BS422 installation and setup guideline

Ver. 1.30

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INTRODUCTION

This manual is intended for installation and configuration of the BS422 for operational use.

It is recommended that engineers doing the installation and configuration of a BS422 have practical experience in installation of radio and computer systems, and have made themselves familiar with the BS422 equipment through appropriate DAMM training courses and study of the content of the TetraFlex manual and other documentation from DAMM.

IMPORTANT:

Updates / changes / important information related to the TetraFlex® system and software may be downloaded from the protected part of www.damm.dk

Please check this URL for updated information before attempting to install or correct errors

NOTE: Chapters marked with a  indicate areas where special care must be taken to avoid personal injury or damage to the equipment.

Before starting installation and configuration, please read the entire manual carefully.

NOTE: It is the responsibility of the system owner / operator to ensure that only authorized service persons has access to the inside circuits of the BS422

NOTE: It is the responsibility of the system owner / operator to ensure that all local legislation, rules and regulations are complied.

Internal fuses protect the BS422. Always replace with fuses of equivalent value and type.

General Warning

This manual contains important safety and operational information. Please read and follow the instructions in this manual. Failure to do so could be hazardous and result in damage to your device.

Changes and modifications to this device not expressly proved by DAMM could void the user's authorization to operate this device

North America regulations
The Base Station Transceivers and products devices mentioned in this User Manual comply to FCC part 90 and Industry Canada (IC) RS119 regulations for such equipment.
The equipment 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 interference when the equipment is operated in a commercial environment. The equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications.

Canadian regulations
Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

RF Exposure
The DAMM developed transmitting devices mentioned in this User Manual have the Nemko approval concerning “Maximum Permissible Exposure Calculations” which are the European limits for maximum permissible exposure defined in the document 1999/519/EC, Council Recommendation of 12. July 1999. A summary of the results is listed below. The specific Nemko Document 128948/5 and 365007-07r01 can be obtained by request from the DAMM Support Department.

In the USA RF Exposure compliance is determined at time of licensing.

In Canada the following minimum safety distances should be maintained based on maximum authorized output power.

Au Canada, les distances de sécurité minimales suivantes doivent être respectées en fonction de la puissance de sortie maximale autorisée.

RF Exposure Requirements(Canada):

Tx.Freq. band: 68-174 MHz		
TR type	Power	Safety Distance m/ft
BS422 68 MHz	450 W E.I.R.P.	5.5/18
	273 W E.R.P.	5.5/18
BS422 146 MHz	794 W E.I.R.P.	7.5/24.6
	484 W E.R.P.	7.5/24.6
Tx.Freq. band: 410-470 MHz		
TR type	Power	Safety Distance m/ft
BS422 420-470 MHz	794 W E.I.R.P.	6.5/21.3
	484 W E.R.P.	6.5/21.3
Tx.Freq. band: 851-869 MHz		
TR type	Power	Safety Distance m/ft
BS422 851-869 MHz	603 W E.I.R.P.	6.5/21.3
	368 W E.R.P.	6.5/21.3

Additionally, a summary of the FCC RF Exposure Requirements is shown in the list below.

RF Exposure Requirements:

Tx.Freq. band: 68-174 MHz	Antenna gain: 12 dBi	Cable loss: 0dB
TR type	Power	Safety Distance cm/ft
BS422 68 MHz	1 carrier 50 W DMR	650/22.3
	1 carrier 50 W Analog	650/22.3
BS422 146 MHz	1 carrier 25 W TETRA	650/22.3
	1 carrier 10 W TEDS	650/22.3
Tx.Freq. band: 410-470 MHz	Antenna gain: 5.2 dBi	Cable loss:
TR type	Power	Safety Distance cm/ft
BS422 410 MHz	1 carrier 50 W Analog	300/9.8
	1 carrier 25 W TETRA	200/6.6
	2 carrier 10+10 W TETRA	150/4.9
	3 carrier 3x4.4 W TETRA	150/4.9
	4 carrier 4x2.5 W TETRA	120/3.9
Tx.Freq. band: 851-869 MHz	Antenna gain: 10 dBi	Cable loss:
TR type	Power	Safety Distance m/ft
BS 422 , 851.1 MHz	60.26 W	6.5/21.3
BS 422 , 860.0 MHz	60.26 W	6.5/21.3
BS 422 , 868.8 MHz	60.26 W	6.5/21.3

Antennas
The outside antenna connected to this device must be installed on an outdoor permanent structure.

L'antenne extérieure connectée à cet appareil doit être installée sur une structure permanente extérieure.

Keep a separation of at least 6 meters / 20 feet from all persons during normal operation.

Notice
- Do not modify any part of this device for any reason
- Do not place any combustible material near the transceiver
- Do not spray any liquid over the device
- Ensure that the power and antenna connections are securely made, using cables recommended and with excess capacity for the power being utilized.

Installing more BS422 according to user manual and using DAMM filter and combiner systems together with tested and verified cabling, connectors and antennas – will avoid any problems with intermodulation. Installation of the maximum number of transceivers will not extend the maximum range of calculated output power and intermodulation according to the DAMM products sheets. Any BS-type determines how many TR modules can be installed and the whole BS design has taken the Tetra specification on the subject matters into consideration. This is e.g. reflected in all DAMM EU certificates / grants and test reports of which you can find on our web page.
Please notice that any BS type / mode shipped to end customer is fully assembled and tested from factory. No assembly is needed in the field except setting up the BS rack or mount the outdoor unit putting on power and LAN/WAN connections.

The installation and user manual refer to product sheets for any unit in the rack which can be accessed on our web page / restricted area for customers and any customer/partner can request a paper copy hereof.

Installing DAMM BS422 according to this installation manual – will prevent issues with RF exposure according to our certifications (see web page).

DAMM User Manual describes installation practices and contains section with recommended BS hardware. Recommended external hardware, cables etc. is tested and verified with DAMM BS-equipment.

TABLE OF CONTENTS

REVISION

Software covered by this manual (for information about other TetraFlex software modules see TetraFlex 8.xx user manual):

Covered TetraFlex 8.xx modules

Software module	Version
Node.exe	8.10
OM.exe	8.01
TR.exe	8.01

Record of Manual Versions Numbers

SW.	Ver.	Release Date	Main Cause of change	Author	Approved
8.01	1.00	15-11-2019	Initial release	JR	
8.10	1.00	30-08-2021	Yearly update, std. release	JR	

Record of Changes of Documents since last Manual Version Number

Man. ver.	Sec.	Page	Cause of change	Date	Initial
1.20		4	RF Exposure Requirements, 800 MHz added	14-12-2021	ASL
1.30		4	RF Exposure Requirements, 800 MHz added	09-03-2022	ASL

IMPORTANT:
DAMM will execute great effort to maintain and update this manual so it will always be up to date regarding information and readability.

