AUSTRALIAN RAIL TRACK CORPORATION LTD

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Engineering Standard – NSW

Category

Communications

Title

Train Radio Systems - CountryNet

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About This Standard

This document provides information concerning the functionality and technical operation of the Australian Rail Track Corporations CountryNet Train Radio System.

This document is primarily intended to be read by parties wishing to gain an understanding of the operation of CountryNet and the options available for installation.

The primary mode of communication for CountryNet is for communications between a Driver and Train Controller. The range of functionality available has been designed to address the operational requirements in regional areas of the state where the radio systems are used.

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Contents

1 Overview

1.1 Introduction

ARTC has three radio systems that have been specifically built to support train operations. Each system provides functionality that has been optimised to address the different communication needs across the Metropolitan and Regional parts of the ARTC network.

MetroNet is a system tailored for the high traffic and demand experienced in the metropolitan areas and CountryNet is optimised for all other areas of the state. WB or local radio is a legacy radio system that has been retained for specific purposes in a variety of configurations.

This document refers to a number of system design documents contained in the Appendices relating to CountryNet. Due to the nature of the Intellectual Property encompassed in these documents, they do not form part of the publicly released standard. However, these documents can be made available subject to suitable confidentiality agreements being executed between ARTC and the Operator and the Operator's sub-contractors.

1.2 Metronet

Metronet coverage is available throughout the Metropolitan Area as shown in the Signaller coverage map in Figure 1 below.

Figure 1: Metronet Signaller Areas

Note: CountryNet does not operate within the electrified area.

CountryNet provides secure voice and data communications between train drivers and Train Controllers. The CountryNet system uses a network of over 100 base stations located along the railway and also uses the Optus Mobilesat satellite to provide coverage over all the regional areas of the state up to the extent of the electrified area. In order to allow for transition between the CountryNet and MetroNet, CountryNet coverage is bounded by Campbelltown, Lithgow, Adamstown and Unanderra.

CountryNet consists of eight separate systems, one serving each country control area. It is based on terrestrial radio in the Railways of Australia band (403-420 MHz), and also uses Optus satellite services to cover remote areas of the State. Satellite radio also serves as a backup to terrestrial if required.

CountryNet provides simultaneous two-way conversation between driver and Train Controller. The Train Controller accesses CountryNet by means of a Train Control Work Station (TCWS). All trains present in a control area appear as "icons" on the screen of the TCWS. The controller places calls to trains by touching the relevant "icon" on the touchscreen of the TCWS.

The CountryNet system can be accessed via two mobile options consisting of a combined terrestrial and satellite system and a satellite only system. The CountryNet satellite only option is referred to as the CountryNet Satellite Mobile (CSM).

Drivers do not place calls – they enter a "call request". The train's icon on the TCWS then changes colour to green, providing a clear visual indication that the request has been made. If more than one train has requested a call, each relevant icon changes to green. An "Answer Next" button permits the Train Controller to answer calls in an orderly fashion.

1.4 Local (or WB) and Mountain Radio

Local or WB radio provides open channel, all informed communications on the frequency 450.050 MHz using a PL (Private Line, also known as CTCSS) tone identifier. The PL tone is not heard by the users and provides a means for the receiving equipment to discriminate between different users on the same 450.050MHz frequency. The letters WB stand for "Without Brakevan" which refers to an earlier usage of the system, however, this designation has become the common term for all 450.050 MHz communications. It is also sometimes referred to as Traffic Radio and old Train Radio. In recent times the term Local Radio has been introduced in reference to this type of communication to denote the new use of the system.

The PL tone generally in use is 173.8 Hz which is used to communicate between WB users in most parts of the state. WB Radio operates in simplex mode, where each user needs to press the talk button during a message in order to transmit a message. In order to limit some of the interference issues inherent in an open channel system, special PL configurations have also been established in areas such as the Hunter Valley.

Mountain Radio is a derivative of WB using a PL tone at 103.5 Hz instead of 173.8 Hz. This system is in use in the Unanderra to Moss Vale Area.

A derivative of WB is also used to provide access to the CountryNet ROAM mode described in the CountryNet system.

2 CountryNet Functionality

The core requirement of CountryNet is to provide communications between the Train Controller (TC) and the Train Driver (TD). The primary medium for communications is the terrestrial system, which consists of approximately 120 Terrestrial bases, strategically placed, and operating on nine UHF channels in the ROA (Railways of Australia) band. Satellite is the prime medium of communications in remote and low traffic density areas, and as a backup to the terrestrial system. CountryNet supports a variety of voice and data calls. All calls are adhere to following principles:

a) All calls are initiated and terminated by TC.

b) Train Drivers can only request a call from TC.

c) Each system can support only one voice call at the time.

d) All calls between TC and TD are of the selective calling type, i.e. no third party can listen in, unless it is directed to.

The following is a summary of the various calls supported by CountryNet, and the main features characterising these calls:

2.1 Normal Calls

Most communications between the Train Controller and Trains Drivers are of the Normal Call type. These calls are private and are established by using selective call techniques. Normal calls initiated by the Train Controller are by the locomotive number. CountryNet must find the locomotive (if it is allocated to the Train Controller and within the Train Control area) and then establish the call over either the terrestrial or satellite system.

Calls from the Train Driver to Train Control are initiated by the driver pressing the "Control" button on the driver’s console. CountryNet converts this action into a data transmission and a call set up procedure follows. This involves displaying the call request to the Train Controller in terms of the locomotive number, the train number and the locomotive location (line and kilometer post).

Only the Train Controller may connect a call for speech. The Train Driver may make a call request but normally is unable to converse with the Train Controller until the Train Controller accepts the call.

2.2 Priority Calls

The Train Controller, in addition to calling an individual train can also broadcast the call to all trains which may be affected by the message. To achieve this the Train Controller initiates a "Priority Call". CountryNet prompts the Train Controller to identify the locomotive to which the call is addressed and the geographic area affected. CountryNet then broadcast the call over all relevant Base Stations and to all satellite trains operating in the selected geographical are. The Priority Call will always cover at least the Base Station on which the addressed locomotive is connected and on the bases adjacent to it. Priority Calls can use either the terrestrial or satellite

systems or a combination of the two.

