figure xx – Installed components

The folder named "Profiles" may not have been created. This can either be created by selecting File and New in Windows Explorer and naming the folder created "Profiles" or it can be left for the programme to create it automatically when it is run. The only reason for creating a new folder at this stage is if a profile has been stored on floppy disc and it needs to be installed in an encoder.)

3.5 Upgrading software

The LinkXP system may be upgraded in three ways.

1. By changing the unit type, or adding a software option may be achieved by upgrading the **licence code**.

2. Upgrading the **firmware** to give the advantage of new features or improvements. This is a completely separate process.

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3. By adding hardware upgrades using the unit's internal option card slot.

New firmware will support all options and unit types and will not affect the licence code. In addition user stored profiles will not be affected.

Units may be upgraded by returning them to Link, but in addition **field upgrade** by the User is a straightforward procedure.

3.5.1 Upgrading model types and options

The model type, plus the firmware options fitted, are upgradeable by changing the unit's licence code.

To do this, contact Link to obtain the required upgrade code. This 12-character code is generated at Link and is specific to each unit. The 12-digit code is entered into the unit from the main menu item **Unit**, Submenu **Lcod**. Once inserted the new functions will be immediately available.

3.5.2 Keeping track of current status

New versions of firmware and details of version changes will be available on the Link web-site www.linkres.co.uk.

Customer Support will provide a password that must be entered in the space provided. Once verified, entry to the site is possible. Follow the on-screen instructions and download the file to the local hard disc and then unzip ready for downloading to the equipment to be updated.

Figure xx – Link website download page

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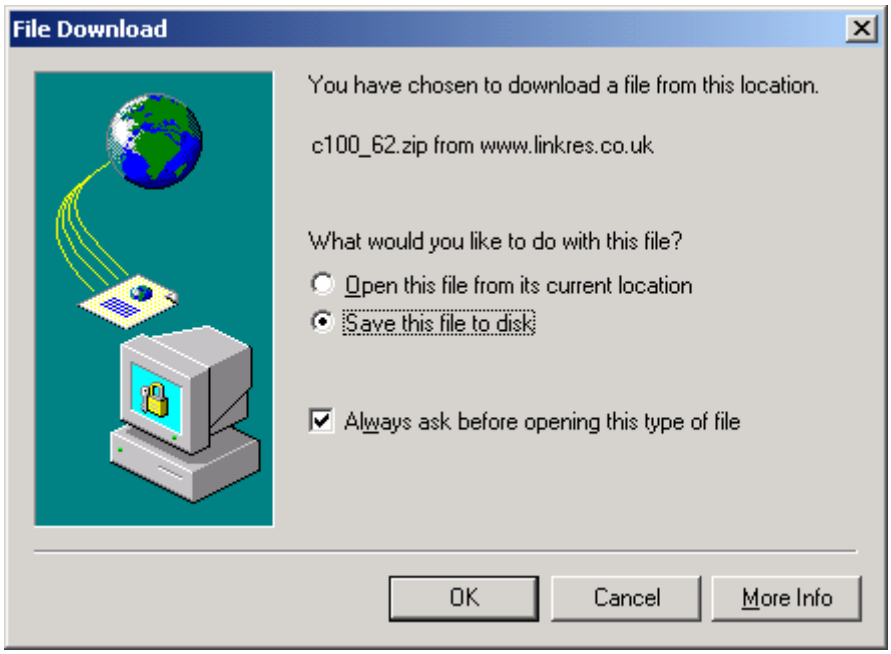

Figure xx – Download and save screen

3.5.3 Upgrade procedure.

The terminal program TeraTerm is needed to install the software. This can be obtained from the site http://hp.vector.co.jp/authors/VA002416/teraterm.html

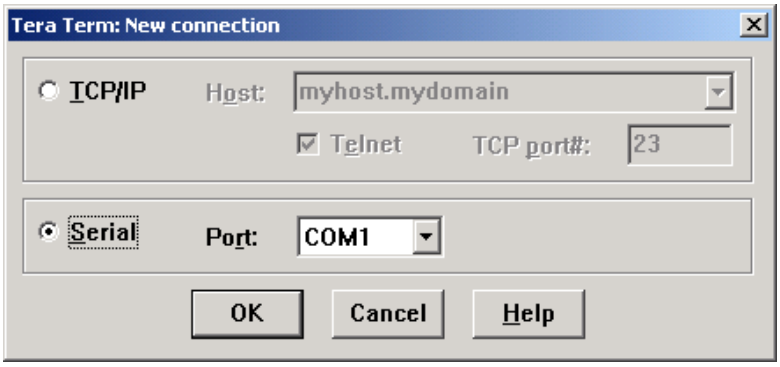

Figure xx – TeraTerm start up window

When TeraTerm is opened, it will show a window like that above. Choose the serial option and configure it for a valid COM port. This will then open another window as shown below:

