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|--------------------|--|--|
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| System Application | High Speed Digital Services                            |  |
| Product Type       | Single In-Line filter                                  |  |
| Product Name       | MF600IT  |  |
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## 1. Introduction:

The Single In-Line filter has been specifically designed to implement the functionality of low pass filter in G.Lite system. G.Lite technology is similar to full rate ADSL in using DMT technology but operates at a lower data rate of up to 1.5 Mbps downstream and 512 kbps upstream, depending on line conditions and lengths.

ADSL Lite is proposed as a lower speed version of ADSL that will eliminate the need for telecom to install and maintain a premise based POTS splitter. Recent field trials of ADSL Lite equipment jointly carried out by a group of manufacturers and a North America network operator has proved the technology, achieving maximum data rate for distance up to 15000 feet, It was found necessary to include one or more low pass filters in series with the POTS terminals in order to reliably achieve maximum data rates. The Single In-Line filter for phones or telephone equipment using a single-line phone jack. The low pass filter provides protection from ADSL signal which may impact through non-linear or other effects remote devices ( telephone sets, facsimile machine, answering machine, voice band modem, etc. ) individually or in groups on line 1 only. For ADSL signal, it also provides protection from the high frequency transients and impedance effects that occur during POTS operation ( ringing transients, on / off hook transients and so on ). This Single In-Line filter also provides a second jack that is unfiltered for connecting ADSL and / or other high speed digital services such as HPN.

Because the Single In-Line filter connects directly to the subscriber loop media, it must also provide some protection for externally induced line hits or faults which could damage any attached equipment or endanger humans interacting with the installed equipment. The circuit protection will be provided mostly by standard central office line protection means and additional protection measures built into the Single In-Line filter to protect against line overstress which could damage the Single In-Line filter itself. The electrical and transmission specifications are designed electronically to meet all the electrical requirements and physical properties as per T1E1.4/2001-007R3 and isolate the high speed DSL and HPN data streams from the voice band Plain Ordinary Telephone Service ( POTS ). This design effectively blocks the ADSL, HPN and other radio frequencies up to 12 MHz.

## 2. Compatibility:

- \* This Single In-Line filter complies with 47 CFR 68 302 ( b ), ( c ), UL 1950, CSA C22.2 No. 950-95, GR 1089-Core, ITU-T K.21 etc. electrical safety requirements for network telecommunication equipment.
- \* This Single In-Line filter complies with all necessary requirements applicable to voice band equipment for FCC CFR 47 part 68 registrations.
- \* This Single In-Line filter is compatible with central office POTS line metallic test equipment for voice band testing.
- \* This Single In-Line filter meets all requirements in this product specification regardless of the Tip-to-Ring polarity.
- \* This Single In-Line filter allows transmission of caller ID information to a connected POTS device when the connected device is in the On-hook or Off-hook state.
- \* This Single In-Line filter allows transmission of voice and voice band data, including cordless telephone sets, V.90 modems and facsimile machines in the Off-hook state.

## 3. References:

|                            |   |
|----------------------------|---|
| Ref. 1 : ETS 300 001       | Attachments to the Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to analogue subscriber interface in the PSTN. |
| Ref. 2 : ANSI T1.413       | Network and Customer Installation Interfaces - Asymmetric Digital Subscriber Line (ADSL) Metallic Interface   |
| Ref. 3 : ITU-T G.992.1     | Asymmetrical Digital Subscriber Line (ADSL) Transceiver   |
| Ref. 4 : ITU-T G.992.2     | Splitterless Asymmetric Digital Subscriber Line ( ADSL ) Transceivers   |
| Ref. 5 : T1E1.4/2001-007R3 | In-Line Filter Standard   |
| Ref. 6 : ITU-T K.21        | Resistibility of Telecommunication Equipment Installed in Customer Premises to Overvoltages and Overcurrents  |
| Ref. 7 : ITU-T K.44        | Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents - Basic Recommendation   |
| Ref. 8 : 47 CFR Part 68    | Connection of terminal equipment to the telephone network, Federal Communications Commission, code of Federal regulations   |
| Ref. 9 : UL 1950           | Underwriters Laboratories, the Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment                                   |
| Ref. 10 : GR 1089-Core     | Electromagnetic Compatibility and Electrical Safety Generic Criteria for Network Telecommunications Equipment   |