Each train within the coverage area of a base station or operating via satellite and receiving a Priority Call connects the call to the locomotive loudspeakers so that the driver hears the call without taking any action. Only the locomotive to which the call was addressed is able to respond to the call.

2.3 Broadcast Calls

Under certain conditions, the Train Controller may elect to make a one-way call to a group of locomotives. Such call is known as a Broadcast Call. It employs the same techniques as a Priority Call, with the exception that no destination loco is nominated for a one-to-one call. All locos that participate in a Broadcast Call, either terrestrial or satellite, connect the call to the locomotive loudspeakers so that the driver hears the call without taking any action. The same geographical areas are used for Priority and Broadcast calls.

2.4 Emergency Calls

A train driver may at any time initiate an "Emergency Call". The Emergency Call request is immediately conveyed to the Train Controller, interrupting a current call if necessary. After the Emergency Call request has been conveyed a distinctive alert tone is sounded over the Train Controller Work Station to provide an audible alarm to the Train Controller. The Train Controller must manually cancel the alert tone. The Train that initiated the call is identified on the Train Controller Work Station in terms of the locomotive number, the train number and the train location (line and kilometer post).

If the Train Controller is connected to another call when the Emergency Call is initiated, CountryNet allows that call to continue for a short period. If the Train Controller has not terminated the current call at the end of that period, the Emergency Call connects automatically and the previous call is cleared.

When the Emergency Call is connected, a command is transmitted on the Base Station on which the call was received and on every adjacent Base Station. The command is addressed to all locomotives and its effect is to connect the call to the locomotive loudspeakers. The drivers in these locomotives hear the outbound audio without taking any action. Only the locomotive that initiated the Emergency Call is able to transmit.

Trains that operate in the satellite zone go through a similar process, except that the criteria for “adjacent” locomotives is not based on being in the operational range of a certain Base Station, but rather on distance. All trains operating within a certain distance (currently set to 50 Kilometers) from the train that initiated the Emergency Call participate in the call, in the sense, that the drivers in these locomotives hear the outbound audio without taking any action.

2.5 Local Calls

Local calls are used between train crews and between train crews and track-side staff and between train crews and signallers. These communications are conducted on an open channel basis using a separate radio system. Further details of this system are contained in section 3.

The power of the radios used (primarily portable radios), and the terrain in which the train

operates determine the range of Local Calls.

2.6 Repeater Call

Under certain circumstances it is necessary for the train driver to leave the locomotive cab and attend to a fault or problem within the vicinity of the train. Communications with Train Control must be maintained during the period that the driver is outside the locomotive cab.

This is be achieved by setting the locomotive radio equipment to a "Repeater" mode. In that mode, calls made by the driver from a portable radio are received by the Local Radio equipment and then retransmitted to Train Control over CountryNet. A similar process takes place for Train Control initiated calls.

2.7 Location Polling

CountryNet provides the Train Controller with the means for polling trains for their position and status. Generally polling is automatic, with trains operating in the terrestrial zone being polled every five minutes. Similarly, trains that operate in the satellite zone, are polled every twenty minutes. In addition the Train Controller can manually poll any train at any time.

Location polling is completely transparent to the Train Driver. Train Drivers get no indication that a poll is taking place. In response to a poll command, the locomotive radio system returns its current latitude and longitude coordinates, as well as, the status of its main radio subsystems. This information is propagated via CountryNet in the form of data and is used to locate the train icon on the TCWS screen. Status information is logged in the Maintenance Terminal if it indicates a fault condition. Terrestrial polling which fails to return location data is automatically re-tried over satellite.

2.8 Data Calls

CountryNet provides for the transmission of data between Train Control and the locomotive radio system. The data can be either ASCII or binary. The flow of data is bi-directional and mainly transparent to the Train Controller and the Train Driver. Data calls can co-exist with voice calls, providing the trains in question operate through separate base stations or via the satellite system.

2.9 Diagnostic and Test Calls

Maintenance of CountryNet and the locomotive radio systems is the domain of the Maintenance Terminal (MT). The MT connects directly to the System Controller, and can generate a range of test and diagnostic calls to any train that operates in the system. As the MT does has no knowledge of whether a certain locomotive operates via the terrestrial or satellite networks, all MT Test Calls are originated via the terrestrial system and then re-tried over satellite, if communications can not be established over the terrestrial system.

2.10Handportable Functionality

The CountryNet ROAM mode is described in section 3.

3 System Description

3.1 Overview

CountryNet is in essence a union of eight independent systems, each serving the needs of the eight Train Control zones in NSW. The systems may vary in the amount of infrastructure they contain, but are identical from the operational aspect. There are no physical interconnections between the system, however, trains have a provision to "change-over" from one system to another, as they cross the boundaries between the Train Control zones. CountryNet provides a variety of voice and data calls, but adheres to the principle that only one voice call can be connected between Train Control and a train (or group of trains) at any given time. Full technical details describing CountryNet components, interfaces and operation are contained in Appendix A – CountryNet System Specification. The network configuration is illustrated in Figure 3 below.