To do this DAMM needs to get feedback from you.
So, if you as reader find anything that could be done better, items that is not dealt with, sections that is difficult understandable etc. DAMM would appreciate your comments

Please mail support on support@damm.dk or
Contact support on +45 73473520

Thank you for your input.

ABBREVIATIONS / DEFINITIONS

Short	Explanation / Definition
AIE	Air interface encryption
API	Application Programming Interface
Application Date	Is checked against the Dongle Application Date Limit. Software package execution is only possible if Application Date is equal or less than the Dongle Application Date Limit. The Application Date is hard coded into the software package and will normally be the same date as the Release Date, but can be set to an earlier date.
Application Date Limit.	All software packages with an Application Date earlier than this Application Date Limit can be executed
Application PC	Any PC, with the exception of RF nodes, which are running DAMM application(s)
BS	Base Station, BS41x or a combination of SB421's and BS421's
BSC	Base Station Controller
BSC.exe	Base Station Controller Software
BSS	Base Station Switch
CAD	Call Authorized by Dispatcher
CDR	Call Data Records
Cell	(Radio) Cell – a radio node with one or more transceivers
Cell ID	ID is broadcasted every 10 sec (configurable).
CF	Compact Flash memory card
CMoIP	Circuit Mode over IP
DB	Data Base
DCK	Derived Cipher Key
DGNA	Dynamic Group Number Assignment
Dongle	A USB dongle, programmed by DAMM, to be inserted in the node and/or application PC. The dongle controls which functions and applications can be executed
Dongle Date Limit	When this date is exceeded the dongle will not allow execution of DAMM software packages
DSA	Dynamic Subscriber Assignment
DSP	Digital Speech Processing
E2E	End to end encryption
ETSI	European Telecommunications Standard Institute
FACCH	Fast Associated Control Channel
FTP	File Transfer Protocol
GCK	Group Cipher Key
GIS	Geographical Information system
GPS	Global Positioning System
GSI	Group Subscriber Identity
GUI	Graphical User Interface
GW	Gate Way
IP	Internet Protocol
ITSI	Individual Tetra Subscriber Identity
L1 Warning	System function is not likely to be affected
L2 Alarm	System function is partly affected
L3 Blocked	Some components of the system are not active
LAN	Local Area Network (For TetraFlex® meaning connection BSC/TR and IP backbone)
MCC	Mobile Country Code
MCCH	Main Control Channel
Missing	A node which has been visible is missing
NM	Network Management
MNC	Mobile Network Code
MS	Mobile Station (Terminal)
Node	Any unit, with exception of redundant BSC(s), running the DAMM bsc.exe application
OM	See TetraOM
OS	Operation System. Windows XP, Vista, 7, CE etc.
PABX	Private Automatic Branch Exchange
PC	Normally the BSC, but could also refer to a standard consumer PC

PD	Packet Data
PEI	Peripheral Equipment Interface
PSTN	Public Switched Telephone Network
PTT	Push to Talk
RAM	Random Access Memory
Release Date.	The date where DAMM releases the software. This date is hard coded into the software package
Release number	Hard coded into the software package and have 2 levels, separated with a dot (example: 7.40)
SACCH	Slow Associated Control Channel
SCCH	Secondary Control Channel
SCK	Static Cipher Key
SDS	Short Data Service
SELV	Safety Extra Low Voltage
Site	Geographical position of equipment or nodes
SLA	Service Level Agreement, earlier called “Service and Maintenance Agreement” (SMA).
SNMP	Simple Network Management Protocol
Software package	A package containing all functions and applications available on the release date.
SSI	Short Subscriber Identity
Subscriber register	Register where the variable data regarding subscribers and profiles are stored.
TBD	To Be Determined
TCP	Transmission Control Protocol
TEA1…	Tetra Encryption Algorithm 1… 2…. 3… 4… etc.
TEI	Tetra Equipment Identification
TETRA	Terrestrial Trunked Radio
TetraOM	The DAMM Tetra Operations & Management command line application
ToIP	Tetra over IP
TSI	Tetra Subscriber Identity, consist of MCC:MNC:SSI
UDP	User Datagram Protocol
User number	Unique DAMM subscriber reference used as an example by the voice GW and to manage terminal exchange
UTP	Unshielded Twisted Pair
VoIP	Voice over IP
WAN	Wide Area Network (For TetraFlex® meaning connection to www, gateways etc.)

PART-1: Hardware Installation

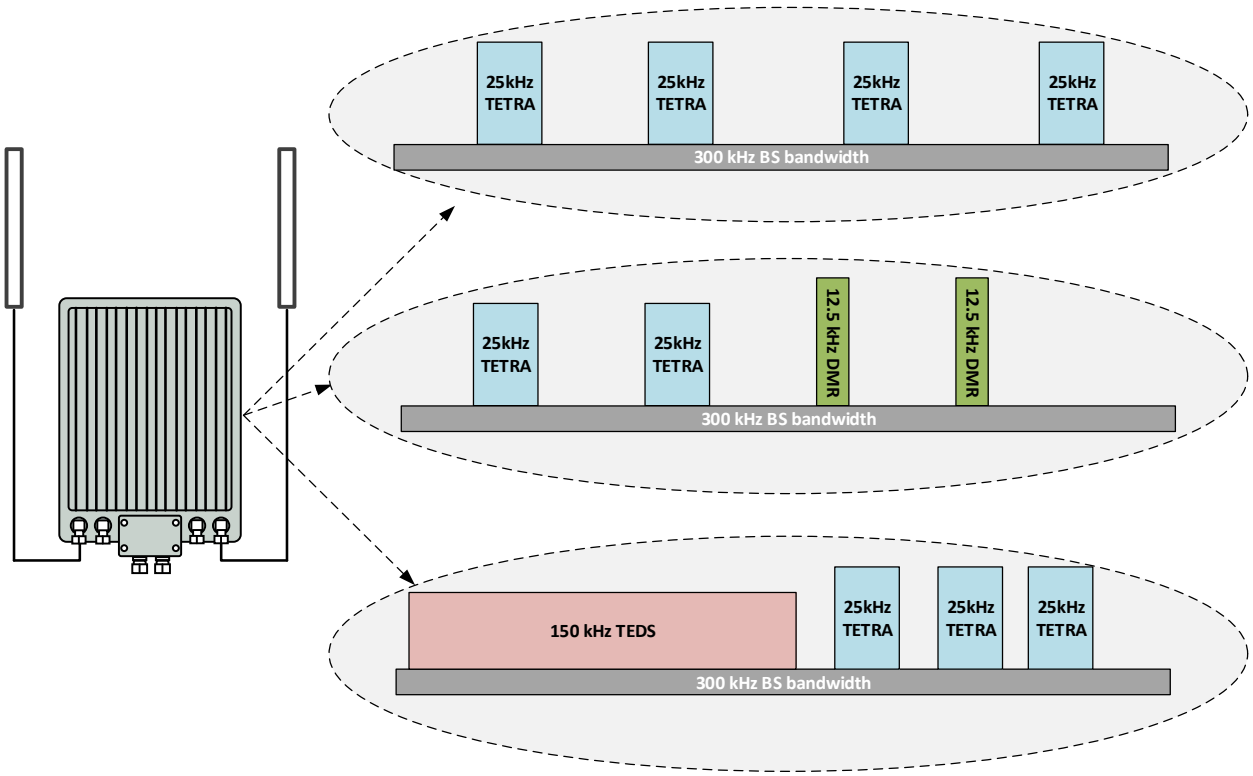
1.1 OPERATIONAL DESCRIPTION OF THE BS422