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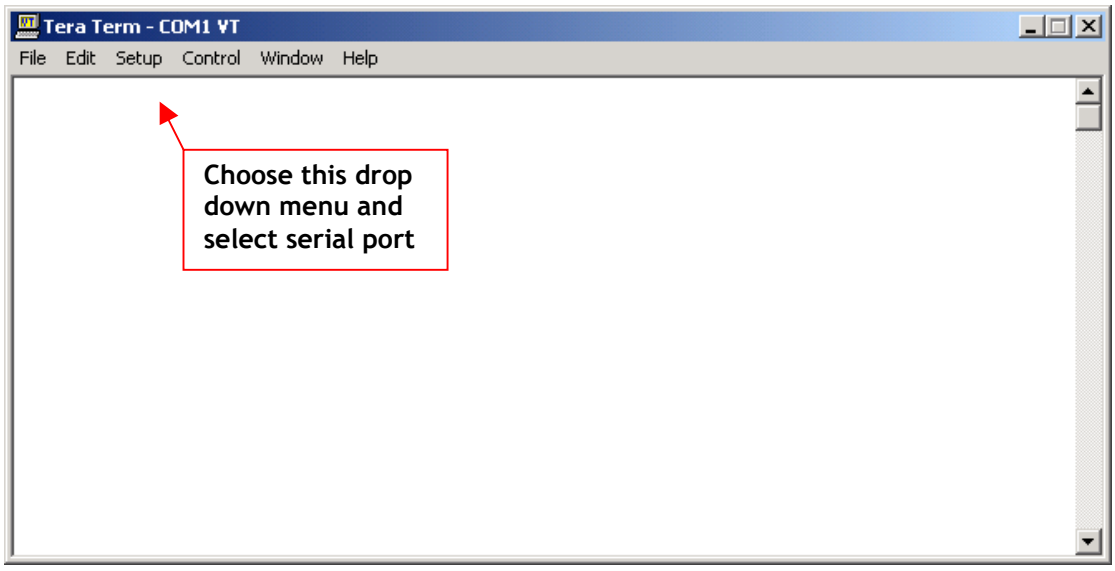

Figure xx – TeraTerm setup screen

From the Set-up drop down menu, choose the serial port option to access the port configuration menu (shown below).

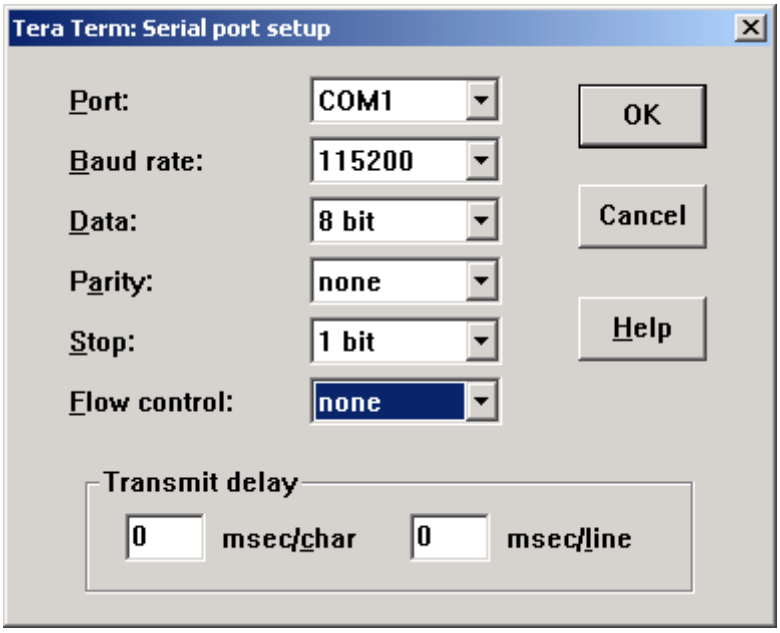

Figure xx – configuring the COM port

Set the port up with the values shown in the screen dump and click ok.

The L1000 must be connected to the PC with a serial cable (minimum connections 2 – 2, 3 – 3 and 5 - 5) between the chosen COM port and LinkXP equipment data port. With the unit un-powered, hold down the left and right arrow keys simultaneously on the front panel, apply the power and continue to hold the keys down for a few seconds.

If the connection is successful, the following prompt will be seen on the PC screen.

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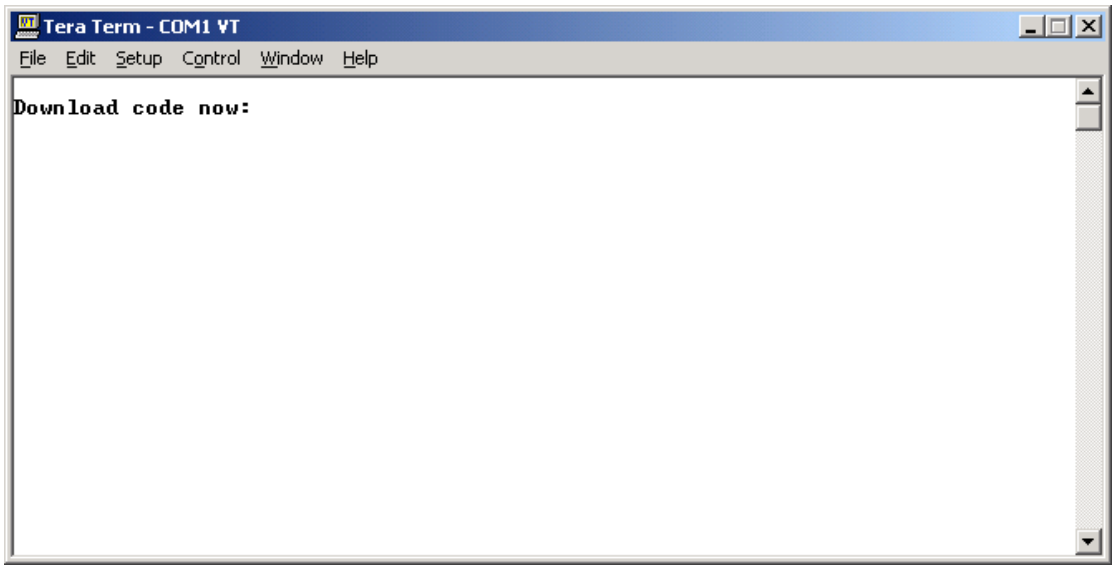

Figure xx – Download ready

Select the dropdown menu File then Send File on the terminal, and select the download file, saved and unzipped on the local hard drive.