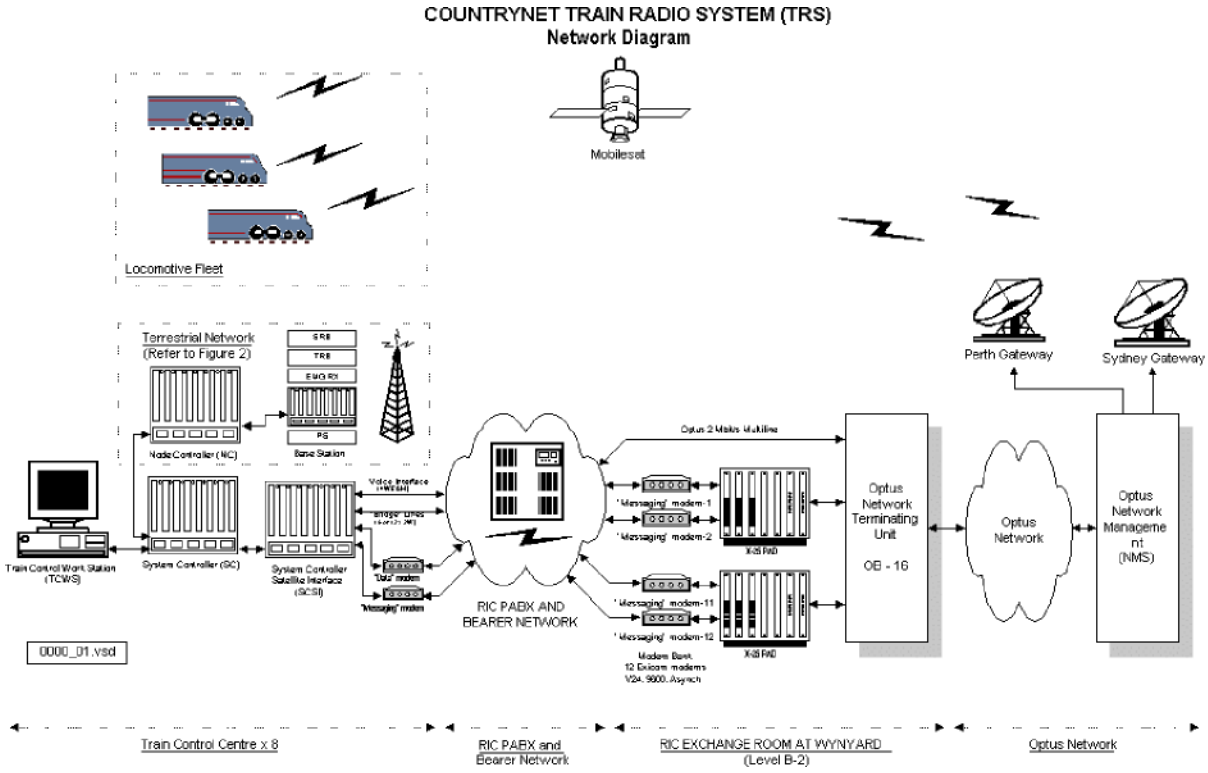

Figure 3: CountryNet System Overview

3.2 Terrestrial System

The terrestrial infrastructure consists of base stations strategically positioned along the major rail routes, and linked via a network of nodes to a single control point, namely, the Train Controller Workstation (TCWS) and the System Controller (SC). The system has been designed to minimise the requirements for links between the base stations and the SC. Node Controllers (NC) are used to group a number of base stations, and route them via a single link to the SC. CountryNet makes use of a variety of links. These include: 4W E&M Voice Link circuits leased from various carriers, and Australian Rail Track Corporation (ARTC) owned bearers and radio links. The terrestrial system configuration is illustrated in Figure 4 below.

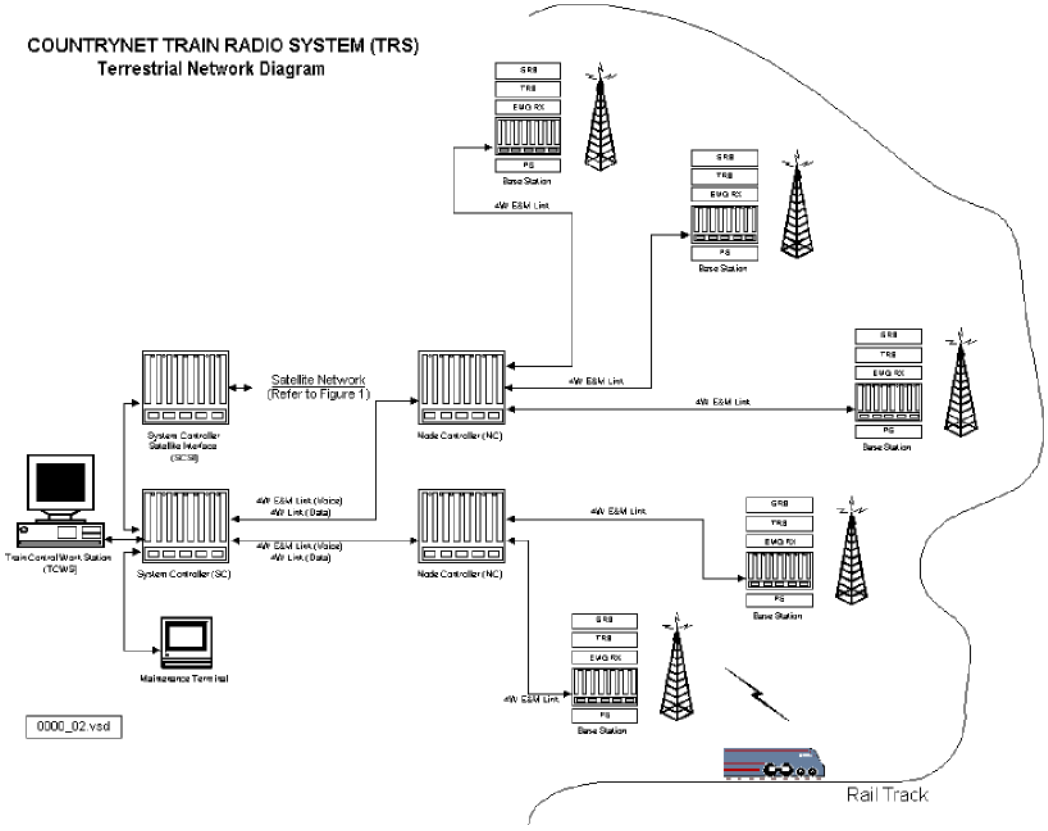

Figure 4: CountryNet Terrestrial Network Overview

3.3 Satellite System

The satellite portion of CountryNet utilises the Optus MobileSat service for both voice and data communications. The MobileSat Short Data Messaging (SDM) service is used also to provide some of CountryNet features when a locomotive utilises the satellite medium. The basic satellite element in the locomotive is the NEC S1 MobileSat Terminal.