The BS422 has all the RF circuitry required for a completely self-contained base station. Its main RF components are outlined in Chapter "BS422 main components".

The BS422 is a multi-technology basestation that is based on a Software Defined Radio, which enables it to operate several different radio technologies:

- TETRA
- TEDS
- DMR Tier 3
- Analog PMR

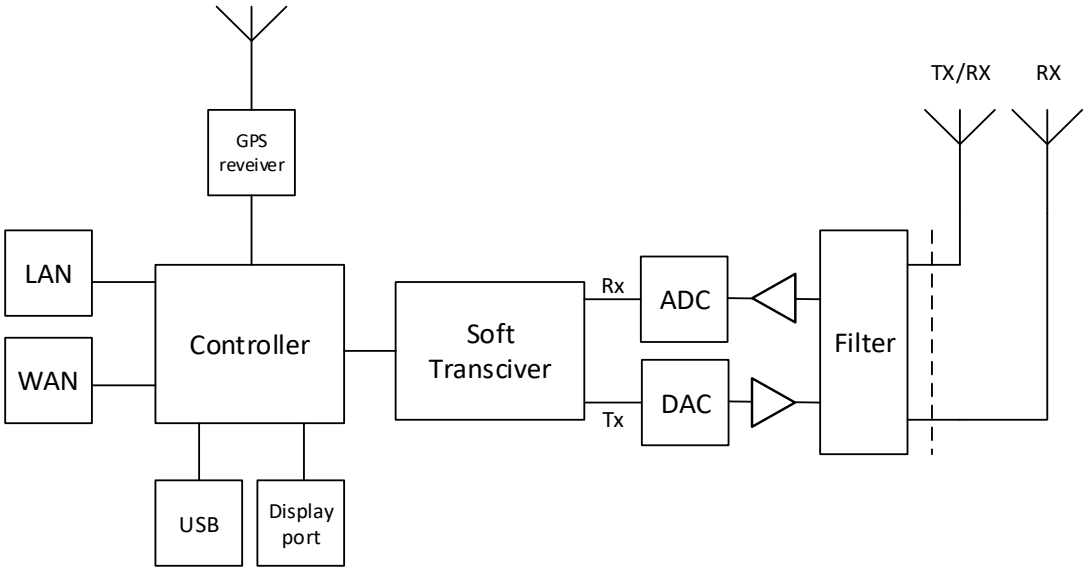
Each BS422 can operate up to four different carriers simultaneously, independent of the selected radio technology, inside a defined band.
The different carriers may operate in different bandwidths depending of the selected technology.



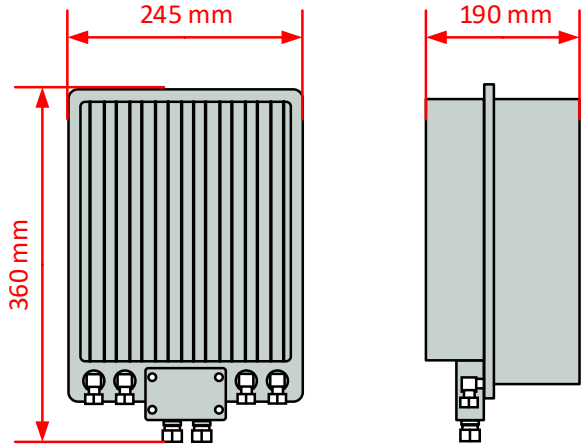
Hardware

The BS422 is a compact single-box unit with build in duplex filter.
The concept is based on a decentral architecture, which means that no further components like servers or switches are needed. All features for a functional trunked radio system is build into the BS422.
The basestation is designed for direct outdoor mounting.

Block diagram:



Dimensions:



Weight	9 Kg (approximately)
Power supply	External -48Vdc source, 100 W (approximately @ full output power)
Cooling	Natural convection (vertical or horizontal cooling plates avaliable)
RF connectors	N-type, female
Control/LAN/WAN	100 Mbps Ethernet, LSA connector
Network Management	MS Windows Remote Desktop

1.2 BS422- INSTALLATION

1.2.1 Environmental / climatic requirements

The Base Station is designed for outdoor operation, such that it can be placed in the antenna mast close to the antennas.

The Base Station is designed to be able to operate at severe environmental conditions.

The Base Station is guaranteed to operate under ambient air temperatures from –25°C to +55°C Celsius. Maximum BS422 cabinet temperature is +85°C. Storage temperature for the BS422 is from –40°C to +85°C.
Note that the guaranteed MTBF data is valid only within the standard specified temperature range

Screening of BS422 to specific customer defined temperature range (from -40°C to +55°C ambient air temperature) is optional upon request.

The Base Station encapsulation complies with IP65

1.2.2 Placement

The recommended placement of the Base Station is as close to the antennas as possible to reduce cable loss. The placement of the Base Station shall be such that it is securely fastened to a mast or building that is able to carry the weight of the BS422 and withstand the local environmental conditions. All cables, antennas etc. shall be properly fastened to the mast or building using appropriate fixtures as to avoid damage to the equipment and possible injury to persons.

1.2.3 Grounding

The BS requires careful grounding.

Grounding is important to protect the equipment when inserting/removing cables and to protect the operator from faulty equipment.

An effective grounding is also important to protect the installation during thunderstorm (lightning).