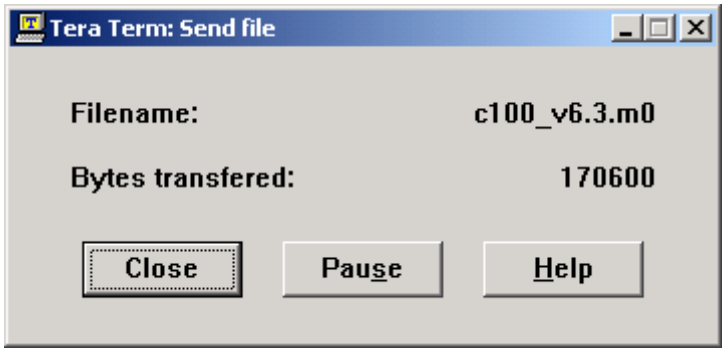

Figure xx – downloading in progress

Once complete, the progress window will disappear, and a short time later (3-5 minutes), the message 'Finished' will appear on the terminal screen. The updated code is now ready to execute at next power up.

N.B. If the power is interrupted at any stage during this process, the new code will not be loaded. In worst cases, the unit will have to be returned to the factory for a factory reinstall.

3.6 Saving and restoring customised profiles

3.6.1 Using the Link Control Software

Saving and restoring customised profiles is done by using the Link control programme.

Connect the PC COM port to the LinkXP equipment's Remote/Alarm D-type connector with a straight serial cable (minimum connections pin 2 – 2, pin 3 – 3 and pin 5 – 5). A gender changer will be needed to enable the cable to connect onto the encoder.

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Start the remote control programme by clicking on the Link Control icon and a window like that shown below will open.

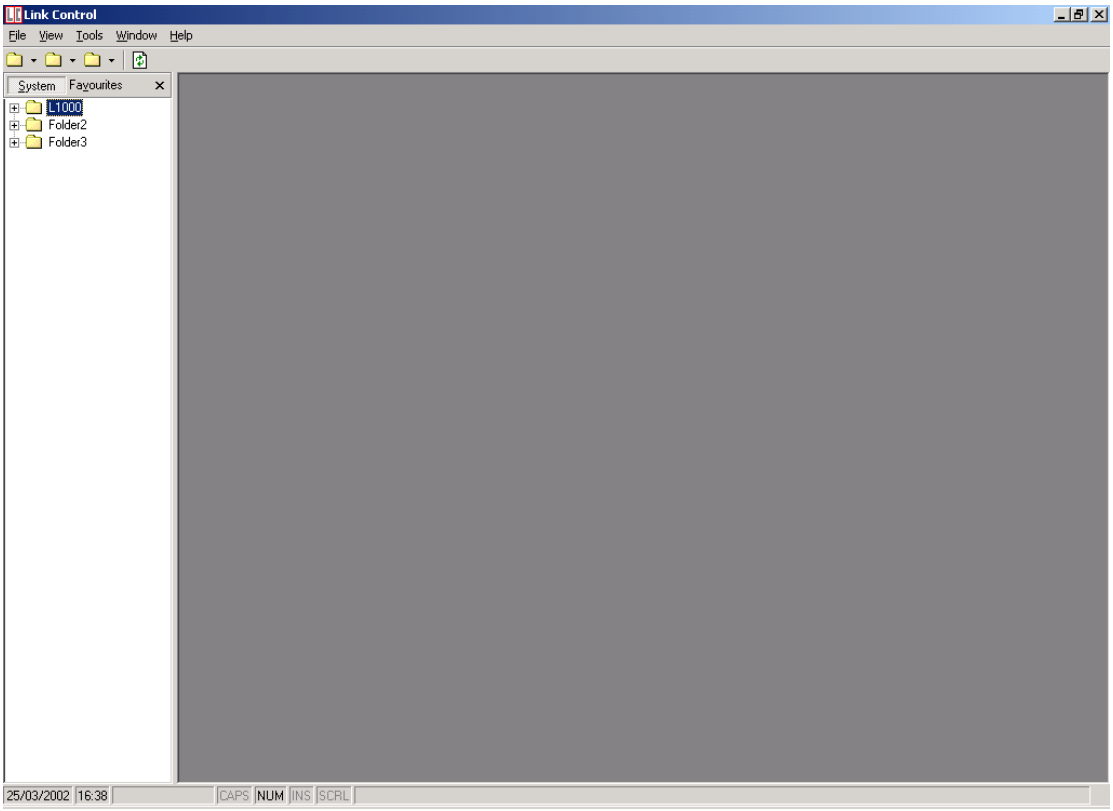

Figure xx – Link Control Programme top-level window

Select the L1000 folder (top of 3) and click on it to expand the tree out.