3.4 GPS Operation

The CountryNet and in particular the locomotive system, make extensive use of Global Positioning System (GPS). CountryNet uses raw GPS data transmitted from the locomotive equipment to locate trains on the Train Control WorkStation screen. In addition to the function of locating trains on computer screens, the locomotive equipment uses GPS data to determine many aspects of its operation. GPS data in conjunction with a locomotive database is used to determine the following operational aspects:

1) Which Train Control Centre is to be used for given geographical areas.

2) Transitions from terrestrial to satellite operation and visa versa.

3) Transitions between Train Control Centres.

4) Selection of operational frequencies in terrestrial areas.

5) Selection of base stations in terrestrial areas.

6) Transitions between base stations whilst operating in a terrestrial area.

Fail safe mechanisms are provided for both terrestrial and satellite areas to allow terrestrial and satellite operation even in situations where GPS information is not available.

4 Technical Specifications

4.1 Introduction

The performance figures given are typical figures, unless otherwise indicated, for equipment tuned with the maximum switching band and operating at standard room temperature. Mobile radio performance shall be as detailed below and in accordance with Australian Standard AS4295 – 1995. The test methods used to obtain the following performance figures shall be as per AS4295.

4.2 ROA Radio Specifications

Parameter	**Requirement**
General	
Modulation	FM
Frequency Error	±1.5kHz (environmental limits in Appendix B - Spec 1122)
Frequency Band	403-420MHz
Channel Spacing	25kHz
Channel Capacity	100 channels minimum - programmed from any combination of frequencies within the switching range.
CTCSS Encoding and Decoding	All EIA frequencies.
Frequency Synthesis	Separate transmitter and receiver synthesisers.
Switching time (transmit to receive and receive to transmit)	To comply with requirements for operation as a trunked mobile under Specification MPT1327 and to comply with BR1845.
Antenna Impedance	50 Ohms unbalanced.
Antenna Connector	BNC or equivalent.
Interface Connector to Mobile Controller	*TBD – internal interface.*
Interface Protocol and Circuits	*TBD – internal interface.*

Power Supply Voltage (specified f)	13.8V DC ±2.5V

Parameter	Requirement
performance)	
Power Supply Noise Immunity	Equipment unaffected by noise of 200mV RMS at any frequency or combination of frequencies between DC and 50MHz.
Reverse Polarity Protection	Indefinite application of reversed polarity power supply shall not affect more than one passive component.
Power Consumption	<0.5A Standby, <1A Receive, <8A Transmit
Environment, Shock & Vibration	Appendix B - Specification 1122
Corrosion Protection and Finishes	Corrosion protection and finishes in accordance with Appendix B - Spec 1122.
Labelling	As per ACA requirements.
Cooling	To be determined by locomotive Operator
MTBF	60,000 hours
Transmitter	
Switching Range	408.625MHz - 410.550MHz
Output Power - High Power	25W ±2.5W (without Diplexer)
Output Power - Low Power	10W ±1W (without Diplexer)
Duty Cycle	Continuous.
Transmit Timer	Transmit Protect - Power Amp switched off when communications to radio processor is lost.
Spurious Radiation	<2.5mW
Distortion	<3%
Intermodulation	15dB below interfering signal.
Antenna Mismatch	Operation into indefinitely applied open circuit or short circuit and all other mismatch conditions without damage.
Deviation	±3.5 kHz for 1kHz input tone at nominal level. *The nominal level is an internal interface and therefore not specified in this document.*
Modulation Linearity	+1, -3dB from 300 to 3,000Hz without CTCSS. +1, -3dB from 500 to 3,000Hz with CTCSS.
Receiver	
Switching Range	418.075MHz - 420MHz

Parameter	Requirement
Sensitivity	0.31mV PD for 12dB SINAD (Including Diplexer)
Selectivity	Better than 74dB (without Diplexer)
Intermodulation	Better than 75dB (without Diplexer)
Desensitisation Immunity	Sensitivity unaffected by input signals of up to 25mW within the transmitter switching range and within the range 450MHz to 470MHz. Better than 90dB at all other frequencies.
Distortion	<3%
Signal to Noise Ratio	>40dB for input signals higher than -80dBm
Modulation Response	Nominal output for input signal with deviation of 3.5kHz and modulating frequency of 1kHz. *The nominal level is an internal interface and therefore not specified in this document.*
Modulation Response Linearity	+1, -3dB from 300 to 3,000Hz without CTCSS. +1, -3dB from 500 to 3,000Hz with CTCSS.
Squelch Setting (RF)	Adjustable over range <10 to [3]20dB Sinad (25 kHz)
CTCSS Sensitivity	0.5mV PD

4.3 Local Radio Specification

Parameter	Requirement
General	
Modulation	FM
Frequency Error	±1.5kHz
Frequency Band	450 - 470MHz
Channel Spacing	25kHz
Channel Capacity	100 channels minimum - programmed from any combination of frequencies within the switching range.
CTCSS Encoding and Decoding	All EIA frequencies.
Frequency Synthesis	Separate transmitter and receiver synthesisers preferred, but not mandatory.