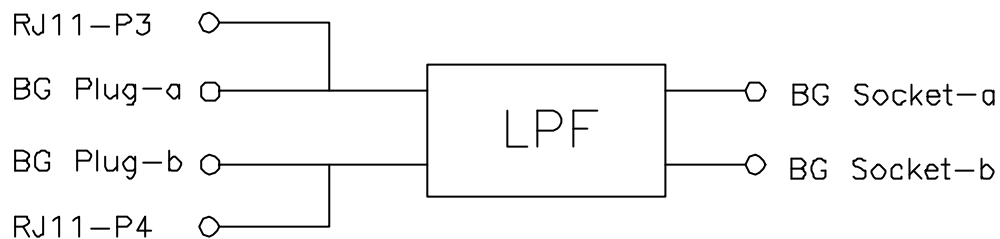
#### 4. Abbreviations:

|        |                                    |
|--------|------------------------------------|
| ADSL   | Asymmetric Digital Subscriber Line |
| CO     | Central Office                     |
| CPE    | Customer Premise Equipment.        |
| POTS   | Plain Old Telephone Service        |
| RT     | Remote Terminal                    |
| DSL-NT | Network termination of ADSL        |

#### 5. Technical requirements:

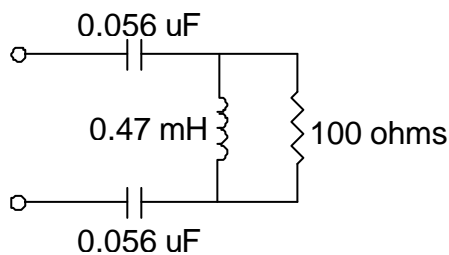
##### 5.1. Schematic:

The following drawing illustrates the schematic of this product.



##### 5.2. ZHP-r definition:

To facilitate testing of the Single In-Line filter independently of the actual modem or specific vendor, ZHP-r is defined to allow proper termination of the ADSL port during voice band testing. The ZHP-r is valid only for voice band frequency. The combination of capacitors in the ZHP-r is only representative. The input shall be 27 nF however derived. ZHP-r equivalent circuit is shown below.



**5.3. Electrical specification:**

The low pass filter shall satisfy the following parametric limits shown in this table across the Line side of this device.

| Splitter parameters                                     | Electrical requirements     |   |
|---|-----------------------------|---|
|   | Range                       | Values  |
| Splitter bandwidth                                      |                             | DC to 4 kHz                                   |
| Nominal voice band                                      |                             | 0.3 kHz to 3.4 kHz                            |
| Ringing frequency                                       |                             | 15.3 Hz to 68 Hz                              |
| ADSL band   |                             | 30 kHz to 1104 kHz                            |
| Line Impedance $Z_L$                                    | 300 Hz to 3.4 kHz           | 600 ohms                                      |
| Line Impedance ZNL-r                                    | 300 Hz to 3.4 kHz           | 1330 ohm // (348 ohm + 0.1 $\mu$ F)           |
| Modem impedance   | 30 kHz to 1104 kHz          | 100 ohms                                      |
| <b>Operation voltage voice band</b>                     |                             |   |
| Nominal signal  |                             | 21 mVpp to 5.4 Vpp                            |
| Ringing signal  |                             | 40 Vrms to 150 Vrms<br>( 113 Vpp to 424 Vpp ) |
| DC voltage  |                             | 0 V to 105 V                                  |
| Max. AC voltage   |                             | 150 Vrms with -105 VDC offset                 |
| Max. differential                                       |                             | 320 V   |
| <b>Operation current voice band</b>                     |                             |   |
| Loop current  |                             | < 100 mA                                      |
| <b>DC resistance</b>                                    |                             |   |
| DC resistance   | Tip to Tip and Ring to Ring | < 50 ohms                                     |
| Isolation resistance                                    | Tip to Ring                 | > 10 Mohms                                    |
| <b>Differential input blocking impedance</b>            |                             |   |
| Line side   | 20 kHz                      | > 2 kohms                                     |
|   | 30 kHz                      | > 3 kohms                                     |
|   | 5 MHz to 10 MHz             | > 2 kohms                                     |
|   | 10 MHz to 400 MHz           | N / A   |
| <b>Voice band characteristics</b>                       |                             |   |
| Insertion loss between 600 ohms resistive single filter | 1004 Hz                     | < 0.7 dB                                      |
| With 5 filters  | 1004 Hz                     | < 1.0 dB                                      |