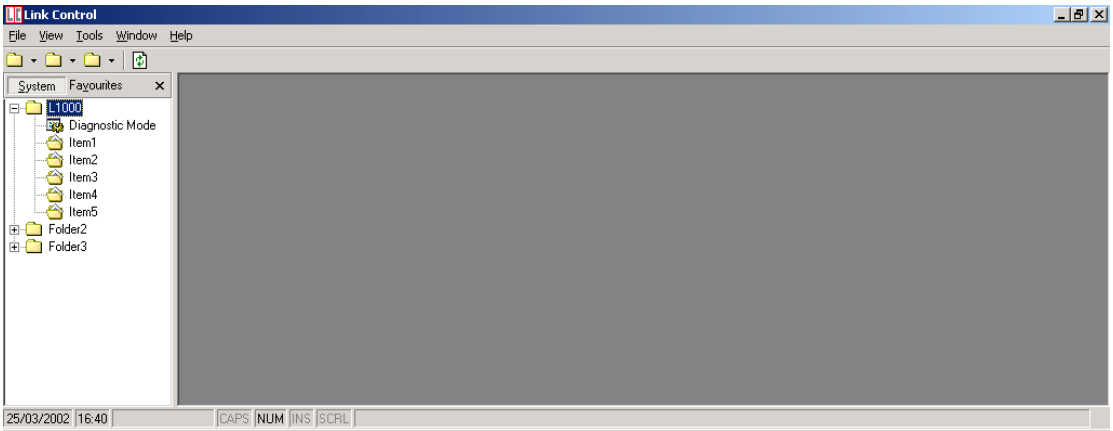

Figure xx – Link Control Programme expanded out

Click on the Diagnostic Mode and this will open the main programme window. A wide range of commands is available, initially all being shown with their default values. These can be edited as required when they are used.

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3.6.2 Copying a profile from memory to disc

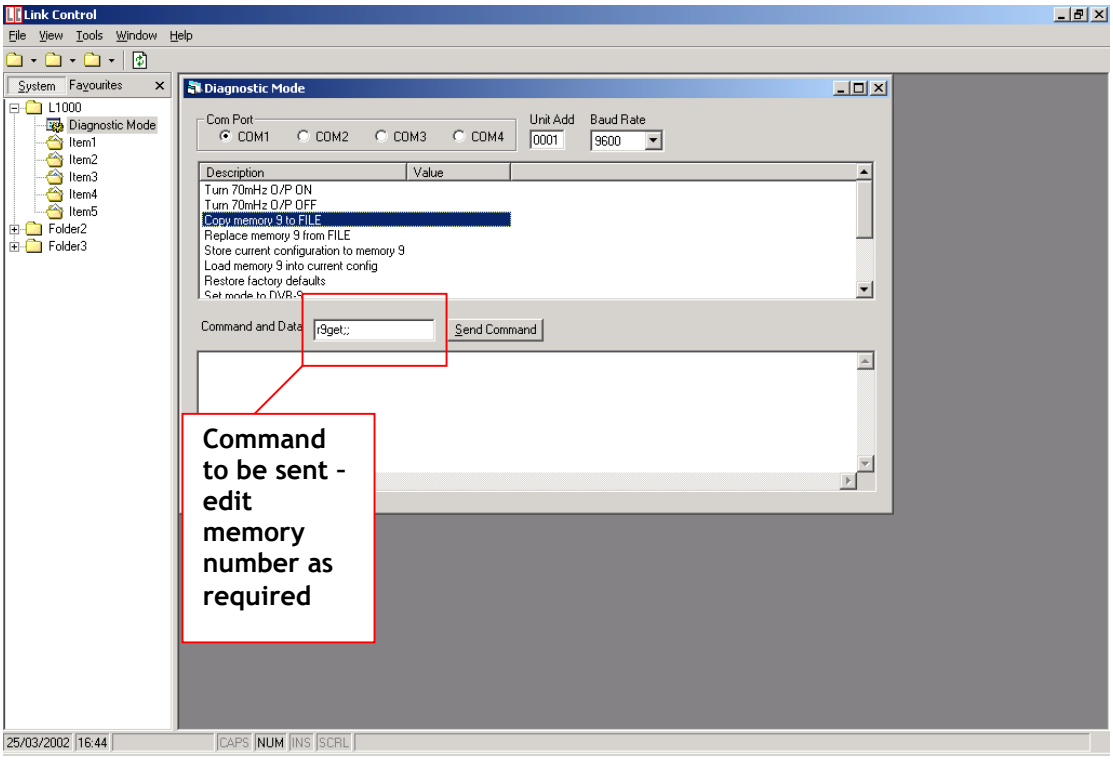

Figure xx – Command window

To copy a configuration from the encoder to the computer's hard disc, select the command "Copy memory 9 to file". The command to be sent will be shown in the centre window and for memory 9 will be **r9get;;**. The value 9 can be edited in the range of 1 – 9 depending on which memory is required. Once this has been done, click on the Send Command button and the encoder will be interrogated for the relevant data. The command sent is displayed in the lower half of the screen and a dialogue box is opened prompting for a file name. The default is Profile1 but this can be edited to any appropriate name.