Switching time (transmit to receive and receive to transmit)	<25ms from receive to transmit on 90% of full power. <25ms from transmit to receive ih f l l i i i

Parameter	Requirement
	with full sensitivity.
Antenna Impedance	50 Ohms unbalanced.
Antenna Connector	Type N Female.
Power Supply Voltage (specified performance)	13.8V DC ±2.5V
Power Supply Noise Immunity	Equipment unaffected by noise of 200mV RMS at any frequency or combination of frequencies between DC and 50MHz.
Reverse Polarity Protection	Indefinite application of reversed polarity power supply shall not affect more than one passive component.
Environment, Shock & Vibration	Minimum Appendix B - Specification 1122
Labelling	As per ACA requirements.
Cooling	To be determined by Operator
MTBF	60,000 hours
Transmitter	
Switching Range	450 - 470MHz
Output Power - High Power	25W ±2.5W
Output Power - Low Power	5W ±0.5W
Duty Cycle	10% transmit, 10% receive and 80% standby.
Transmit Timer	Transmit Protect - Power Amp switched off when communications to M.C. is lost.
Spurious Radiation	<2.5mW
Distortion	<3%
Intermodulation	15dB below interfering signal.
Antenna Mismatch	Operation into indefinitely applied open circuit or short circuit and all other mismatch conditions without damage.
Deviation	±3.5 kHz for 1kHz input tone at nominal level. *The nominal level is an internal interface and therefore not specified in this document.*
Modulation Linearity	+1, -3dB from 300 to 3,000Hz without CTCSS. +1, -3dB from 500 to 3,000Hz with CTCSS.
Receiver	

Switching Range	450 - 470MHz.

Parameter	Requirement
Sensitivity	0.31mV PD for 12dB SINAD.
Selectivity	Better than 74dB.
Intermodulation	Better than 75dB.
Desensitisation Immunity	Sensitivity unaffected by input signals of up to 25mW within the transmitter switching range and within the range 403MHz to 413MHz. Better than 90dB at all other frequencies.
Distortion	<3%
Signal to Noise Ratio	>40dB for input signals higher than -80dBm
Modulation Response	Nominal output for input signal with deviation of 3.5kHz and modulating frequency of 1kHz. *The nominal level is an internal interface and therefore not specified in this document.*
Modulation Response Linearity	+1, -3dB from 300 to 3,000Hz without CTCSS. +1, -3dB from 500 to 3,000Hz with CTCSS.
Squelch Setting (RF)	Adjustable over range <10 to [3]20dB SINAD (25kHz).
CTCSS Sensitivity	0.5mV PD

5 Locomotive Antennas

5.1 General

The Contractor shall supply and install antennas on the locomotives in accordance with Appendix B & C Specifications 1122 and 1133. The antennas shall be of low profile construction and shall be ruggedly built. The antennas shall be constructed of materials which are unaffected by the chemicals and compounds which accumulate on locomotives and which are used to clean locomotives.

The antennas shall be sufficiently robust to withstand coal dropping from coal loaders as the locomotive passes through the loader without impairment of the antenna performance or corrosion resistance.

5.2 UHF Antennas

UHF antennas shall be of low profile, cast or machined construction and shall be inherently earthed. The antenna earthing shall be sufficient to protect the train crew from any risk of electric shock if the antenna should come into contact with the overhead electrical wiring.

The antenna radiation pattern shall be omni-directional in the horizontal plane and at elevations of up to thirty degrees with a gain of not less than 0dBi in any direction. The antenna bandwidth shall be not less than 20MHz for A VSWR of 2.0 to 1.

Radio Frequency Systems Type LU1-H or Radio Frequency Systems TLA400 have been successfully used in existing installations.

5.3 Antenna Separation

CountryNet mobiles normally operate in duplex mode when in the CountryNet terrestrial area. It important that the antenna is located to minimise interference form other transmitting antenna on the train where these will be transmitting inside the CountryNet terrestrial area.

There is no concern, say with MetroNet as this will not, under normal conditions transmit within the CountryNet area and will not therefore cause interference or receiver de sensing to the CountryNet mobile.

Consideration has to be given to other system receivers, and their antennas, where these need to function in the CountryNet area (such as WB/local radio).

CountryNet Mobiles can transmit unsolicited messages outside of the CountryNet terrestrial area. There is therefore the possibility that interference may occur to another system when outside of CountryNet terrestrial area..

Sharing of antennas for CountryNet terrestrial operation is not recommended, nor are separate Tx or Rx connections available.

5.4 GPS Antennas

As indicated above trials have shown that GPS antennas must be separated by at least 1 metre from sources of RF in the ROA band if there performance is to be maintained.

The CountryNet processor requires valid GPS data while in and outside of the CountryNet area, it is important that its associated antenna is therefore distanced from other sources of RF radiation.

5.5 Satellite Antennas

Antennas that are currently in use are:-

SpaceCom steerable Dome Antenna Model A2457

The Operator shall provide mobile antenna subsystems that are fully equipped to:

- interface fully with the Mobile Satellite Transceivers;
- meet the locomotive mounting requirements and height profiles detailed in section 5.5.1
- operate reliably in the locomotive environment

5.5.1 Antenna Profiles And Mounting Requirements

All antennas shall be installed in a manner as not to impinge upon the clearances specified in ARTC Standard C2100 "Transit Space Handbook" and associated standards.

The satellite antenna will be mounted so as to limit degradation of the GPS receiver performance with particular emphasis on limiting desensitisation.

5.5.2 Antenna Environment

The antennas shall be inherently earthed. The antenna earthing shall be sufficient to protect the train crew from any risk of electric shock if the antenna should come into contact with the overhead electrical wiring.

In nomal operating environment it is likely that the antennas will be subject to:

- Rain;
- Diesel fuel spillage and fumes;
- Diesel exhaust;
- Automatic train washing brushes;
- Direct UV sunlight.
- Impacts from objects such as coal.

The Operator shall ensure that an antenna radome or cover is provided to protect the antenna against this locomotive exterior environment, maintaining the MTBF specification of Section 5.5.3 and maximum height profiles ARTC Standard C2100.

5.5.3 MTBF

The MTBF of the complete Mobile Satellite Transceiver system shall exceed 60,000 hours within the locomotive operating environment. This figure shall include all elements of the satellite equipment, including transceiver, antenna, handset (optional), LNA, HPA and cabling.

5.6 Locomotive Equipment Safety

5.6.1 Radiation Hazards and Safety

The Operator shall determine the level of radiation hazard for each antenna subsystem in accordance with AS2772, and where hazards exist, shall implement a suitable method for protection and warning of occupational and non-occupational personnel.

