

# **MainNet PLUS™**

## **Installation Manual & User Guide**



**Release 2.1  
October 2006**

## NOTICES

1. See Chapter 6 for important regulatory and legal notices
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## 1. MainNet PLUS System Architecture

### 1.1 General

MainNet's PLUS system provides Power Utilities with the ability to supply Broadband Communication services to their customers over their existing electricity infrastructure. The PLUS BPL (Broadband over Power Line) communication system is based on a unique and patented technology that enables high data rate communication over noisy low and medium voltage power lines, combining both access and in-home networks in one system. By bridging the last mile between the Internet backbone and the user's home over the electricity grid, PLUS allows home users direct access to broadband Internet and IP Telephony through any electrical outlet in the home.

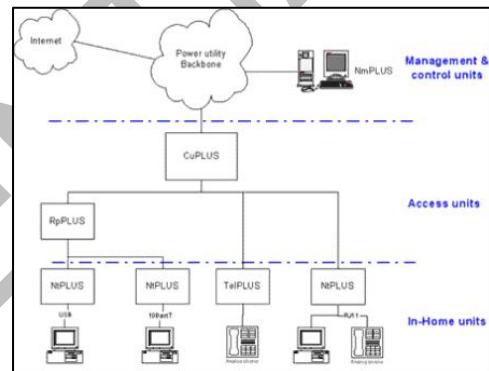
### 1.2 PLUS Architecture Overview

The PLUS system architecture consists of three distinct elements as the figure to the right shows.

**Access** – consists of units installed by the power utility along the street's power lines. These are Concentrator Units (CuPLUS units) that connect and transfer the communication signal from the Copper/WiFi/Fiber backbone to the electricity grid; and Repeaters (RpPLUS units) that transfer the signal along the grid and allow it to reach the user's home. These units are commonly known as the PLUS BPL backbone.

**In-Home** – consists of units installed by the end user at their home or office by simply plugging them into any outlet on the premises ('plug and play'). These units called Network Termination units (NtPLUS units), transfer the signal from the electricity grid to the user's computer via standard Ethernet or USB connections.

**PLUS BPL Element Management and Control** - installed at the utility's regional control center. The system, called NmPLUS, is a unique BPL network element management solution for network monitoring, management and diagnostics of MainNet's PLUS BPL network devices.



### 1.3 PLUS Unit Configuration

A PLUS unit can be configured as either an aggregation device CuPLUS or a repeating device RpPLUS. This configuration can be done prior to installation or remotely after installation via a remote telnet session. Network termination units, NtPLUS, are the end user application devices.

### **1.3.1 PLUS Aggregation Unit (CuPLUS)**

The CuPLUS aggregates all the units within its coverage area. The CuPLUS interfaces with the traditional telecom backbone eg., DSL, ADSL, WiFi, Fiber-Ethernet, etc. Data enters the CuPLUS via a 10/100BaseT connector and is bridged to the electricity grid either through a BPL coupler (inductive or capacitive) for medium voltage BPL Access applications or via the power supply cable for low voltage BPL Access and low voltage in-building applications. The CuPLUS converts the traditional Ethernet to BPL Ethernet. The BPL Ethernet is injected on the electric grid using one of the previously referenced coupling methods.

Communication between the CuPLUS and the units is done via a proprietary SNMP-like protocol - MACPLUS™. All the units self provision and dynamically register to the CuPLUS when activated, and the CuPLUS contains a dynamic table of all units in its span of control with information regarding their MAC address, their IP address and the traffic they receive/deliver. This table is constantly updated, as the whole system is dynamic and constantly changing. The information held by the CuPLUS is used both for routing/bridging by the CuPLUS and for management of the PLUS network by the NmPLUS™ and Intelligent Grid portal.

Communication between the CuPLUS and the NmPLUS is done via SNMP V2. The MIB alarms and events generated by the PLUS units are available for use by external MIB browsers, if needed.

### **1.3.2 RpPLUS**

The RpPLUS unit's primary function is to bridge the communication link between the CuPLUS and the NtPLUS. The RpPLUS receive and transmit communication from other PLUS units nearby (CuPLUS, other RpPLUSs' or NtPLUSs') according to a least cost routing algorithm to ensure that the best communication, between the CuPLUS and end unit application is achieved. This is accomplished due the sophisticated and dynamically adjusted Smart Repetition™ mechanism which is part of the MainNet MACPLUS.

The MainNet MACPLUS also enables a PLUS unit (non-CuPLUS) auto-provisioning. When a PLUS unit is inserted into a BPL network following the boot cycle, the unit will seek all available CuPLUS configured devices within its communication range. The PLUS unit will be dynamically assigned to the CU to which it has the best connection. The units can be configured with a private static IP or provisioned to receive an IP address from the DHCP server located at the NOC. Should a connection to another CuPLUS be discovered that is better, the RP will "hop" to that CuPLUS and re-register itself.

The RpPLUS is bridged to the electricity grid either through a BPL coupler (inductive or capacitive) for medium voltage BPL Access applications or via the power supply cable for low voltage BPL Access and low voltage in-building applications.

### **1.3.3 Customer Premises Equipment (CPE)**

The NtPLUS is the user premise equipment which may be plugged into any outlet in the end user's home or office. The NtPLUS bridges the communication from the electricity wiring to the user's computer over regular Ethernet via a 10BaseT. This, combined with the fact that the unit auto-provisions itself in the same way as an RpPLUS, results in almost no need for configuration of the user PC. After plugging the NtPLUS unit into the outlet, the user needs only to plug the Ethernet cable from the NtPLUS unit into their network card on the PC, or install the USB drivers and connect the USB cable. After doing so, the PC automatically receives an IP address from the DHCP server and is free to surf the Web over an always-on connection (24/7 connection). An IP verification process implemented into the system assures that only a valid IP received from the DHCP server is allowed to surf from the specific NtPLUS being used by the user.

Many service parameters for the NtPLUS can be configured in the system through the NmPLUS – including bandwidth limitation, priority, blocking the service to the unit, disabling and enabling the different ports of the unit, and more. More details on these features can be provided as part of the NmPLUS installation.

## 2. Plus Network and Deployment Guidelines

The PLUS™ is a robust Broadband over Power Line (BPL) system developed to:

- Comply with the RF emissions limits established by the FCC Part 15 rules.
- Provide reliable service with network availability 24/7 assuming that electric power is available.
- Requires no re-design or modifications to the existing electric distribution system.
- Does not require pre-network design site survey or RF attenuation analysis.
- Does not impact the power utility's daily operations of the electric distribution grid.

The PLUS meets or exceeds these basic development targets using a sophisticated Layer 2 commutation protocol along with network elements that are remotely monitored and managed. Today over 20,000 end users are receiving broadband data service over the power grid using the MainNet PLUS.

The integrity of the PLUS begins with its sophisticated communications system. In order to meet Quality-of-Service (QoS) limits the network must be deployed in accordance with basic design principals. No guarantee of QoS can be made due to the variability of the electric grid environment. However, QoS can be maximized and controlled by following some simple and basic design guidelines.

### 2.1 Quality of Service (QoS)

QoS is the measure of bandwidth in Kilobits per second ("Kbps") delivered to the users desktop. Broadband as defined by the FCC is considered service in excess of 200 Kbps both upload and download. Synchronous service is where the upload and download bandwidth are equal.