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Registered in London No. 2074604 Web: www.linkres.co.uk Fax: +44 (0) 1923 241 357

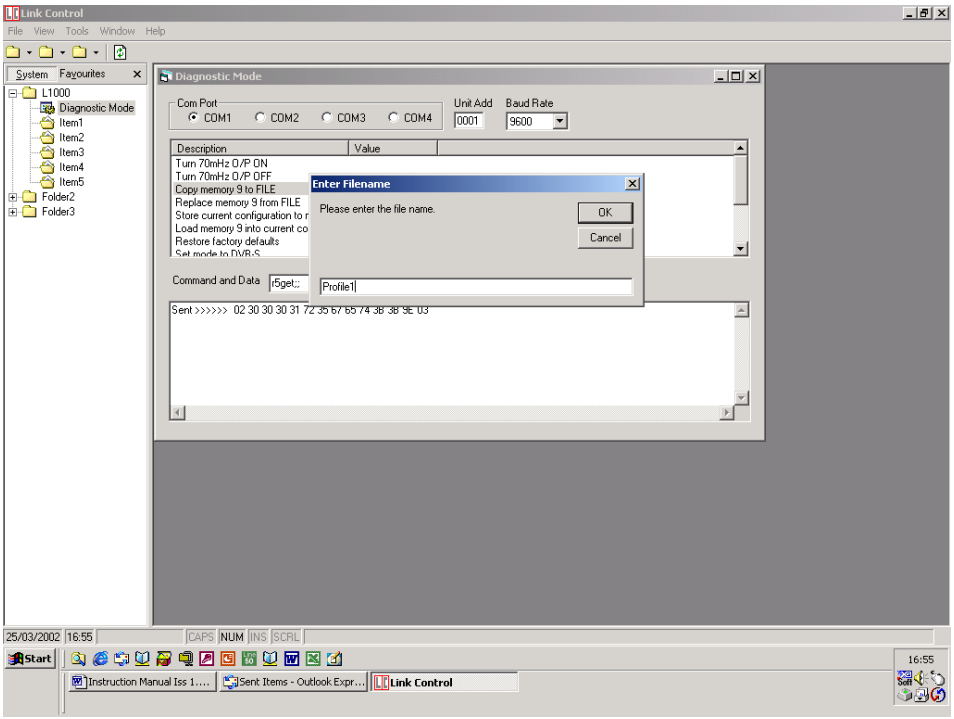

Figure xx – About to copy profile 1 to disc

If the folder "Profiles" does not exist, the programme will create it now. The named file will then be stored in "Profiles", from which it can be restored to any memory location.

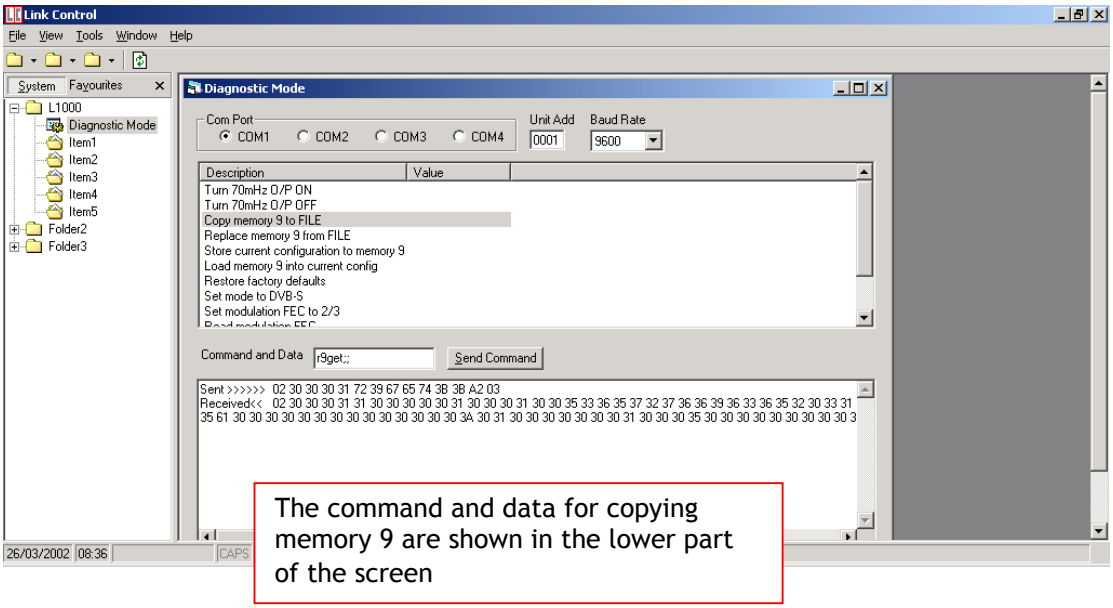

Figure xx – Data copied

3.8.2 Loading a configuration file from disc to a memory location

To load a configuration in memory, select the command "Replace memory 9 from FILE".