The general construction design standard shall conform to AS3260.

5.6.2 Lightning and Surge Protection

The Contractor shall provide lightning and surge protection equipment, necessary to preserve operator safety and protect the Satellite Transceiver from surges originating from the antenna subsystem.

This detail shall be sufficient to ensure compliance with the requirements of AS 1768.

6 Equipment Installation Options

6.1 Standard CountryNet System

Figure 5 is a block diagram depiction of the various elements that constitute the locomotive equipment. This configuration reflects the existing design, but is not necessarily a recommended blueprint for an alternate design. Changes in technology and obsolescence of various components may dictate a different configuration. Nonetheless, the existing configuration is as good a tool to convey the functional requirements of the locomotive equipment.

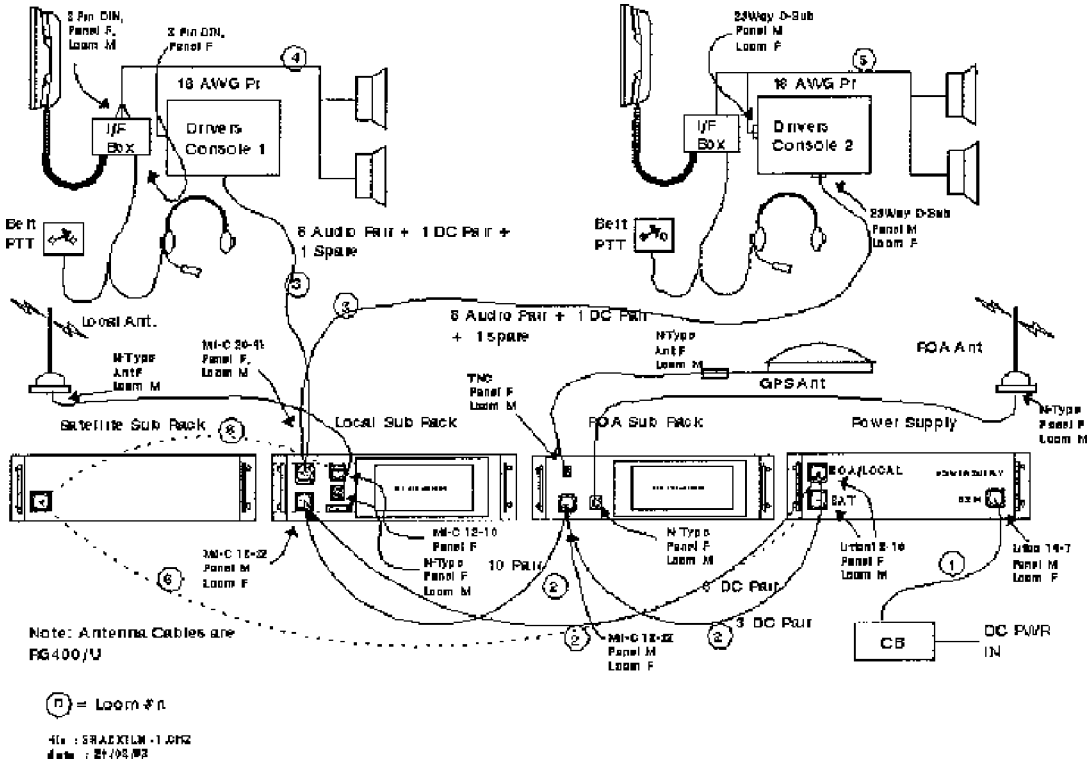

Figure 5: CountryNet Locomotive Equipment

In broad terms the locomotive equipment is made up of the following elements:

a) An ROA band radio and antenna for communication with Train Control.

b) An UHF radio and antenna for local communications.

c) A MobileSat transceiver and interface.

d) A GPS receiver and antenna.

e) A Driver's Console (or two) complete with a handset and two loudspeakers.

f) A Mobile Controller.

g) A Power Supply.