The grounding shall be as specified in paragraph “1.2.6 Power connection to SB422”

1.2.4 BS422 main components

Filter cover and filters removed. BS viewed from the filter (back) side

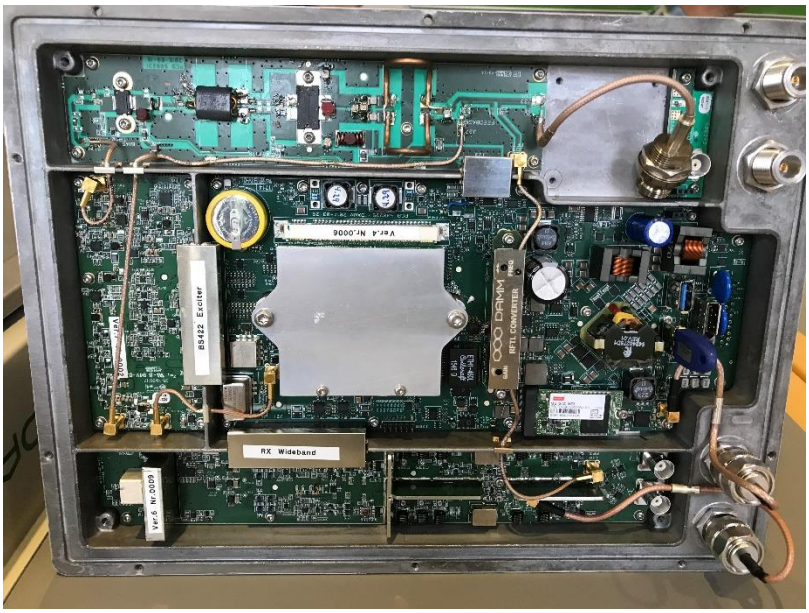


Figure 1-1: BS422 main components

The HDMI monitor connector together with the USB connector allows a connection of a standard monitor and mouse/keyboard connection

If monitor, keyboard and mouse are connected, the Windows 10 operation system in the BS422 can be accessed directly for configuration or faultfinding purposes

To access the connectors, remove the filter cover

To access the CF card also remove the filter mounting plate
The connectors need not to be unscrewed, just carefully lift the filter base plate slightly and the CF card can be removed / inserted

1.2.5 Attaching RX/TX antennas

Before installing the Base Station please read the application note in the TetraFlex user manual about the Antenna Systems.

The following antenna cables shall be attached:

1.2.5.1 Single BS422 installation recommendation

- 3 cables to the BS422 (one for Tx/Rx-A, one for Rx-B, and one for GPS*)

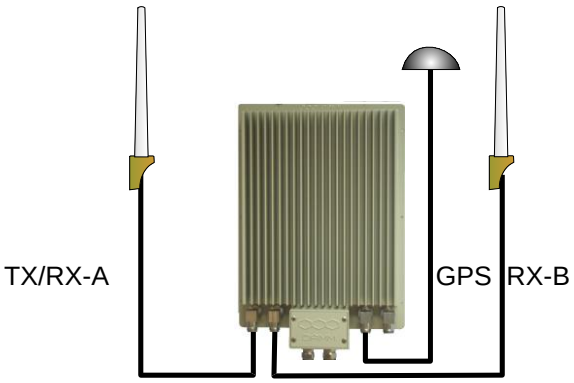


Figure 1-2: Single BS422

NOTE: The BS422 will function with only Tx/Rx-A and without GPS antenna with the following limitations:
Timing via GPS will not be available (BS422 runs on internal oscillator - Not recommended) and there will be no Diversity when only using one Rx antenna.

1.2.5.2 Dual BS422 installation recommendation

- Cables to the 2 x BS422 (two for TX/RX, two for GPS* and two for RX-B / A-OUT between the BS422's)

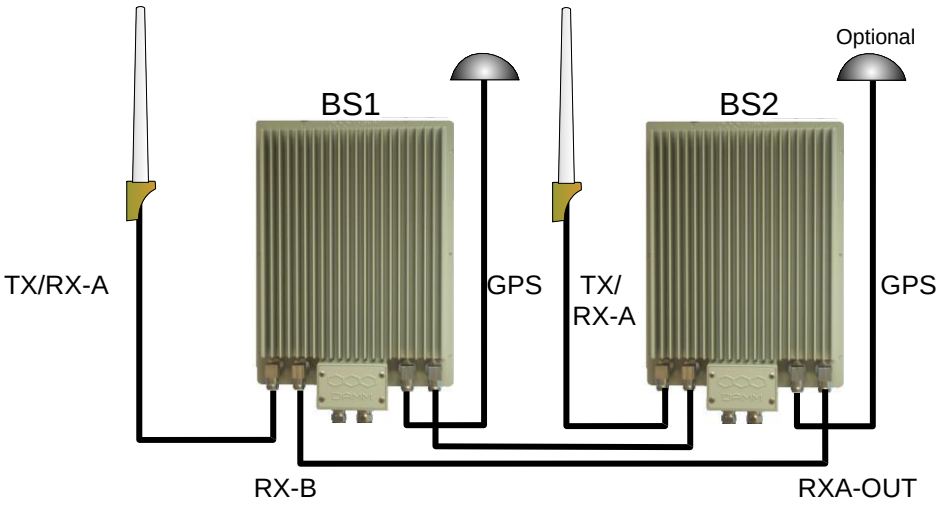


Figure 1-3: Dual BS422

NOTE: 2 x BS422 with 2 GPS antennas will provide full GPS redundancy (Antenna and GPS receiver)

*If using BS422 with build in GPS Antenna the external is not connected.

1.2.6 Power connection to BS422

Before starting this task, please read the entire chapter carefully.

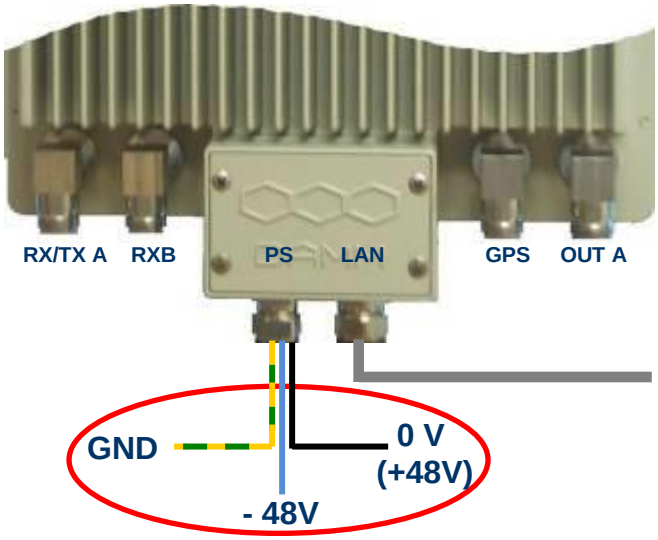


Figure 1-4: Power connection

The BS422 is operated at -48V nominal DC SELV (Safety Extra Low Voltage).