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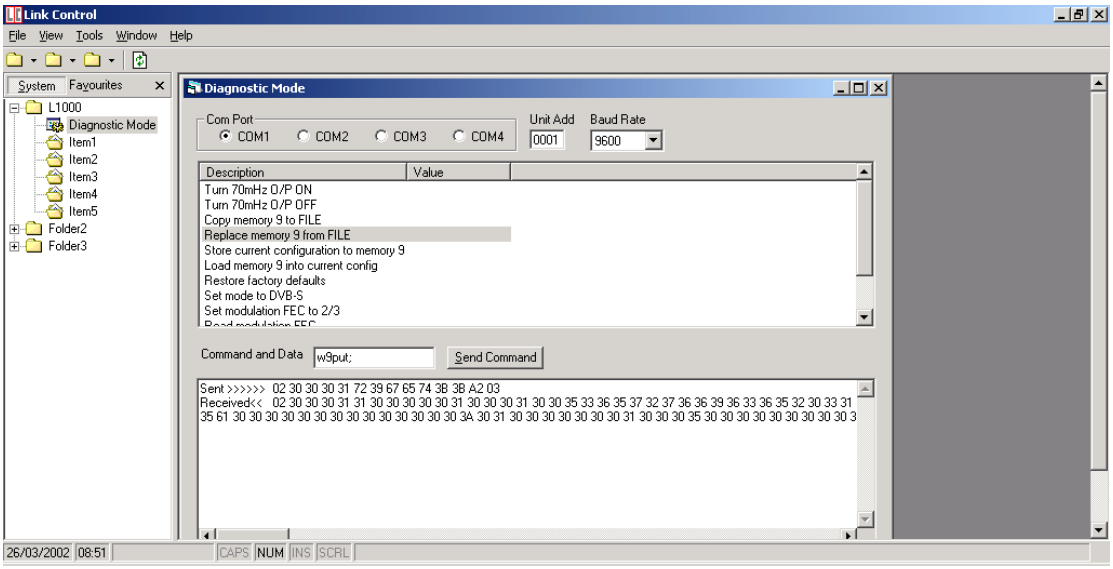
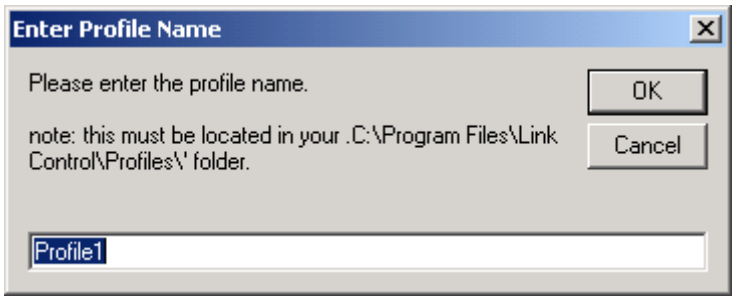


The command **w9put;** is displayed in the centre window where 9 is the memory location that will be filled with the new profile. The memory number can be edited to any value in the range of 1 – 9 as required, but it must be remembered that any profile that is stored in that location will be overwritten when the new profile is loaded. It is therefore good practice to save any existing configurations before overwriting them. If a mistake is made and the wrong configuration is overwritten, it can be restored easily and quickly.

Once the memory location number has been edited and the "Send Command" button has been pressed, a secondary window will open asking for the name of the file to be loaded to the designated memory. It is not possible to edit the pathname because by default this is the folder "Profiles". Enter the name of the required file and click on OK. The file will be transferred to the specified memory location and is immediately ready for use.



Other memories can be configured in the same way.

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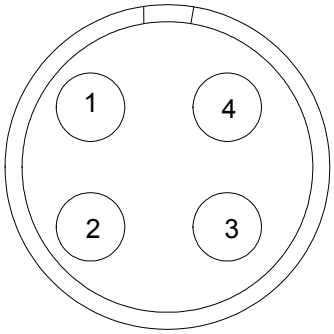
3.7 Lemo connector pin-outs

3.7.1 4 Way power connector

Locating lug

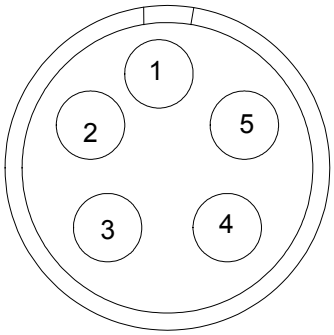


Pins 1 & 2 soldered together – negative – black wire connected

Pins 3 & 4 soldered together – positive – red wire connected

3.8.2 5 Way Audio

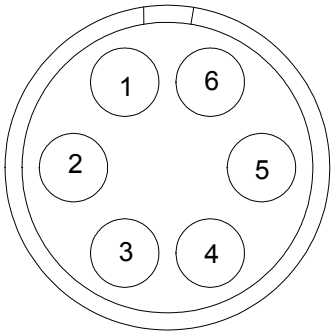
Locating lug



Pin 1 Left +
Pin 2 Left -
Pin 3 common ground
Pin 4 Right +
Pin 5 Right -

3.7.3 6 Way data and remote control

Locating lug



Pin 1 data input TX wired with orange wire
Pin 2 data input RX wired with orange wire
Pin 3 data input ground wired with orange wire
Pin 4 remote control input TX wired with yellow wire
Pin 5 remote control input RX wired with yellow wire
Pin 6 remote control ground wired with yellow wire