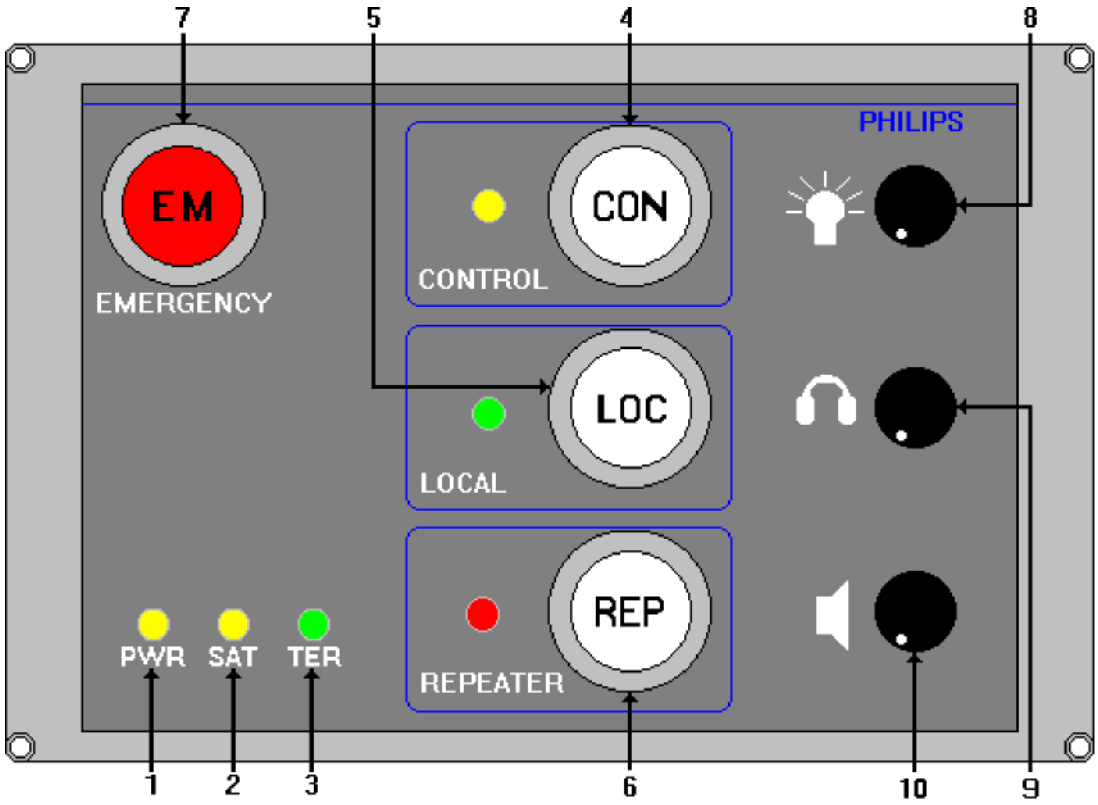

Figure 6: CountryNet Driver's Console

Standard CountryNet equipment is available from Systems Integration Services (SIS) and Comgroup (formerly Simoco).

The standard drivers console is illustrated in Figure 6 above.

6.2 CountryNet Satellite Mobile

6.2.1 Overview

The Countrynet Train Radio System is the primary mode of communication between Train Controllers and Drivers in the country areas of NSW. In order to suite the particular requirements of Heritage and Short line operators, a simplified CountryNet solution has been developed by ARTC. This solution is referred to as the CountryNet Satellite Mobile (CSM).

An interface has been developed for use in conjunction with the NEC S2 satellite transceiver that will enable operation over the CountryNet system. The CSM is a satellite only communication system and all calls to and from the controller in CountryNet areas will be over the OPTUS Mobilesat system. No CountryNet terrestrial infrastructure is used on the locomotives. The CSM

makes use of the existing NEC handset and speaker for

communications over CountryNet. The CSM is packaged in a single 19” rack unit and consists of the following equipment:-

1) The Control and Interface Board,

2) the SRM9000 UHF Transceiver for local radio,

3) the S2 MobileSat Terminal, and

4) the Locomotive Identification Device LID1004A

A standard Locomotive Identification Device (LID1004A) is fixed to the train and provides for unique reporting of locomotive ID. It is only programmable by the controlling authority, and should ne ver require re-programming in the field.

The NEC handset is user friendly as it provides a visual indication of the call progress as also the signal strength at all times. The CSM configuration is illustrated in Figure 7 below.

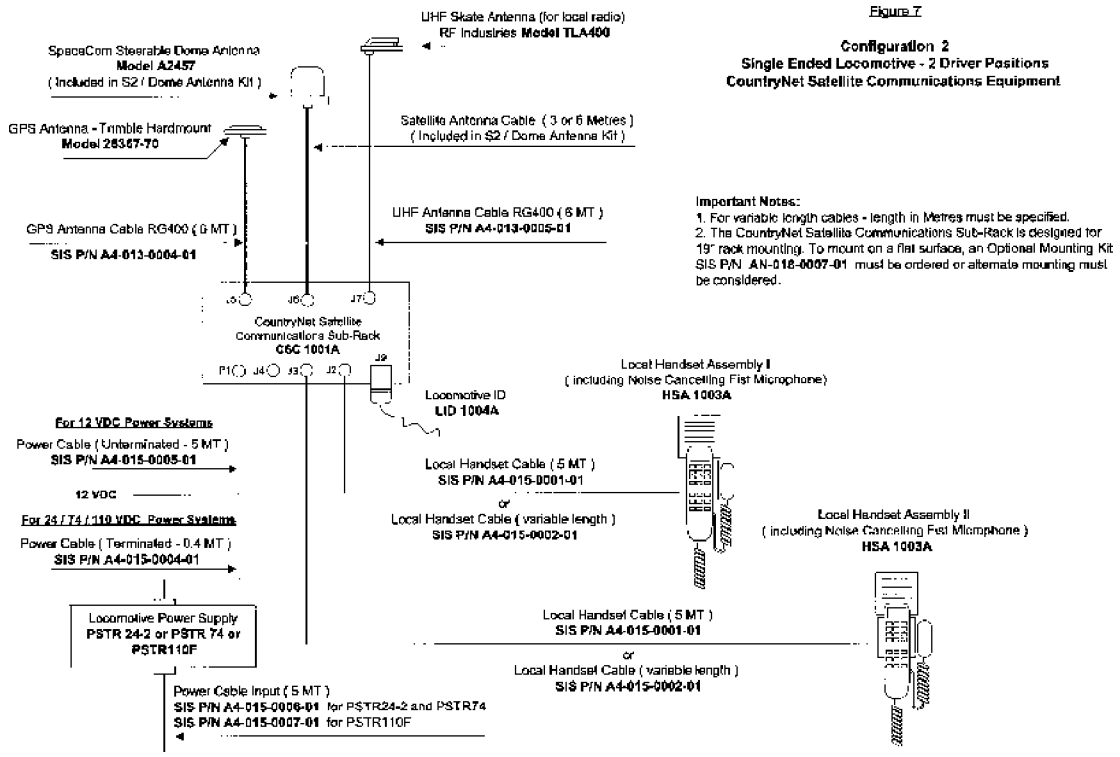

Figure 7: CSM Locomotive Equipment

The CSM supports the following CountryNet functionality: -

(a) Normal calls with the Controller:-

(b) Emergency calls with the Controller.

(c) Priority calls with the Controller.

(d) Broadcast calls with the Controller.

(e) GPS location polls.

In addition, the S2 transceiver can be used as standard satellite telephone and the user can generate and receive calls from outside train control. This however provides additional redundancy as it enables the user to communicate with train control over his desk phone, in the event of a breakdown in train radio communications. However, while on the track and unless there is a breakdown in train radio communication, the S2 should always be available for train radio communications, and should not be used for making any other calls.