DO NOT UNDER ANY CIRCUMSTANCES USE A POWER SUPPLY THAT HAS THE MINUS CONNECTED TO POWER SUPPLY CHASSIS

The cables used for power supply must be equal to or more than 3 x 1,5mm^2

Connect the three wires in the power connection cable according to the color markings inside the BS422 system connector.

1.2.6.1 System Connector

There is two type of System Connetors:

1. System Connector with LAN and WAN (30528001)
2. System Connector with LAN and PPS (30528002)

Use a LSA tool for the Ethernet connection, a small flat screedriwer for the power connector and torx screwdriver for the fastner clamps.

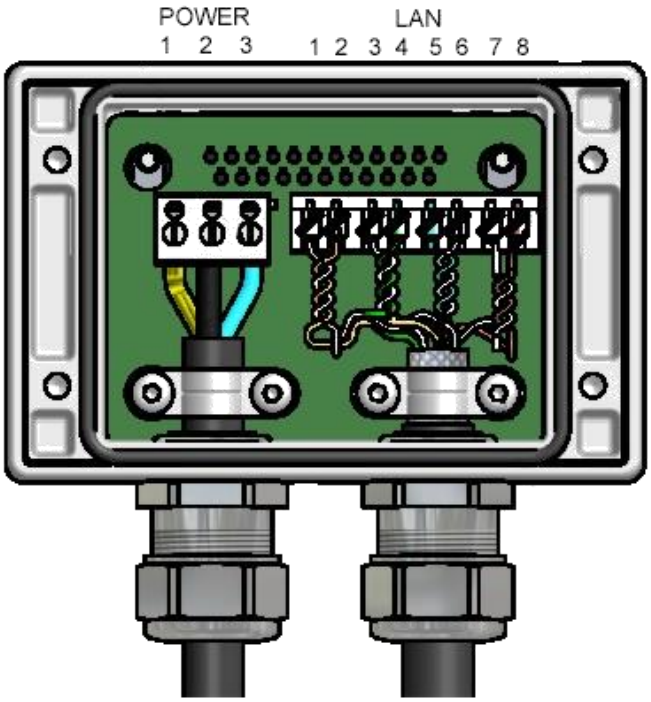
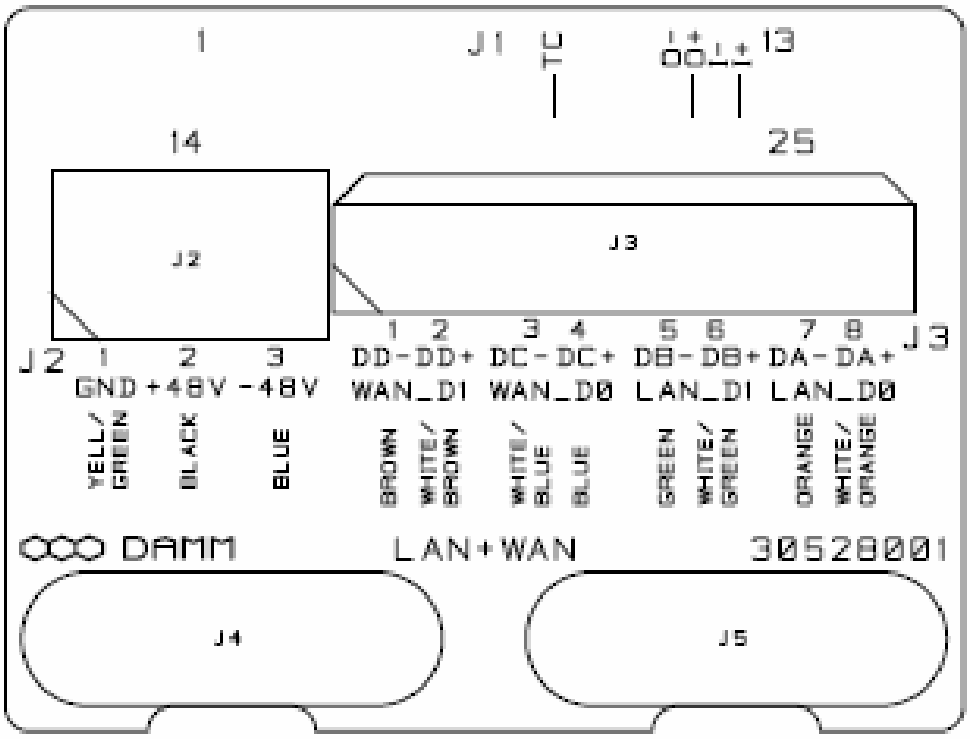
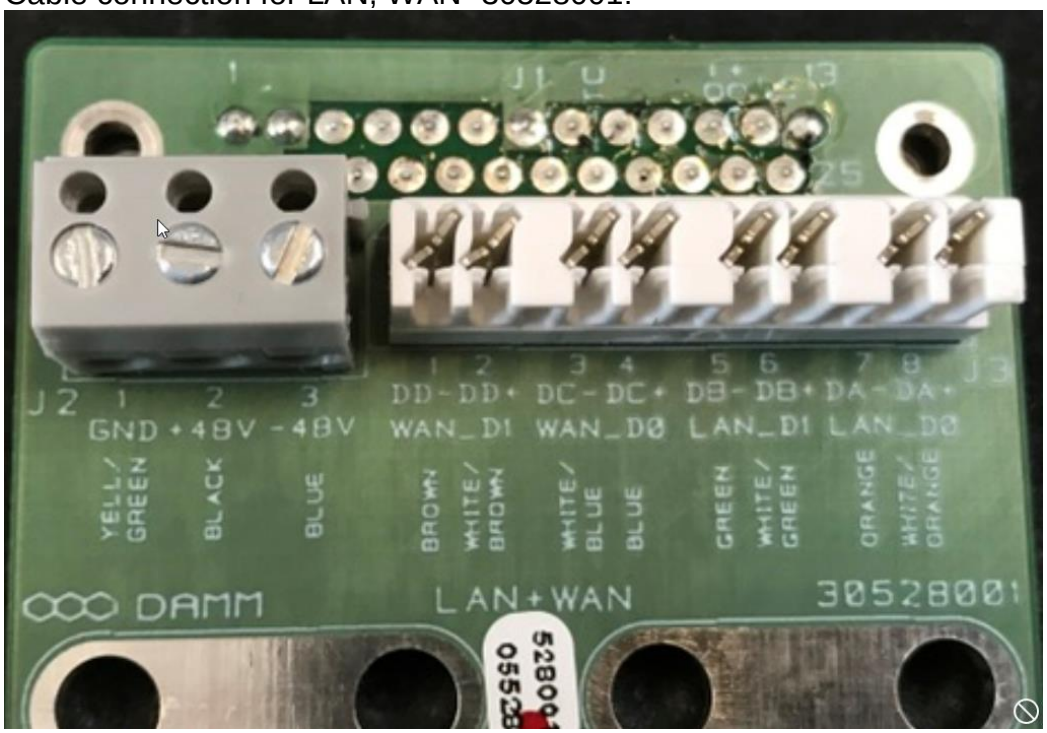