The MainNet PLUS has the ability to control QoS to the consumer and allows for three operator controlled QoS thresholds which each can specify maximum upload and down load levels. The ability to control QoS provides two key advantages to the network operator:

1) The operator can develop and offer different price products that more closely match consumer needs and desires. Not all customers require unlimited upload and download bandwidth. Since bandwidth is the most significant cost element in running a data service provider enterprise, a way to differentiate customers and to set pricing appropriate to the customer requirements is important.

2) The PLUS network is a shared bandwidth network where all users in a PLUS BPL cell are sharing in the total bandwidth available. QoS allows the



operator to place restrictions on bandwidth therefore limiting any user's ability to overwhelm the network to the disadvantage to the other users.

*Note: QoS is not the only feature that MainNet uses to manage bandwidth. MainNet has included a number of other QoS mechanisms to insure fairness in the network.*

QoS is impacted by a number of factors, available bandwidth at the CuPLUS, over-subscription of the network, number of simultaneous users, traffic on the BPL network, traffic on the Backbone network, traffic on the Internet, PC hardware and software, etc. From a PLUS network design perspective distance from the CuPLUS and the number of repetitions that data packets must go through to reach the CuPLUS significantly impact QoS. With each repetition the available bandwidth at that point is reduced by 1/3<sup>rd</sup>. After three (3) repetitions, due to the method MainNet uses for communication, bandwidth is no longer degraded. MainNet however recommends that the maximum number of repetitions be no more than five (5) for any one user. This only impacts users at the edge of the PLUS BPL network cell because the closer a user is to the CuPLUS the fewer repetitions the user will encounter.

## 2.2 Latency

Latency is the measure of time in milliseconds (ms) that it takes data packets to reach their destination. Latency impacts specific applications including Voice over IP (VoIP) and online gaming. Most other casual applications such as email file upload and downloads, and casual Internet usage are not generally affected by latency. For VoIP applications the roundtrip latency should be less than 150ms.

With every repetition of the PLUS network approximately 10 – 15 ms of latency is added. Latency is added with every repetition. Therefore for VoIP applications with roundtrip latency budget of 150ms that maximum number of repetitions on the PLUS BPL network is five (5).

## 2.3 Recommend Design Standards for the MainNet PLUS™

MainNet, with more than 30,000 PLUS elements in operation world-wide has obtained extensive experience in the design, deployment and operation of the PLUS BPL network.

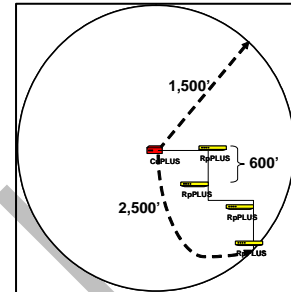
On the US electric grid, distance between repeaters has been greater than 2,800 feet. But this was in ideal conditions which include very low ambient RF interference, a new underground electric distribution network and mid-day. Overhead distribution, age and type of wiring, ambient RF noise and time-of-day are all factors that will impact the performance of the BPL network.

It is recommended that the PLUS BPL network be designed for a maximum number of repetitions to the edge of a PLUS cell of no more than

five (5). The number of repetitions is impacted by the electric distribution network environmental factors including ambient noise environment, overhead or underground distribution, age and type of wiring, industrial, commercial or residential area, transformer age and type, and the presence of splices, taps, etc.

PLUS BPL cell design should follow the following guidelines:

- The maximum distance as the crow flies from the CuPLUS is no more than 1,500 feet radius.
- The maximum distance in cable feet from the CuPLUS is no more than 2,500 feet radius.
- The maximum distance between RpLUS units is no more than 600 feet.



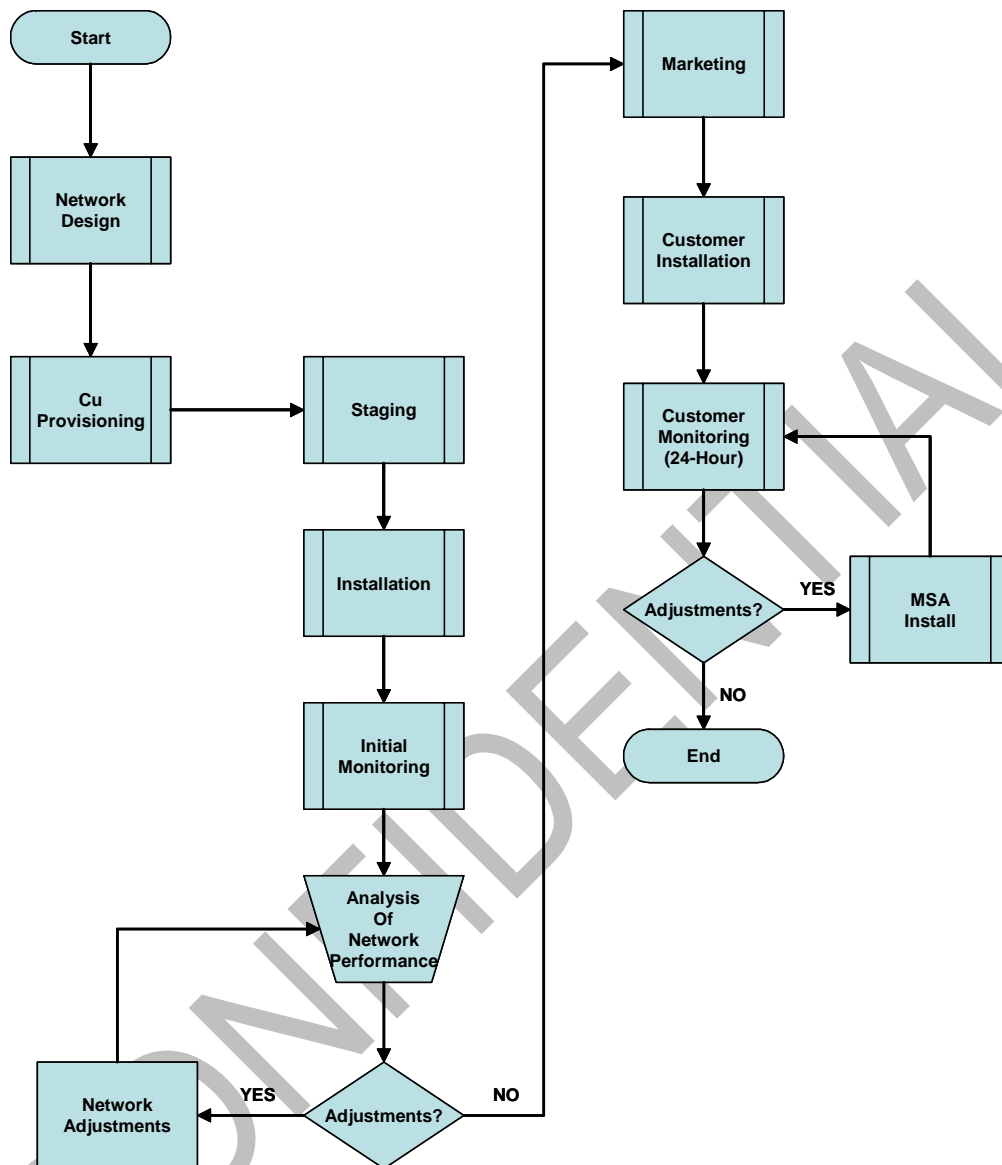
Variation on these guidelines should only be done after extensive testing and evaluation including both daily and seasonal measurements. It is important to recognize that the electric grid is a dynamic RF environment. The MainNet PLUS was developed with this in mind and overcomes this variability through its robust MACPLUS™. The PLUS elements with the MACPLUS enable the BPL system to deliver service continuously 24/7 under any conditions.