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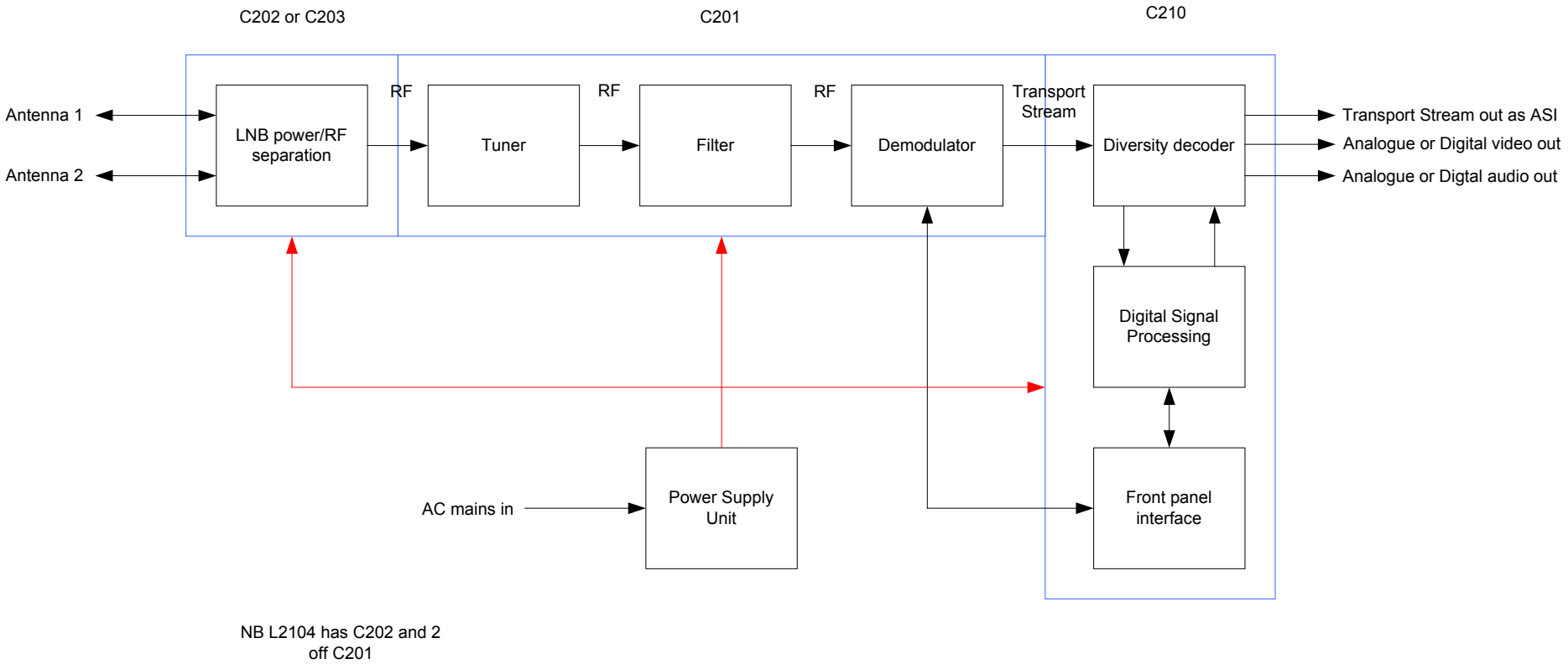
Block Diagrams