Figure 1-5: System Connector

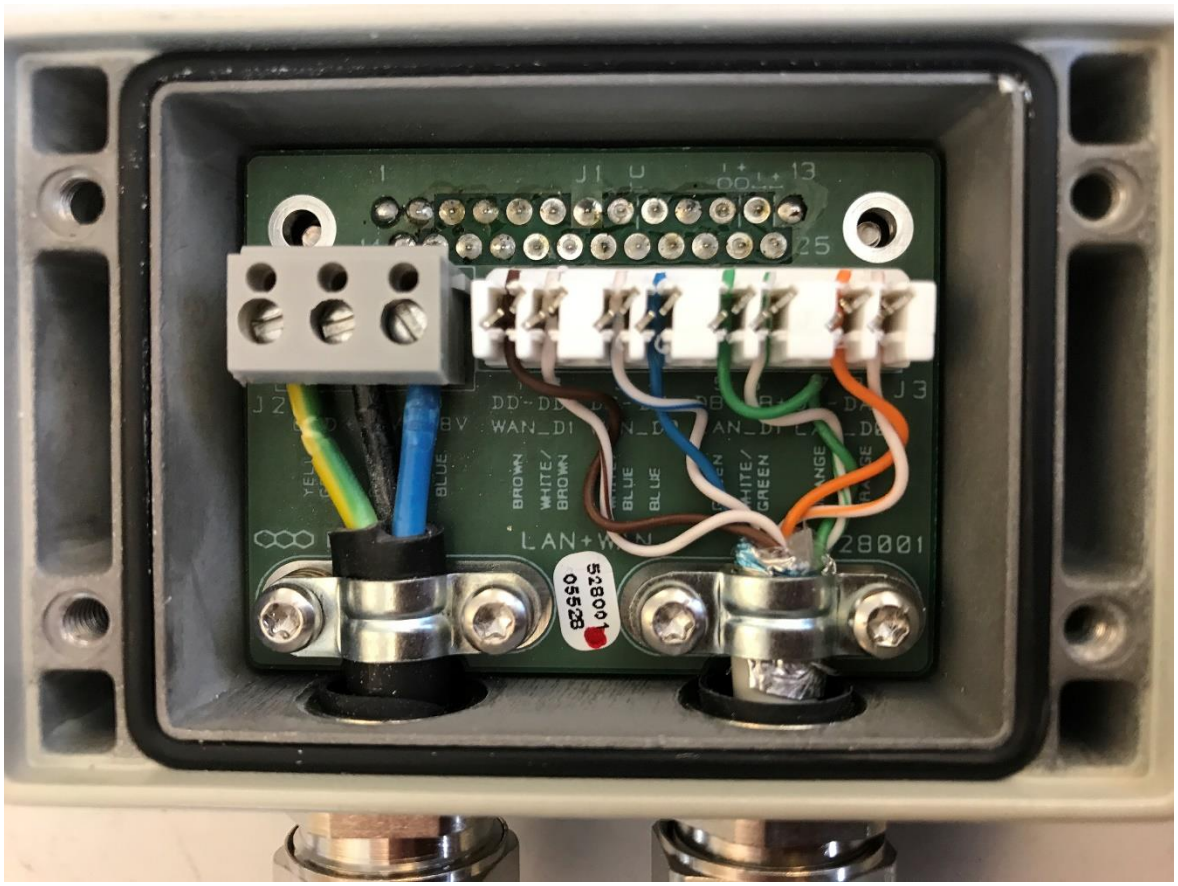


Cable connection for LAN, WAN- 30528001:



NOTE: Cable used must be 0.4mm^2 to 0.6mm^2 (24AWG) solid cores

LAN /WAN connector:



1.2.7 Ethernet Connection

The BS422 supports either 2 x 100 Mb/s. Ethernet connection for WAN and LAN or as an option 1 x 100Mb/s Ethernet for LAN and a Ethernet type DC connection for timing (PPS).

The purpose of the connections is

- To establish connection for control of the base station
- To establish connection to other BS422 and for timing and synchronization. (1 sec Pulse- PPS).

The Ethernet connections are limited to SELV (Safety Extra Low Voltage) connections.

The PPS DC timing connection can be connected to another BS422 for timing. Arresting units are an integrated part of the BS422

POWER:
NOTE: Cable used must be equal to or more than 3 x 1,5mm^2 (e.g. DAMM no. 883013)

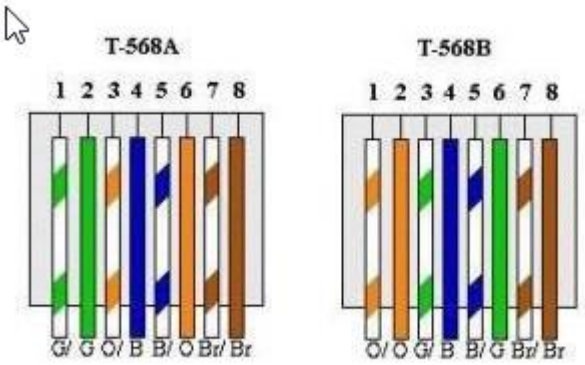
Ground	GND	1	Yellow/Green
0	+	2	Black
-48Volt	-	3	Blue