## 2.4 Introduction to MainNet PLUS™ Network Design

The design of a MainNet PLUS network is relatively simple. Features of the MACPLUS™ which include smart repetition, self configuring, CuPLUS provisioning among others; and, the use of features such as DHCP and unit configuration templates within the NmPLUS™ minimize the design complexity to a few simple steps.

While the design process is simple, the variability of the electric distribution network result in a design process that is not an exact science but requires post installation analysis and possible network adjustments before release for public use. The process begins with the utility plant distribution network drawings and ends with post installation evaluation and acceptance. Once complete the network can be released to marketing for customer use.

A flow chart of the PLUS BPL network design and acceptance process is presented below.



## 2.5 MainNet Network Design Procedure

1. Obtain detailed scale electric utility distribution drawings which transformers, phases, underground and overhead distribution, junctions, normal opens and distance. In addition, if available, the drawings should identify low voltage power availability, poles and street lights.
2. The most important step of any PLUS BPL network design is identification of CuPLUS location. The CuPLUS is the aggregation point for all cell network traffic. It is the hub of the cell network and serves as the primary data point for distance measurement for cell size.

3. The CuPLUS and all other medium voltage elements will be installed at or in close proximity to each distribution transformer. In overhead applications the medium voltage PLUS element is installed in the utility space below the top off the transformer but above the Neutral. The units are installed in an NEMA 4x (IP65) enclosure and generally mounted on the pole using a pole stand-off mounting bracket.
4. The optimal CuPLUS location will consider the following:
  - a. Maximize homes passed with the cell
  - b. Minimize distance to the edge of the cell in both cable radial and aerial radial distance.
  - c. Ease and cost to provision and deliver Internet backbone.
  - d. In a multi-cell environment (all cases except single cell trials) the proximity to other CuPLUS elements. (Note: CuPLUS elements should not be near units to each other. A minimum distance in cable length between CuPLUS units should be 1,200 feet.)
  - e. Distribution phases and the ease of routing signal from the RpPLUS units to the CuPLUS.
5. RpPLUS units will be installed at every transformer within the PLUS BPL network cell. Close attention should be paid to the Phase(s) present at each location on overhead applications and in URD settings the present of normal opens (NO) and junctions. RpPLUS units are likely to be installed in each of these zones as well. For overhead applications where multi-phase wiring is present you should attempt to select a common phase for all traffic. At intersecting points on the cell network a multi-phase coupler can be used to bridge communication. Ideally you wish to minimize the multi-phase couplers since they are added cost and take longer to install. Typically, two – three are required in every overhead distribution cell.
6. Produce work orders which should include detailed information on unit location and phase coupling requirements. Any special instructions should also be included on the work order system. The installation work order form should include space for the installer to note the date, location, MAC Address and IP Address (if Applicable), and type of unit installed. These forms should be returned to the network engineer for verification and installation into NmPLUS, the MainNet PLUS element management system. (Note: This step cannot be overlooked. It is impossible after installation to identify unit locations without this data. If this data is not delivered and input into NmPLUS the only method of recovery is field verification which is costly and time consuming.)

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**PLUS Element Installation Form**

<b>Form: Modem Install</b>					
<b>Unit Configuration:</b>	<input type="checkbox"/> CuPLUS	<input type="checkbox"/> RpPLUS	<input type="checkbox"/> Other	<input type="checkbox"/> Medium Voltage	<input type="checkbox"/> Low Voltage
<b>MAC:</b>					
<b>Location:</b>	<input type="checkbox"/> Transformer	<input type="checkbox"/> Handbox or Pedestal	<input type="checkbox"/> Meter Base	<input type="checkbox"/> Other _____ _____	
<b>Transformer ID:</b>	Note: Include Transformer ID for all installations				
<b>Circuit/Phase:</b>					
<b>Physical Address:</b>	Note: For transformers include location with address e.g., Front Right Corner of property 1234 Main Street.				
<b>Special Notes:</b>	E.g., Double Coupler installed.				
<b>Date Installed:</b>					
<b>Installer:</b>					
<b>Start Time:</b>					
<b>End Time:</b>					

## **2.6 Post Installation Monitoring & Evaluation**

As has been stated previously, the design of a BPL Network is not precise. Post installation monitoring and analysis is part of the network design process. From NmPLUS the cell and all its elements should be monitored for a period of at least 48 hours. Data related to the quality of the links between elements and to and from the CuPLUS will be captured and report on an hourly basis. The data will be reviewed by the design engineer whom shall identify any problematic links. NmPLUS provides a bad links report to simplify this analysis step. All bad links will be evaluated through field inspection and corrective measures taken. Typically bad links are a result of poor installation or the need for an additional repeater. Field inspection and evaluation will assist in determining the corrective measure.

### **2.6.1 Corrective Actions**

Work orders are produced for the identified corrective measures. Following completion, the network will be further analyzed. Additional measures will be taken until the network is operating within design/operations specifications. The following identifies some of the standard suggested corrective actions.

*Note: Do not make modifications to the wiring harnesses, attempt to produce your own special harness, use damaged equipment, re-use equipment without first bench testing to insure that it is in good working order. After attempting the recommended corrective actions suggested below or if the scenario you encounter does not fit within the situations listed please contact: MainNet Technical Support at [support@mainnet-plc.com](mailto:support@mainnet-plc.com) or via phone at +1.703.476.4700.*

#### **2.6.1.1 Problem Scenerio 1: Poor Medium Voltage Link (step 1)**

The first action on any link problem is to check all connections. Has the unit been installed according to standard installation practices (see Section 3.) If the link is extremely bad check the coupler continuity. The couplers are made to withstand normal handling and are tested before packaging however in cases where a coupler is re-used or mishandled damage could occur.

#### **2.6.1.2 Problem Scenerio 2: Poor Medium Voltage Link (step 2)**

a.) *Medium Voltage OH* (Applies only in cases where more than one phase is present on the pole) – The standard installation is a single MV OH coupler paired with a single Neutral/URD coupler (see Section 3.1). In certain scenarios, due to noisy wires or certain elements attenuating the signal might negatively impact the loose cross coupling that generally occurs. Remove the Neutral/URD coupler and install a medium voltage OH coupler on an

uncoupled phase. If two phases, are available couple to the phase with the bad link. Note unlike the standard installation where the coupler directional arrows are in the same direction be sure to install the new OH coupler with its directional arrow in the opposite direction of the OH coupler that it is paired with. (See section 3.2)

b.) *Medium Voltage URD* - The standard installation is a single MV Neutral/URD (see Section 3.3). In certain scenarios, due to noisy wires or certain elements attenuating the signal, the link between transformers may be less than acceptable. Replace the standard URD wire harness with a special double coupler URD wire harness and install a second Neutral/URD coupler on the uncoupled primary cable.

#### **2.6.1.3 Problem Scenerio 3: Poor Low Voltage Link Problem**

The preferred method for installation of LV Access elements is 240V 3-wire (i.e., PH-PH-N). If the link is below standard acceptable tolerances test the following alternatives to determine the best solution: AØ-BØ; AØ-N; or BØ-N. Start with AØ-BØ. Be sure to allow each arrangement to operate for at least twenty-four (24) hours before making additional changes. Only make additional changes after analyzing at least 24 hours of link data.