3.8.2 L2102/L2104 Receiver block diagram



NB L2104 has C202 and 2 off C201

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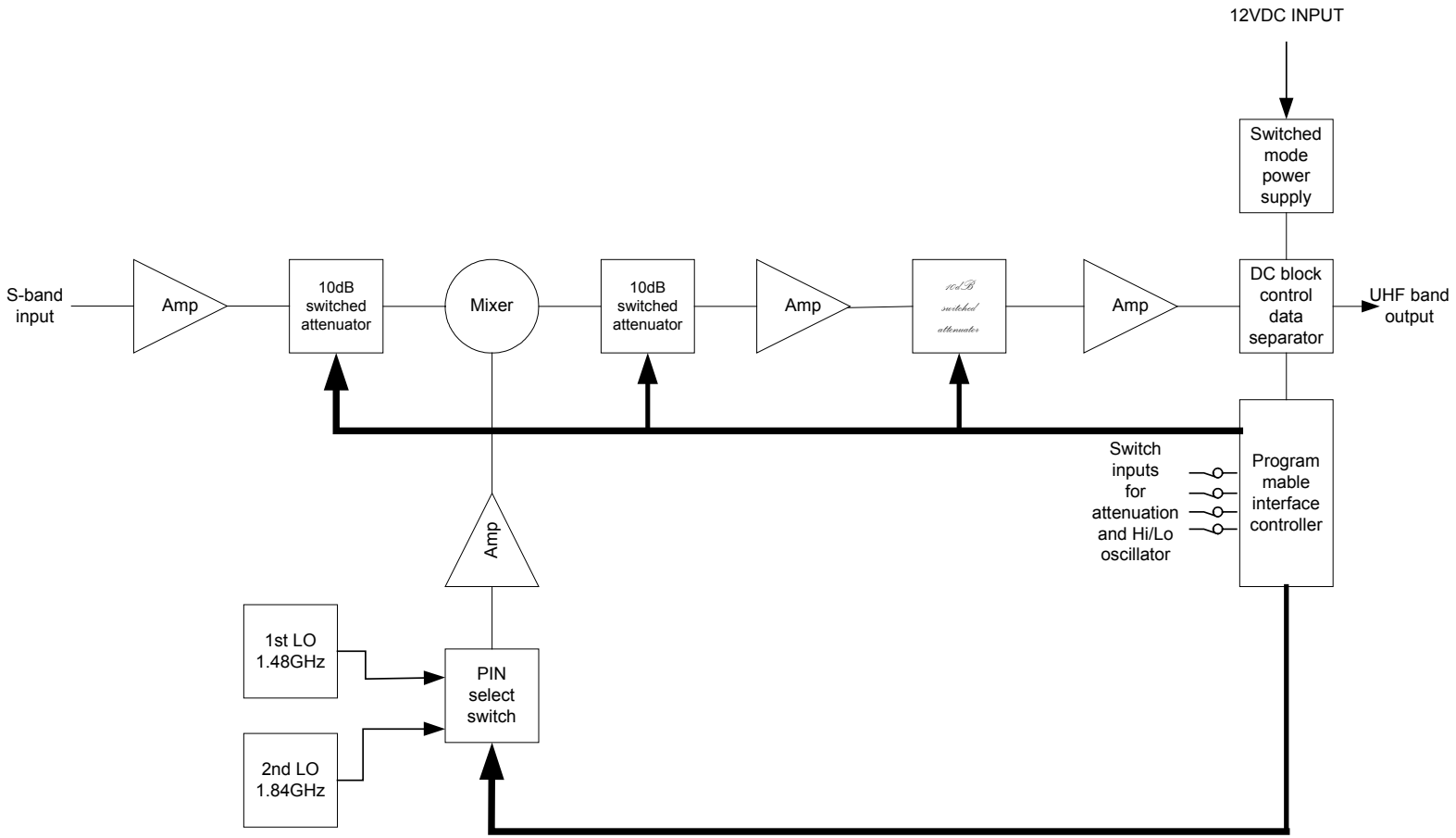
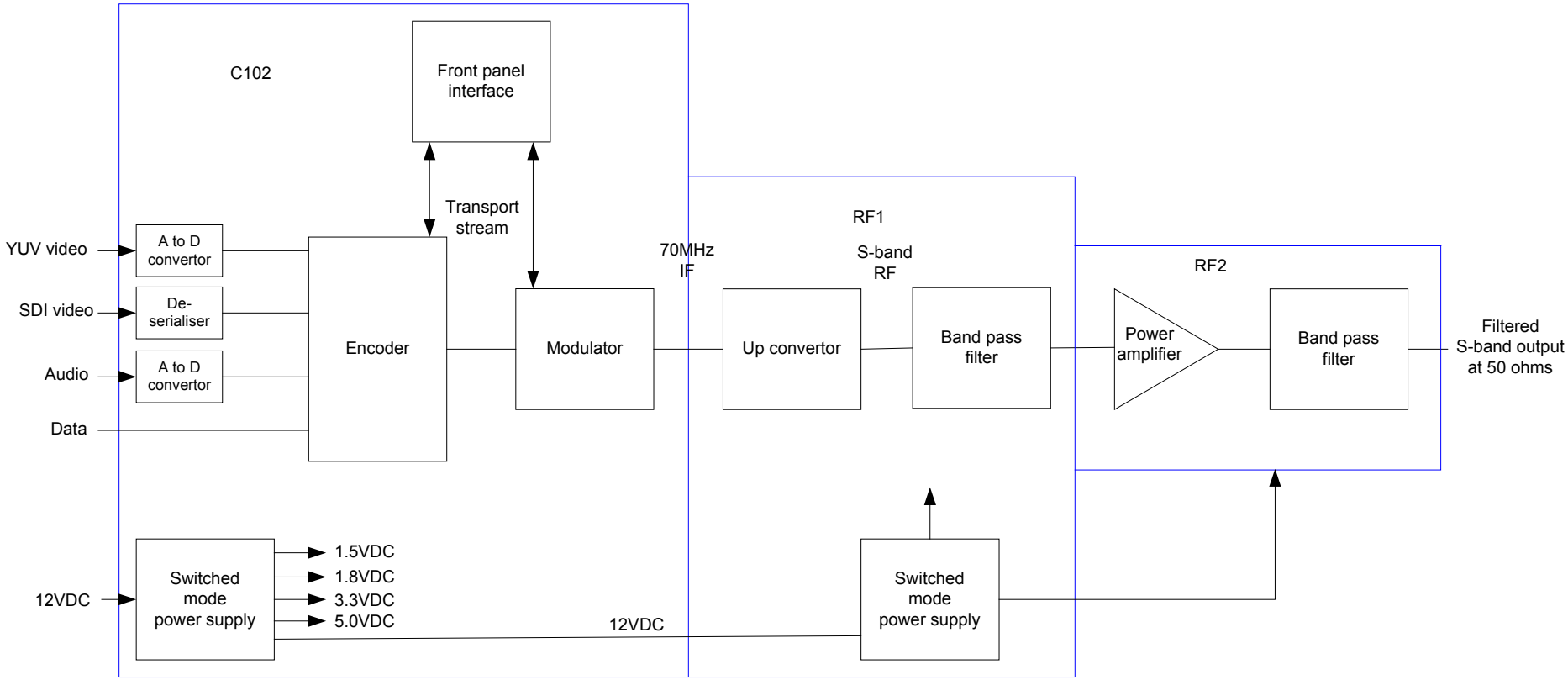
3.8.2 L3010 Down convertor block diagram



3.8.3 L110x Encoder/transmitter block diagram



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