1.2.8 RJ45 Ethernet Connection terminals

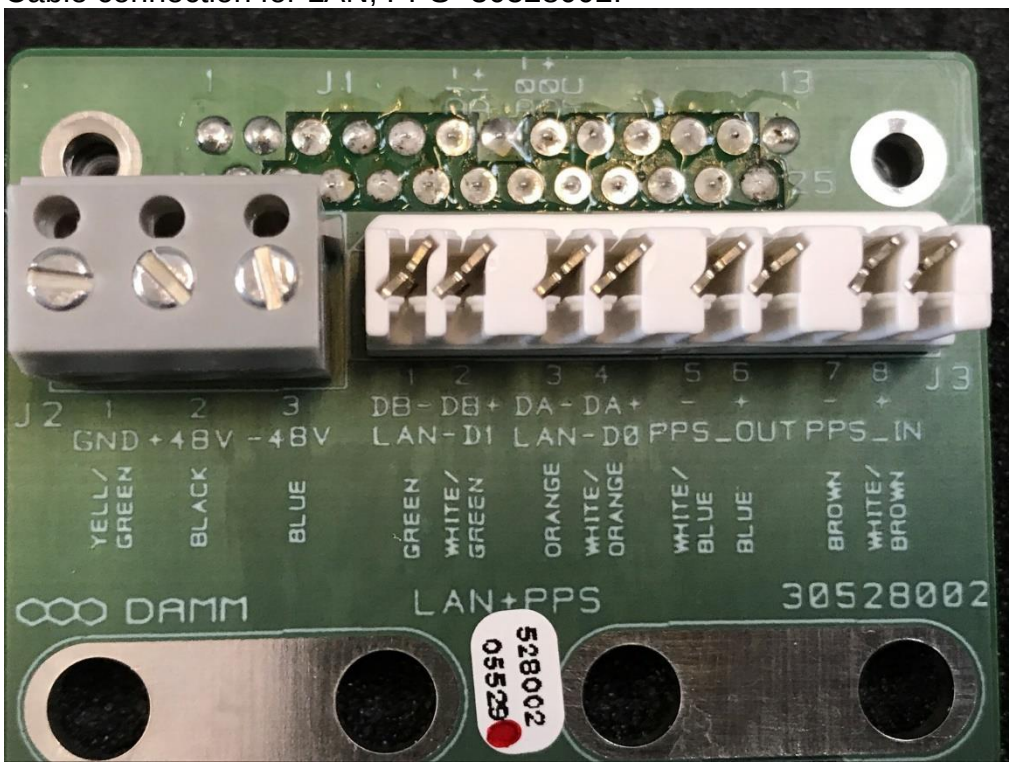
RJ45 connection for WAN/ LAN:

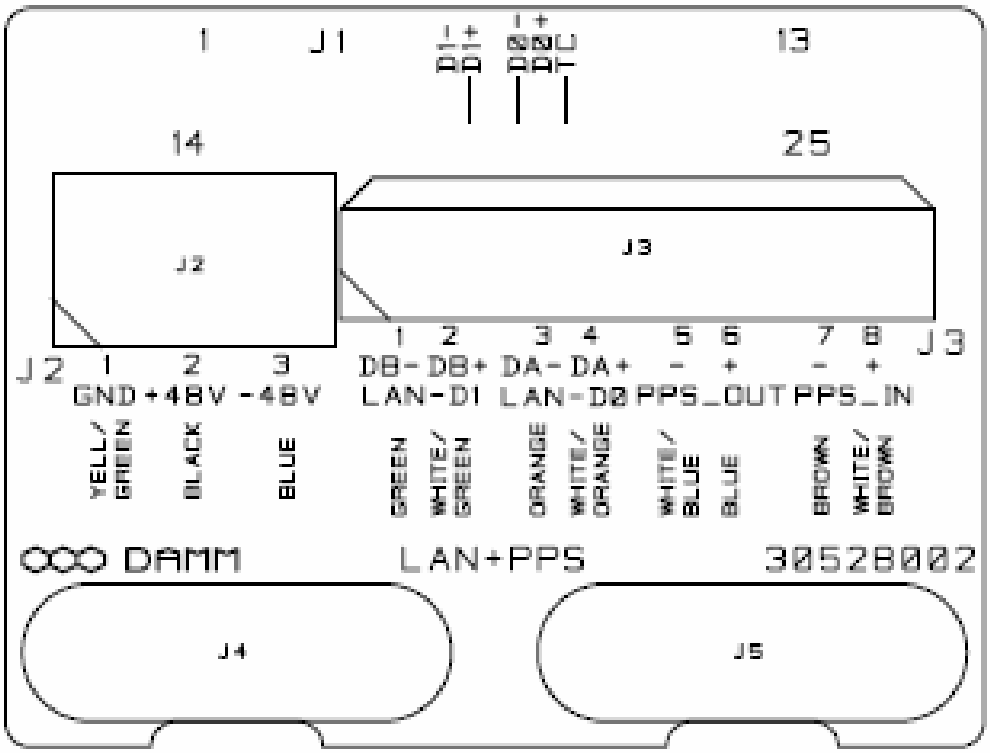
LAN CABLE CAT.5/6					
RJ45	DAMM COLOR	T568A COLOR	T568B COLOR		FUNCTION
SH	SHIELD	SHIELD	SHIELD		SHIELD
8	BROWN	BROWN	BROWN	DD-	$\overline{\text{WAN\_DT}}$
7	WHITE	WHITE/BROWN	WHITE/BROWN	DD+	WAN_DI
5	WHITE	WHITE/BLUE	WHITE/BLUE	DC-	$\overline{\text{WAN\_D0}}$
4	BLUE	BLUE	BLUE	DC+	WAN_D0
6	ORANGE	ORANGE	GREEN	DB-	$\overline{\text{LAN\_DT}}$
3	WHITE	WHITE/ORANGE	WHITE/GREEN	DB+	LAN_DI
2	GREEN	GREEN	ORANGE	DA-	$\overline{\text{LAN\_D0}}$
1	WHITE	WHITE/GREEN	WHITE/ORANGE	DA+	LAN_D0

As shown on Board



Cable connection for LAN, PPS- 30528002:





LAN CABLE CAT.5/6					
RJ45	DAMM COLOR	T568A COLOR	T568B COLOR		FUNCTION
SH	SHIELD	SHIELD	SHIELD		SHIELD
6	ORANGE	ORANGE	GREEN	DB-	$\overline{\text{LAN\_D1}}$
3	WHITE	WHITE/ORANGE	WHITE/GREEN	DB+	LAN_D1
2	GREEN	GREEN	ORANGE	DA-	$\overline{\text{LAN\_D0}}$
1	WHITE	WHITE/GREEN	WHITE/ORANGE	DA+	LAN_D0
5	WHITE	WHITE/BLUE	WHITE/BLUE	DC-	$\overline{\text{PPS\_IN2\_OUT}}$
4	BLUE	BLUE	BLUE	DC+	PPS_IN2_OUT
8	BROWN	BROWN	BROWN	DD-	$\overline{\text{PPS\_IN1}}$
7	WHITE	WHITE/BROWN	WHITE/BROWN	DD+	PPS_IN1