#### **2.7 Network Release**

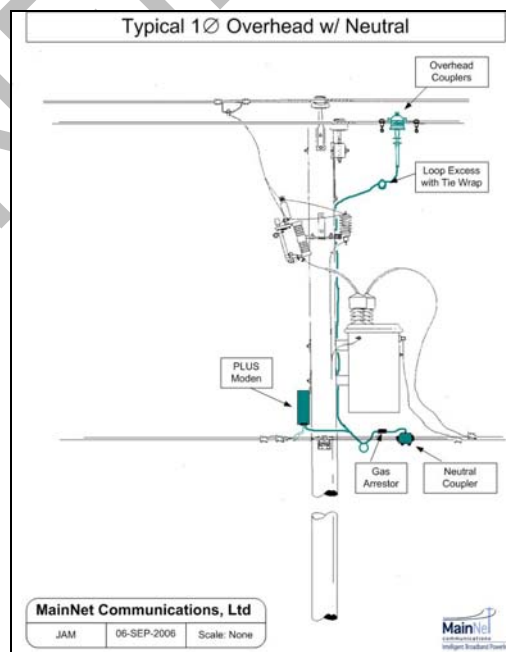
Once all corrective measures have been implemented and the system has been optimized it shall be released by the network designer to Operations who will then assume responsibility for monitoring and network integrity. Operations will release the network to Marketing for subscriber sales.



### 3. Hardware Installation Procedure

#### 3.1 Single Phase Overhead Installation – Typical

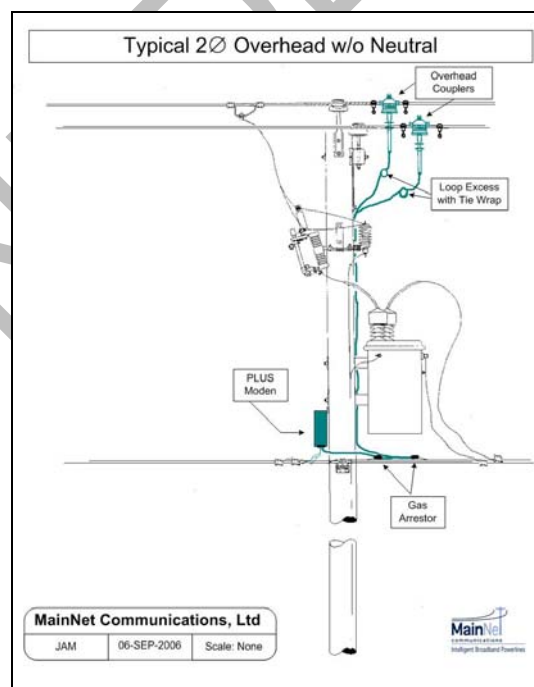
- a) Bolt enclosure to pole (above, below or beside the transformer but above the secondary neutral. If there is no secondary neutral be sure the unit is located in the electric utility designated space on the pole.
- b) Connect 3 wires (2 black wires & and one white wire) to the secondary side of the transformer. The black wires shall be connected to the secondary phase wires and the white to the secondary neutral.
- c) Handle MV coupler with care. DO NOT hold or carry from the cable ends rather grab by the coupler head or by the neck (weather skirt).
- d) Install the MV coupler and the neutral coupler with the arrows pointing in the same direction.
- e) Install the MV coupler directly above the neutral coupler (or as close as the grid would allow).
- f) Close the MV coupler with care. The split cores must come together but there is no need to over torque the screw.
- g) The MV coupler should be the last element installed and in a maintenance situation it should always be the first element removed (prior to working on other elements).





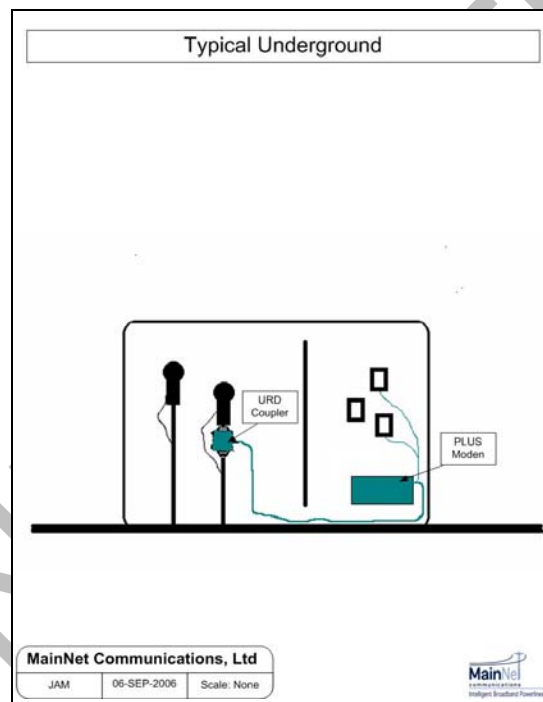
### 3.2 Double Phase Overhead Installation - Special

- a) Bolt enclosure to pole (above, below or beside the transformer but above the secondary neutral. If there is no secondary neutral be sure the unit is located in the electric utility designated space on the pole.
- b) Connect 3 wires (2 black wires & and one white wire) to the secondary side of the transformer. The black wires shall be connected to the secondary phase wires and the white to the secondary neutral.
- c) Handle MV coupler with care. DO NOT hold or carry from the cable ends rather grab by the coupler head or by the neck (weather skirt).
- d) Install MV couplers with arrows pointing in opposite directions.
- e) Install MV couplers directly opposite to each other (or as close as the grid would allow).
- f) Close the MV couplers with care. The split cores must come together but there is no need to over torque the screws.
- g) The MV couplers should be the last elements installed and in a maintenance situation it should always be the first element removed (prior to working on other elements).



### 3.3 Single Phase Underground Installations - Typical

- Connect 3 wires (2 black wires & and one white wire) to the secondary side of the transformer. The black wires shall be connected to the secondary phase wires and the white to the secondary neutral.
- Snap off plastic neutral coupler ends to fit cable.
- Underground coupler should be positioned above the concentric neutral.
- Where possible train the bleeder around the outside of the coupler.
- Connect coupler lead to Underground coupler.