6.2.2 Functionality Aspects

The following table provides a brief summary of the CSM functionality: -

Type of Call	Functionality
Initialisation, logging on and registration.	® All that a driver is required to do after power up of the CSM system, is to press P1. Selection of Train Controller area is normally an automatic function, however, override capability is also provided. ® Once the call is answered, the controller can register the locomotive on his screen as per current procedures.
Normal calls	® To initiate a normal voice call by the driver, the driver will press P1 on the NEC handset. ® The controller can then answer the call as per current procedures by just touching the icon and thereon proceed to register the locomotive on the screen. ® The driver communicates with train control using the provided fist microphone. The NEC handset is not normally used for voi9ce communications. ® From then on, the controller can at any time cal the locomotive by just pressing the respective icon. ® The call progress tones, alert tones etc in the loco are similar to the existing functionality in a locomotive.
Emergency calls	® An emergency red button is located on the left hand side handset. This button must be Pressed for at least 1 second t an emergency call. ® As with the current functionality, if the controller is on another

	normal voice call, an incoming emergency call will disconnect the existing normal call and connect the emergency call automatically. ® While an emergency call is in progress, subsequent emergency calls at the train controller's workstation will be queued.
Priority calls.	® A priority call can be set up by the controller to a CSM loco in the same manner as for existing locos in the current system.
Broadcast calls.	® A broadcast call can be set up by the train controller that can also include a CSM loco as per the current system.
Location polls	® Existing functionality will be maintained. Locomotives that are registered on the train controller's screen will be polled for their co-ordinates as per current functionality. ® A train controller can also manually initiate a location poll in accordance with existing functionality.
Train control changeovers	® The changeover process is in accordance with the standard system.
Local calls	® The driver can make a local call by picking up the fist microphone and pressing the transmit button.
Repeater calls	® Repeater calls are available using a series of button presses.

7 CountryNet Standard and CSM Functionality Comparison

Facilities/Features	**CountryNet**	**CSM**	**Comments**
Terrestrial UHF	Yes	No	
Satellite	Yes	Yes	
Local 450.05 interface	Yes	Yes	
Roam	Yes	Yes	
Auto Handover at Boundaries	Yes	Yes	
Driver to Driver	Yes ***(through built in radio – at least 5KM range.***	***Yes (through built in radio – at least 5KM range.).***	
Driver to Signaller/Trackside	Yes ***(through built in radio – at least 5KM range.***	***Yes (through built in radio – at least 5KM range.***	
Tunnels ***in Terrestrial areas***	Yes	No	
Call Functionality			
Driver NCD	Push Button	Keypad – push button	
Emergency	Push Button	Push Button	
Priority calls	Touch Screen	Touch Screen	
Broadcast calls	Touch Screen	Touch Screen	
GPS Location Polls	Auto	Auto	
NCD Call Initiated from Touch Screen	Yes	Yes	
Driver Call initiated from Control Console	Yes Pushbutton	No handset	
NCD Registration/Cancellation	Yes	**Yes**	

Initialisation or Registration to NCD Database Automatic	Yes	Yes	
Provision for Hands free operation	Yes	No	

8 Customised Solutions

8.1 Development Guidelines

If standard equipment from approved suppliers is not purchased, a Type Approval process will be required prior to accreditation for the equipment being granted. The certification process will be at the operator's cost and be conducted by either ARTC or a third party approved by ARTC. The Type Approval process and requirements is described the Train Radio Type Approval Standard.

The non-standard application will be required to conform with the CountryNet Air Interface as detailed in Appendix A - CountryNet System Specification. Functional performance will be verified against the procedures within Appendix D - Locomotive Test Plan.

The radio equipment shall be designed to meet the requirements of the specific installation, however, the equipment shall be designed to meet or exceed the requirements of Appendix B & C specifications 1122, 1133 and tested to meet the requirements of IEC68 (formerly AS 1099) as described within the specification.

8.2 Database Upgrades

The master database is held within the Train Controller ground equipment. For new installations a copy of the current database will be available on disk. The Operators equipment will be required to accept the standard database format. Database upgrades are carried out using a manual process. Updated versions of the database will be supplied to the Operators point of contact for installation into all CountryNet equipped locomotives under the control of that Operator. The Operator shall include facilities to efficiently read upgraded database files and load them into their CountryNet compatible equipment.

9 Coverage

9.1 Terrestrial

Coverage is defined as 100% coverage of all crossing loops and major railway stations, extending 5 kilometres from the centre of the crossing loop in both the Up and the Down directions of travel, 95% of each track kilometre between crossing loops or major stations, and 100% coverage of tunnels in terrestrial areas.

9.2 Satellite

As the satellite system is based on a public network, coverage criteria is measured in terms of call success throughout the area of operation. All satellite train radio implementation will be required to conform to the following call success methodology. At least 9 out of 10 calls initiated shall be successfully received and voice messages will be clearly understood by both parties.

Of the 9 successful calls, at least two thirds should be established in the first attempt with the remaining one third established in no more than three attempts. Any call requiring more than three attempts shall be categorised as fail.

The acceptance criteria will therefore be such that for every 10 calls made, at least 9 calls shall be successful as follows:-

- 6 calls Should be successful in the first attempt
- 3 calls Should be successful in at least three attempts

Any call requiring more than three attempts shall be categorised as fail. If the driver does not respond or is unable to accept the call after three attempts by the controller, a failure will be registered.

No satellite coverage is provided or required for tunnels.

10 Locomotive Power Supplies

The following +12V DC nominal power supplies manufactured by CM. Technology Pty Ltd have been used for standard installations as follows:-

- PSTR24-2: For 24 VDC applications
- PSTR74: For 74 VDC applications
- PSTR110: For 110 VDC applications

This information is provided to assist Operators with equipment selection. Operators should confirm that the above units are suitable for individual locomotive environments and applications.

Appendix A

CountryNet System Specification

Appendix B

CountryNet Equipment Specification 1122

Appendix C

CountryNet Equipment Specification 1133

Appendix D

CountryNet
Locomotive Test Plan