As shown on Board

PART-2: Configuration

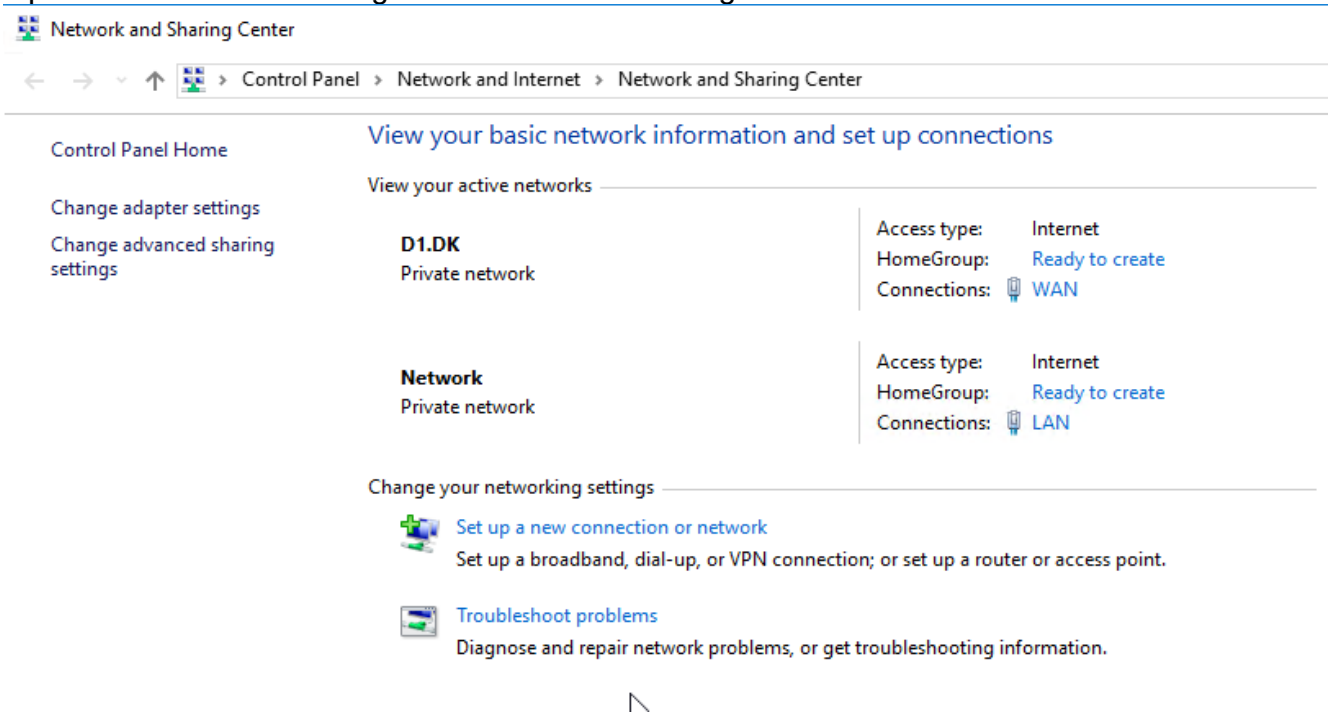
2.1 BS422 CONFIGURATION

The BS422 software is preinstalled from factory with default setting (see bellow) and before the system can be used in an installation this default settings must be adapted to the actuel need. Please also consult TetraFlex user manual for more details on how to change settings.

Factory settings:
Login user name: **tetraflex** (please change for security reasons)
Login password: **xxxxx** (please change for security reasons)
LAN IP: **172.16.1.10**
WAN IP: **auto (DHCP)**
Node No.: **1**
MCC:**238**
MNC:**16024**
Mode and TR Physical freq.: **Predefined from ordering**.

2.1.1 Set-up of LAN and WAN IP address

Open Network and Sharing Center Windows settings:



PS: The WAN and LAN connections will only showup if there is an active connection at the other end of the Ethernet cable. If the WAN or LAN connections is not shown you can set the IP address etc. by clicking on the “Change adapter settings” and right click on LAN or WAN and make the setup in “Properities” – “Internet Protocol Version 4”.

Set the WAN and LAN network parameters for you network (see default factory settings)

2.1.2 Setting the frequenzies of the BS422

2.1.2.1 Some useful TetraOM Commands

For detailed OM overview please see OM help files.

Note Only main commands are listed, subcommands may be available

Node Controller:
(Network connection in OM – BSC LAN IP and port 1024)

S00	SW Version
S00/C	Compiler options
S04	License dongle setting Node
S10	Network status
S12	Tetra Cell Status
S13	Voice GW status
S14	Packet Data Status
S15	Application GW status
S16	Terminal GW status
S20	Subscriber registers
S20/SAVE	Save actual register to text file
S20/READ	Load data from text file
S21	Subscriber profile
S22	SSI Register Status
R/S65	(repeating) Multicast / Unicast addresses
S71	General Node configuration
R/S99/TS	(repeating) Shows all timeslots

TR422 Transceiver:
(Network connection in OM – BSC LAN IP and port 42022)

00	SW Version
01	Display TR Status
03/A	Alarm Flags*
05	BSC status
06	Input Power
10	TX key state
11	TX output
21	RSSI level
31	OCXO sync
R/34	(repeating) Display all CMoIP connections
R/63	(repeating) Internal GPS status
63/VER	GPS module version
71	Common system configuration
71/TXREFLWR/c	SWR alarm setting (- Tx reflected blocking alarm (default, + warning only alarm)
98	Hardware ID
99/RESTART	Restart BS421 (Soft restart)

*) Alarm BS 422 (OM command 03/A)	Comment
00: TX PLL unlocked	Blocking Alarm (Hardware fault)
01: TX loop unstable	Blocking Alarm (Hardware fault)
03: TX temperature high	Blocking Alarm (TR421 temperature over 80˚C TX stopped)
06: TX output power	Blocking Alarm (Check TX out power)
07: TX ant. reflected L2	Blocking Alarm (can be changed to non-blocking with command 71/TXREFLWAR/+)
08: TX ant. reflected L1	Non-Blocking Alarm
10: RX PLL unlocked	Blocking Alarm (Hardware fault)
11: RX LO1 injection low	Non-Blocking Alarm (Hardware fault)
16: 36.864MHz PLL unlocked	Blocking Alarm (Hardware fault)
18: L3 Frequency Setup	Non-Blocking Alarm
19: DSP watchdog	Blocking Alarm
20: DSP Time Sync	Non-Blocking Alarm
21: BSC Message Link	Blocking Alarm (No Link to BSC)
22: BSC1 Message Link	Non-Blocking Alarm (No Link to BSC1)
23: BSC2 Message Link	Non-Blocking Alarm (No Link to BSC2)
24: Time Sync	Non-Blocking Alarm
25: Internal GNSS RX	Non-Blocking Alarm
26: External 1 Sync input	Non-Blocking Alarm
27: External 2 Sync input	Non-Blocking Alarm
28: Sync Phase Detector	Non-Blocking Alarm
29: Century Second error	Non-Blocking Alarm