## 4. Product Specifications

### 4.1 NtPLUS™ Specifications

#### Electrical Requirements

- Input Voltage 80 – 265 VAC
- Input Frequency 48 – 63 Hz
- Power dissipation 4.8 Watts

#### System Specifications

- Software upgradeable
- Modulation method – OFDM

#### Interface

- PC 10/100BaseT RJ45
- BPL Communication over 120/240V Power Cable

#### Environmental Class

- IP 20

#### Casing

- ABS+PC (Polycarbonate) UL 94-VO

#### Dimensions

- Height - 35mm
- Width – 115mm
- Length – 220mm

#### Weight

- 0.58 Kg

#### Operating Temperature

- -10°C to 55°C (ambient)

#### PLUS™ System Supports:

- DHCP Server/ DHCP relay - according to standards IEEE RFC 2131 and 2132
- VLAN Trunking using MainNet's VPN PLUS configuration method
- H323
- SNMPv2
- FTP and Telnet are supported
- FTP runs over TCP

#### Standards compliance

- EN 60950 (2<sup>nd</sup> Ed.)
- EN 55024 Immunity
- EN 55022 Emission
- UL 60950
- FCC Part 15, In-home & FCC Part 15 Class B Peripheral

## **4.2 PLUS™**

### **Electrical Requirements**

- Input Voltage 80 – 265 VAC
- Input Frequency 48 – 63 Hz
- Power dissipation 4.8 Watts

### **System Specifications**

- Software upgradeable
- Modulation method – OFDM

### **Interface**

- PC 10/100BaseT RJ45
- BPL Communication
  - Over 120/240V Power Cable
  - Multi-connector cable via Neutral Coupler and MV OH Coupler

### **Environmental Class**

- IP 20

### **Casing**

- ABS+PC (Polycarbonate) UL 94-VO

### **Dimensions**

- Height - 35mm
- Width – 115mm
- Length – 220mm

### **Weight**

- 0.58 Kg

### **Operating Temperature**

- -10°C to 55°C (ambient)

### **PLUS™ System Supports:**

- DHCP Server/ DHCP relay - according to standards IEEE RFC 2131 and 2132
- VLAN Trunking using MainNet's VPN PLUS configuration method
- H323
- SNMPv2
- FTP and Telnet are supported
- FTP runs over TCP

### **Standards compliance**

- EN 60950 (2<sup>nd</sup> Ed.)
- EN 55024 Immunity
- EN 55022 Emission
- UL 60950
- FCC Part 15 – BPL Access

#### **4.4 MV OH Coupler Specifications**

##### **Electrical Rating**

- Max Voltage: 25kV Phase-Phase
- Frequency: 50/60 Hz
- Max Current: 200A

##### **RF Carrier Range**

- 2 – 30 Mhz

##### **Impulse Withstand Voltage (BIL)**

- 125KV / 1.2/ 50µSec

##### **Continuous Withstand Voltage**

- Dry: 35 kV
- Wet: 35 kV

Note: All test at one (1) minute test protocol

##### **Applied Standards**

- IEEE 1313, 1996
- IEEE 4, 1978

##### **Dimensions**

- L = 200 mm
- H = 140 mm
- W= 130 mm

##### **Weight**

- 1450 g.

##### **Safety**

- 3-Element Surge Arrester Gas Tube with radial leads and fail-safe measure
- DC Spark-Over Voltage (100 V/sec) = 90V
- Power Handling (8/20µsec - 10X) = 10KAmp
- 1A in-line fuses

## **5. Safety**

Use simple precautions to protect staff and equipment. Hazards include exposure to RF waves, lightning strikes, and power surges.

### **5.1 Exposure to RF Energy**

To protect from overexposure to RF energy, install MainNet PLUS modems so as to provide and maintain the minimum separation distances from all persons. For more information about RF Exposure please refer to the US Federal Communications Commission Office of Engineering and Technology Bulletin 56. You can obtain a copy from

<http://www.fcc.gov/oet/info/documents/bulletins/>

### **5.2 Lightning and Surge Protection**

To protect both your staff and your equipment, implement lightning protection as follows:

- Observe all local and national codes that apply to grounding for lightning protection.
- Install your modules at least 2 feet (0.6 meters) below the tallest point on the tower, pole, or roof. In all BPL Access medium voltage applications insure that the units are installed in the electric space on the pole or pad mounted transformer where access is limited to technicians qualified to work in high voltage distribution network environment.
- Before performing and maintenance or other modifications be sure that the medium voltage coupler is the last element installed and is the first element removed prior to beginning maintenance or service.
- For overhead medium voltage BPL Access applications insure that the overhead coupler gas arrester is connected to an earth bonded neutral.
- Configure a drip loop with the excess cable at the base of the overhead coupler and train the remaining cable down the pole. (see the figures in section 3.1 & 3.2.)

### **5.3 Conforming to Regulations**

Ensure that your network conforms to applicable country and local codes, such as the NEC (National Electrical Code) in the U.S.A. If you are uncertain of code requirements, engage the services of a licensed electrician.

#### **5.4 Protecting Cables and Connections from Wind**

Cables that move in the wind can be damaged, impart vibrations to the connected device, or both. At installation time, prevent these problems by securing all cables with cable ties, cleats, or PVC tape.

#### **5.5 Moisture**

Over time, moisture can cause a cable connector to fail. You can prevent this problem by

- Including a drip loop where the cable approach to the module is from above.
- Wrapping the cable with weather-resistant tape.
- On coupler connectors, use accepted industry practices to wrap the connector to prevent water ingress. Although the male and female type connectors form a gas-tight seal with each other, the point where the cable enters each connector can allow water ingress and eventual corrosion. Wrapping and sealing is critical to long-term reliability of the connection. Use Universal Electronics weather-tight wrap named Coax-Seal or a similar product.
- Perform the following steps to wrap the cable:
  1. Start the wrap on the cable 0.5 to 2 inches (about 1.5 to 5 cm) from the connection.
  2. Wrap the cable to a point 0.5 to 2 inches (about 1.5 to 5 cm) above the connection.
  3. Squeeze the wrap to compress and remove any trapped air.
  4. Wrap premium vinyl electrical tape over the first wrap where desired for abrasion resistance or appearance.
  5. Tie the cable to minimize sway from wind.

## 6. Legal & Regulatory Notices

### 6.1 Important Note on Modifications

Intentional or unintentional changes or modifications to the equipment must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty.

### 6.2 U.S. Federal Communication Commission (FCC)

This device complies with Part 15 of the FCC Rules and Regulations. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for an Access BPL Class A device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference. This equipment generates, uses, and can radiate radio-frequency energy and may cause harmful interference to radio communications. If this equipment does cause harmful interference, which can be determined by turning the equipment on and off, the user/operator is encouraged to correct the interference by one or more of the following measures:

- Increase the separation between the affected equipment and the unit;
- Decrease the unit power level;
- Have a notch or notches created at the specific frequency or frequencies where the unit is determined to be creating interference. (Note: The notches provided will be software based and provide a notch filter capable of attenuating emissions within the frequency band specified to a level of at least 20dB below the Part 15 limit.;
- Remove or turn-off the unit.

#### **Important Note:**

In accordance with the FCC Rules and Regulations as defined in 47 CFR 15.615, entities operating Access BPL systems shall supply the following MainNet information on the Access BPL system for inclusion into a publicly available database:

**FCC ID: G2ACCPLUS**

**Operating Frequencies: 4.0 – 21.0 MHz**

**Manufacturer: MainNet Communications, Ltd.**

**Access BPL Equipment Type: PLUS**



**Important Note:**

Intentional or unintentional changes or modifications must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty.

MainNet Communications, Ltd, MainNet Power Line Communications, Inc., the MainNet Logo and all other trademarks indicated as such herein are trademarks of MainNet Communications, Ltd and MainNet Power Line Communications, Inc. All other product or service names are the property of their respective owners.

MainNet Communications, Ltd, 47 Hanessi'im St., Raanana - North 43583, P.O.B 192, ISRAEL.

<http://www.mainnet-plc.com>

Address inquiries to: support@mainnet-plc.com

MainNet Power Line Communications, Inc., PO Box 2458, Falls Church, VA 22042

<http://www.powerline-plc.com>

Address inquiries to: support@powerline-plc.com

### 6.2.1 FCC Labeling BPL Access Device

#### **BPL Access unit; FCC compliance labeling; MainNet PLUS**

**Manufacturer: MainNet Communications, Ltd**

BPL Classification: Broadband over Power Line Access Product

Note: FCC ID Label Details – The label below shall be fixed to the base of the plastic housing.

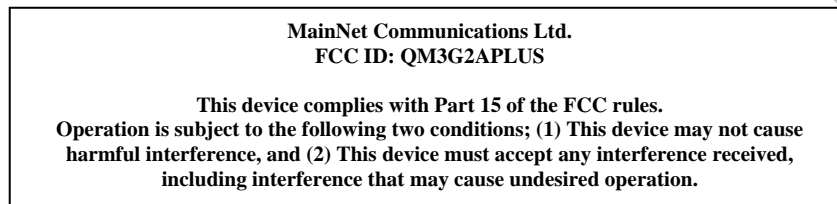


Figure – Expanded View of Label

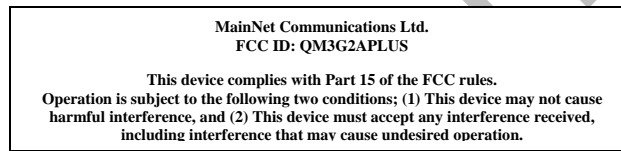


Figure - Actual Size of Label

### 6.2.2 FCC Labeling BPL In-Home Device

#### **BPL In-home unit; FCC compliance labeling; MainNet PLUS**

**Manufacturer: MainNet Communications, Ltd**

BPL Unit Type: Broadband over Power Line In-Building Product

Note: FCC ID Label Details – The label below shall be fixed to the base of the plastic housing.

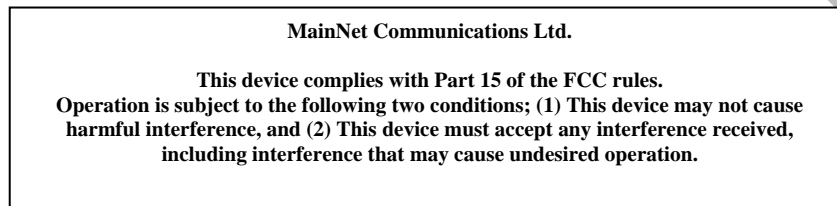


Figure – Expanded View of Label

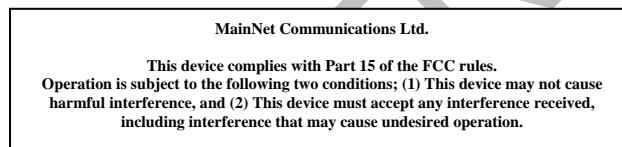
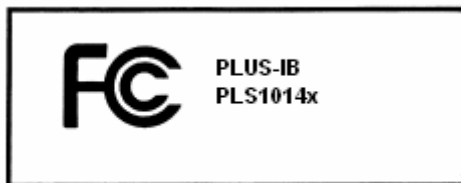


Figure - Actual Size of Label



## 6.3 Legal Notices

### 6.3.1 Limited Warranty, Software License Agreement & Notices

**CAREFULLY READ THE TERMS AND CONDITIONS OF THIS AGREEMENT BEFORE OPENING THIS PACKAGE. OPENING THIS PACKAGE INDICATES YOUR ACCEPTANCE OF THESE TERMS AND CONDITIONS. IF YOU DO NOT AGREE WITH THE TERMS AND CONDITIONS OF THIS AGREEMENT, PROMPTLY RETURN THIS PACKAGE UNOPENED TO THE PLACE OF PURCHASE FOR REFUND IN THE AMOUNT YOU PAID.**

**MainNet Communications, Ltd.** offers a warranty covering a period of one year from the date of purchase by the customer. If a product is found defective during the warranty period, MainNet will repair or replace the product with the same or a similar model, which may be a reconditioned unit, without charge for parts or labor. The specific terms of the warranty and software license agreement are provided below.

**Warranty.** For a period of one (1) year from the date of the authorized purchase of the hardware from MainNet by Customer, as defined below, MainNet warrants to Customer only that Unit(s), as defined below, shipped under this Agreement, will: (i) be newly manufactured or warranted as equivalent to new, and (ii) be free from defects in material and workmanship. For the purpose of this Agreement, "Customer" is defined as the authorized purchaser of the hardware from MainNet, and the term does not include any assignee or subsequent purchaser from an authorized Customer, or any other third party. For the purposes of this Agreement, "Unit(s)" is defined as the hardware shipped to Customer by MainNet, including the software components of the hardware.

**Remedy.** For a period of one year (1) year from the date of the authorized purchase by Customer, Customer's exclusive remedy, for any breach of the Warranty, including any cause of action sounding in contract, tort, strict liability or otherwise, or for any defect or nonconformity of a Unit shall be the replacement by MainNet of any defective Unit returned to MainNet by Customer with identical or comparable Unit or components, or at the option of MainNet the repair and return of the defective Unit to Customer within 30 days of receipt of the defective Unit by MainNet; provided however that Customer returns the defective unit with a Return Material Authorization (RMA) questionnaire and obtains an RMA number from MainNet; and further provided that all returns shall be in original packaging or equivalent. Any Unit

returned to MainNet without prior authorization for its return or proper packaging may be refused at the option of MainNet. The customer shall pay all shipping cost to return the unit to MainNet. Any unit returned to MainNet that upon inspection by MainNet is deemed to be functioning properly will be returned to the customer who will be charged a diagnostic fee of \$50.00 for each unit. The customer will also be charged a shipping and handling fee of \$4.35 for each non-defective unit returned to the customer.

**Exclusions from Warranty.** MainNet shall have no obligation under this Warranty or otherwise for correcting, curing, or otherwise remedying any nonconformity or defect with respect to the condition or operation of any system of which the unit was a part including but not limited to, the effective non-compliance of all or part of any system of which the unit was a part under applicable FCC or other governmental regulations.

**Supervision.** Except as otherwise expressly provided herein, MainNet shall not be responsible for technical support of Customer's customers/end users.

**Disclaimer.** EXCEPT AS SETFORTH ABOVE, ALL PRODUCTS COVERED BY THIS AGREEMENT ARE SOLD BY MAINNET "AS IS". MAINNET DISCLAIMS ANY AND ALL PROMISES, REPRESENTATIONS, AND WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR USE WITH RESPECT TO THE UNITS, AND/ OR WARRANTY OF NON-INFRINGEMENT OF ANY INTELLECTUAL PROPERTY RIGHTS OR ANY OTHER RIGHTS OF THIRD PARTIES. BY WAY OF ILLUSTRATION THIS EXCLUSION INCLUDES BUT IS NOT LIMITED TO CONDITION, LATENT AND HIDDEN DEFECTS, AND ITS MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR USE AND WITH RESPECT TO THE NATURE AND QUALITY OF ANY OTHER PERFORMANCE BY MAINNET HEREUNDER. DUE TO ABSENCE OF CERTAIN APPLICABLE REGULATORY STANDARDS OR GUIDELINES (COLLECTIVELY "REGULATORY STANDARDS"), THERE CAN BE NO ASSURANCE THAT SUCH REGULATORY STANDARDS WILL BE DEFINED OR ENACTED OR IN THE EVENT ANY REGULATORY STANDARDS ARE ENACTED, THE SYSTEM WILL BE FOUND COMPLIANT THEREWITH OR THAT THE SYSTEM'S PERFORMANCE WILL NOT BE ADVERSELY AFFECTED.

IN NO EVENT SHALL MAINNET BE LIABLE TO CUSTOMER AND/OR END USERS FOR ANY INCIDENTAL, SPECIAL, INDIRECT, EXEMPLARY, OR CONSEQUENTIAL LOSS OR DAMAGES, INCLUDING BUT NOT LIMITED TO, LOSS OF BUSINESS, MANPOWER, LABOR COSTS, PROFIT,

REVENUE AND/OR DATA WHETHER ARISING FROM BREACH OF CONTRACT, TORT STRICT LIABILITY OR OTHERWISE OR ANY CLAIMS OR DEMANDS BROUGHT AGAINST ONE PARTY BY ANY OTHER PARTY OR OTHERWISE, EVEN IF THE PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH CLAIMS OR DEMANDS. IN NO CASE SHALL MAINNET'S LIABILITY EXCEED THE PRICE YOU PAID FOR THE PRODUCT.

**Limited License.** MainNet grants Customer the right to use MainNet Programs so long as Customer is using the Programs for a twelve month term and distribute MainNet Programs to Customer's Service Providers and End Users; provided, however, that distribution of the MainNet Programs and all encryption programs and feature activation software supplied to Customer (collectively, the "Software"), and other printed materials accompanying the Software ("Documentation") shall be accomplished per this license agreement. For the purpose of this Agreement, "Programs" are defined as limited to: NmPLUS, NmDirect, NmDirect2 and MACPLUS. The foregoing limited right is granted for use of the Programs directly only with units purchased from MainNet. The license shall be renewed for subsequent twelve month terms upon receipt of payment of the software license maintenance fee from the Customer. MainNet shall be responsible for invoicing the customer for the software maintenance license fee on an annual basis at least 30 days prior to the expiration of the license.

Customer may use Software for demonstration purposes subject to the terms and agreements of this license.

Software is owned by MainNet and its suppliers and is protected by United States and international copyright laws and international trade provisions. Customer must treat the Software like any other copyrighted material. Customer acknowledges that no title to the intellectual property in the Software is transferred to Customer, and Customer will not acquire any rights to the Software except as expressly set forth herein.

Customer agrees not to attempt, and to use reasonable efforts to prevent Customer's employees and contractors from attempting to copy, modify, distribute, reverse engineer, disassemble, decompile, or make any attempt to discover the source code of the Software, including encryption programs and feature activation software, except to the extent that such prohibition is restricted by applicable law.

In addition to other warranties under the Agreement, MainNet represents and warrants that the Software shall perform substantially in accordance with the specifications therefor and contain no viruses, bombs or other software mechanisms, techniques or devices designed to disrupt, disable or stop its processing of data or other performance in accordance with its applicable documentation, user manuals, functional descriptions and specifications.

THE WARRANTIES PROVIDED HEREIN ARE PROVIDED BY MAINNET AND NOT MAINNET'S SUPPLIERS. CUSTOMER ACKNOWLEDGES THAT THE MAINNET PROGRAMS MAY INCLUDE ENCRYPTION TECHNOLOGY, FOR WHICH EXPORT CONTROLS HAVE BEEN IMPOSED BY THE UNITED STATES AND FOREIGN GOVERNMENT ENTITIES.

In exercising its rights under this Agreement, Customer shall not export or re-export the MainNet Programs in violation of export control, law or regulation imposed on the MainNet Programs by the United States or any other country or organization or nations within whose jurisdiction Customer operates or does business.

If this Software is to be acquired by the U.S. Government, the Software and related Documentation is commercial computer software and commercial computer software documentation developed exclusively at private expense, and (i) if acquired by or on behalf of a civilian agency, shall be subject to the terms of this computer software license as specified in 48 C.F.R. 12.212 of the Federal Acquisition Regulations and its successors; and (ii) if acquired by or on behalf of units of the Department of Defense ("DOD") shall be subject to the terms of this commercial computer software license as specified in 48 C.F.R. 227.7202-2, DOD FAR Supplement.

**Termination.** This Agreement is effective until terminated. This Agreement also will terminate if Customer does not comply with any terms or conditions of this Agreement. Upon such termination Customer agrees to destroy the Unit and Software and erase all copies residing on computer equipment.

## NOTICES

### **Federal Communication Commission (FCC)**

This device complies with Part 15 of the FCC Rules and Regulations. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference. This equipment generates, uses, and can radiate radio-frequency energy and may cause harmful interference to radio communications. If this equipment does cause harmful interference, which can be determined by turning the equipment on and off, the user/operator is encouraged to correct the interference by one or more of the following measures:

- Increase the separation between the affected equipment and the unit;
- Enable the notch protocol;
- Decrease the unit power level;
- Remove or turn-off the unit.

### **Important Notes:**

1. Intentional or unintentional changes or modifications must not be made unless under the express consent of the party responsible for compliance. Any such modifications could void the user's authority to operate the equipment and will void the manufacturer's warranty.



### **6.3.2 Standard Purchase Terms and Conditions**

Purchase of products and services from **MainNet Communications, Ltd.** are subject to the following Purchase Terms and Conditions. The purchaser, by accepting delivery of the products and/or services from MainNet, acknowledges acceptance to these terms and conditions.

#### **SCOPE**

The Terms and Conditions ("Terms") contained herein shall apply to all quotations and offers made by and purchase orders accepted by MainNet. These Terms apply to all sales made by MainNet except to the extent the Terms conflict with a Sales Agreement signed by MainNet and Buyer. These Terms apply in lieu of any course of dealing between the parties or usage of trade in the industry. These Terms may in some instances conflict with some of the terms and conditions affixed to the purchase order or other procurement document issued by the Buyer. In such case, the Terms contained herein shall govern, and acceptance of Buyer's order is conditioned upon Buyer's acceptance of the terms and conditions herein, irrespective of whether the Buyer accepts these conditions by a written acknowledgement, by implication, or acceptance and payment of products ordered hereunder. MainNet's failure to object to provisions contained in any communication from Buyer shall not be deemed a waiver of the provisions herein. Any changes in the Terms contained herein must specifically be agreed to in writing signed by an officer of MainNet before becoming binding on either party.

#### **PRICE, TAXES AND QUOTATIONS**

Prices are subject to change on thirty days notice to Buyer. Any order that can be cancelled and rescheduled pursuant to paragraph 6(a) is subject to a price change immediately. All prices are exclusive of any present or future sales, revenue or excise tax, value added tax, turnover tax, import duty (including brokerage fees) or other tax applicable to the manufacture or sale of any product. Such taxes, when applicable, shall be paid by Buyer unless Buyer provides a proper tax exemption certificate. Unless otherwise agreed to in writing by the parties, prices quoted by MainNet are those current at the date of quotation and shall be subject to variation by MainNet.

#### **DELIVERY**

Unless otherwise agreed in writing, sales are FOB destination region port of origin. MainNet may deliver products in one or more consignment and invoice each consignment separately. MainNet reserves the right to ship product that is not subject to cancellation in advance of the agreed shipping date. Unless otherwise agreed in writing, delivery time is not of the essence. Except as

specified in 6(b), MainNet does not accept liability for any loss arising from delay in delivery of products.

### **PAYMENT TERMS**

Unless otherwise agreed in writing, Payment terms shall be 50% down payment with confirmed order and net thirty (30) days from the date of invoice following receipt of products and services for remaining balance of order. Buyer agrees to pay interest on any unpaid balance at a rate of 1.50 percent per month on the outstanding balance due. Unless otherwise agreed in writing, all payments are to be in United States dollars. MainNet may require payment to be secured by an irrevocable letter of credit or a bank guarantee acceptable to MainNet. Where payment is made by letter of credit, all costs of collection shall be for Buyer's account. In the event that MainNet is required to bring legal action to collect delinquent accounts, Buyer agrees to pay reasonable attorneys fees and costs of suit.

### **NON-CONFORMING DELIVERY AND RISK OF LOSS**

Buyer shall notify MainNet of any visible defects, quantity shortages or incorrect product shipments within seven (7) days of receipt of the shipment. Failure to notify MainNet in writing of any visible defects in the products or of quantity shortages or incorrect shipments within such period shall be deemed an unqualified waiver of any rights to return products on the basis of visible defects, shortages or incorrect shipments, subject to Buyer's rights under the **Limited Warranty** Section of this agreement.

### **ORDER CANCELLATION**

(a) Buyers Cancellation: Buyer may cancel any order for convenience on the following terms: (i) For standard products, Buyer may cancel or reschedule a product without penalty if the cancellation is more than sixty (60) days from the Confirmed Shipping Date (as specified in MainNet's Order Acknowledgement or other document); cancellations within 60 days of a Confirmed Shipping Date must be approved in writing by a MainNet sales manager or corporate officer and may be subject to special charges (ii) For nonstandard parts, custom products, or standard parts with minimum usage Buyer may cancel or reschedule more than ninety (90) days from the Confirmed Shipping Date, except that Buyer shall accept delivery of all such products which are completed at the time of cancellation or rescheduling. Those nonstandard products which are in the work-in-process inventory at the time of cancellation or rescheduling shall be paid for by Buyer at a price equal to the completed percentage of the product multiplied by the price of the finished product. Buyer also shall pay promptly to MainNet the costs of settling and paying claims arising out of the termination of work under

MainNet's subcontracts or vendors and any accounting, legal, and clerical costs arising out of the cancellation.

(b) MainNet's Cancellation: MainNet shall have the right to cancel any unfilled order without notice to Buyer in the event that Buyer becomes insolvent, adjudicated bankrupt, petitions for or consents to any relief under any bankruptcy reorganization statute, or becomes unable to meet its financial obligations in the normal course of business. Any order that can be cancelled or rescheduled by Buyer pursuant to paragraph 6(a) may be cancelled or rescheduled by MainNet if notice is given to Buyer.

#### **LIMITED WARRANTY**

Except as specified below, products sold hereunder are sold "AS IS" and shall be subject to MainNet's Limited Warranty and Software License Agreement. THE FOREGOING WARRANTY AND REMEDIES ARE EXCLUSIVE AND MADE EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED OR OTHERWISE, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND/OR NONINGRINTMENT OF ANY INTELLECTUAL PROPERTY RIGHTS OF THIRD PARTIES. MAINNET DOES NOT ASSUME OR AUTHORIZE ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER LIABILITY IN CONNECTION WITH ITS PRODUCTS.

#### **LIMITED LIABILITY**

Neither MainNet nor Buyer shall be liable for incidental or consequential damages, including but not limited to, the cost of labor, re-qualifications, rework charges, delay, lost profits, or loss of goodwill arising out of the sale, installation or use of any MainNet product. If MainNet has any liability for breach of contract, breach of any implied condition, warranty or representation, the aggregate liability of MainNet to Buyer shall be limited in respect of any occurrence or series of occurrences to the contractual value of the products or services that are the subject of the contract.

#### **NO LICENSE; INTELLECTUAL PROPERTY OF MAINNET AND OTHERS**

Except as expressly provided, nothing within any of the Products and Services shall be construed as conferring any license under any of the MainNet's or any third party's intellectual property rights, whether by estoppel, implication, waiver, or otherwise. Without limiting the generality of the foregoing, you acknowledge and agree that the Products and Services provided are protected by copyright, trademark, patent, or other proprietary rights of MainNet and its affiliates, licensors, and service providers. Except as expressly provided to the contrary, you agree not to modify, alter, or deface any of the trademarks, service marks, or other intellectual property made available by MainNet in connection with the Products and Services. You

agree not to hold yourself out as in any way sponsored by, affiliated with, or endorsed by MainNet, any of MainNets' affiliates, or any of MainNets' service providers. You agree not to use any of the trademarks or service marks or other content accessible from MainNet of any purpose other than the purpose for which such content is made available to customers of MainNet. You agree not to defame or disparage MainNet, the trademarks or service marks of MainNet, or any aspect of the Products and Services. You agree not to adapt, translate, modify, decompile, disassemble, or reverse engineer the Products and Services or any software or programs used in connection with the MainNet Products and Services.

#### **CONFIDENTIAL INFORMATION**

Except as required by law, neither party shall use (except for purposes connected with the performance of its obligations hereunder), divulge or communicate to any third party any information of the other it reasonably knows to be confidential.

#### **FORCE MAJEURE**

MainNet shall not be liable for any damage or penalty for delay in delivery or for failure to give notice of delay when such delay is due to the elements, acts of god, acts of the Buyer, act of civil or military authority, war, riots, concerted labor action, shortages of materials, or any other causes beyond the reasonable control of MainNet. The anticipated delivery date shall be deemed extended for a period of time equal to the time lost due to any delay excusable under this provision.

#### **EXPORT REGULATIONS**

Buyer agrees to comply fully with all laws and regulations concerning the purchase and sale of products. In particular, Buyer agrees to comply with the Export Administration Regulations of the United States in so far as they apply to the sale of products. The products are licensed by the United States for delivery to the ultimate destination as shown on the shipment/invoice address and any contrary diversion is prohibited.

#### **ASSIGNMENT AND SUBCONTRACTING**

MainNet shall be entitled at all times to assign its rights under the contract (in whole or in part) or to subcontract any part of the work or services to be provided under the contract as it deems necessary or desirable.

#### **NOTICES**

Any notice hereunder shall be deemed to have been given if sent by prepaid first class mail to the party concerned at its last known address. Notice to

MainNet shall be to the regional sales office in the territory or to MainNet PLC, Inc., Attn: Legal Dept., PO Box 2458, Falls Church, VA 22042.

**WAIVER**

Failure by MainNet to exercise or enforce any rights hereunder shall not be deemed to be a waiver of any such right nor operate so as to bar the exercise or enforcement thereof at any time or times thereafter.

**APPLICABLE LAW**

Unless otherwise agreed in writing, the terms and conditions contained herein shall be governed by and construed under the laws of the Commonwealth of Virginia, USA.

## 7. How to Contact MainNet

MainNet Communications, Ltd,  
47 Hanessi'im St.  
Ra'anana - North 43583  
P.O.B 192, ISRAEL.  
+972.9.770.0800  
<http://www.mainnet-plc.com>

MainNet Power Line Communications, Inc.  
PO Box 2458  
Falls Church, VA 22042  
+1.703.476.4700  
<http://www.powerline-plc.com>

For technical support address inquiries to: [mainnet@mainnet-plc.com](mailto:mainnet@mainnet-plc.com)

For sales outside North & South America address inquiries to:  
[mainnet@mainnet-plc.com](mailto:mainnet@mainnet-plc.com)

For sales inside North & South America address inquiries to:  
[sales@powerline-plc.com](mailto:sales@powerline-plc.com)