| Splitter parameters  | Electrical requirements |               |
|--|-------------------------|---------------|
|  | Range                   | Values        |
| Attenuation distortion between 600 ohms resistive single filter                                  | 200 to 3.4 kHz          | < 1.0 dB      |
| Attenuation distortion between 600 ohms resistive with 5 filters                                 | 200 to 3.4 kHz          | < 5 dB        |
| 600 ohms return loss single filter   | SRL-L                   | > 23 dB       |
|  | ERL                     | > 23 dB       |
|  | SRL-H                   | > 23 dB       |
| 600 ohms return loss with 5 filters  | SRL-L                   | > 20 dB       |
|  | ERL                     | > 13.5 dB     |
|  | SRL-H                   | > 7 dB        |
| Complex* ZNL-r Return loss single filter   | SRL-L                   | > 26.5 dB     |
|  | ERL                     | > 17 dB       |
|  | SRL-H                   | > 9 dB        |
| Complex* ZNL-r return loss with 5 filters  | SRL-L                   | > 15 dB       |
|  | ERL                     | > 8 dB        |
|  | SRL-H                   | > 2 dB        |
| * 1330 ohms in parallel with the series connection of a 348 ohms resistor and a 100 nF capacitor |                         |               |
| Longitudinal conversion loss ( LCL )   | 200 Hz to 1 kHz         | > 58 dB       |
|  | 1 kHz to 3 kHz          | > 53 dB       |
| Delay distortion   | 200Hz to 4 kHz          | < 100 $\mu$ s |
| Inter-Modulation distortion  | 2nd                     | > 57 dB       |
|  | 3rd                     | > 60 dB       |
| <b>ADSL band characteristics</b>   |                         |               |
| Common mode rejection  | 40 kHz                  | > 45 dB       |
|  | 1.1 MHz                 | > 45 dB       |
| ADSL band attenuation  | 30 kHz                  | > 24 dB       |
|  | 1 MHz                   | > 65 dB       |

**5.4. DC characteristics :**

All requirements of this specification can be met in the presence of all POTS loop currents from 0 mA to 100 mA. This Single In-Line filter can pass POTS tip-to-ring DC voltages of 0 V to 105 V and ringing signals of 40 Vrms to 150 Vrms at any frequencies from 15.3 Hz to 68 Hz superimposed on DC voltages in the range from 0 V to 105 V. The DC resistance from tip-to-ring at the line port interface with the phone interface shorted, shall be less than or equal to 50 ohms for one filter. The DC resistance from tip-to-ground and from ring-to-ground at the Phone interface with the Line interface open shall be greater than or equal to 10 Megohms. The ground point shall be local building or green wire ground. As an objective, the DC resistance should exceed 10 MΩ.

**5.5. Test methods :**

**5.5.1. Off-hook insertion loss :**

The insertion loss of a device connected into a given transmission system is defined as the ratio, expressed in dB, of the load power available ( before and after insertion ) delivered to the output network beyond the point of insertion at a given frequency. In general, the insertion loss is defined as the ratio, expressed in dB of the power delivered to a load with the circuit in place and the power delivered to a load without the circuit in place. The added insertion loss shall be measured using the test up in figure 2. For measuring POTS band insertion loss for single filter module also for single filter with four added parallel load filters. General Insertion loss equation can be expressed as follows. Insertion loss =  $20 \log | V2 / V1 |$  dB where

V1 = the measured voltage value of load without LPF in circuit.

V2 = the measured voltage value of load with LPF in circuit.

The test setup is shown in drawing below.

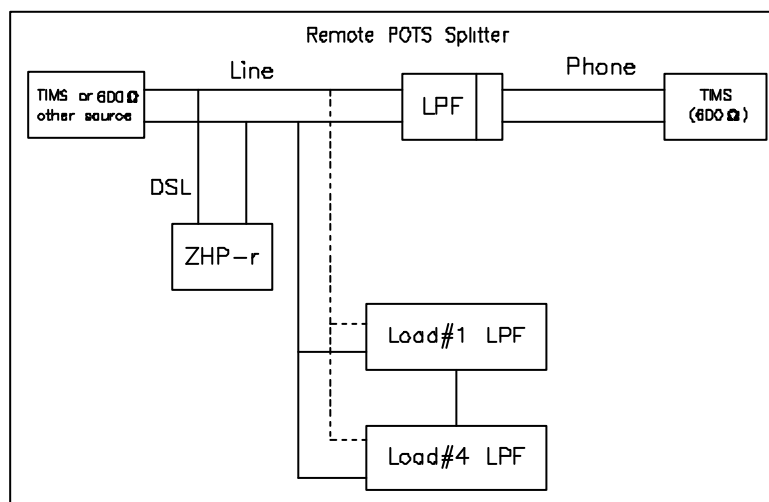


Figure 2.



**5.5.2. Return loss:**

Return loss measure the amount of energy that is lost due to reflection which resulted from impedance mismatching at the interface. Return loss is essentially defined as the ratio of the power incident upon a given transmission system to the power reflected caused by impedance mismatch with respect to reference impedance at the interface between source and device. Return loss figure are a function of the impedance of the circuit involved and are therefore frequency dependent. These impedance must be closely maintained in order to reduce the possibility of undesirable reflection and echoes which in long distance circuit the telephone user or destroy the data being sent. To perform the return loss test, open, short, load calibration must be done prior measurement while the LCR impedance analyzer being selected in impedance mode. Return loss is general expressed in decibels. General return loss equation is as follows.

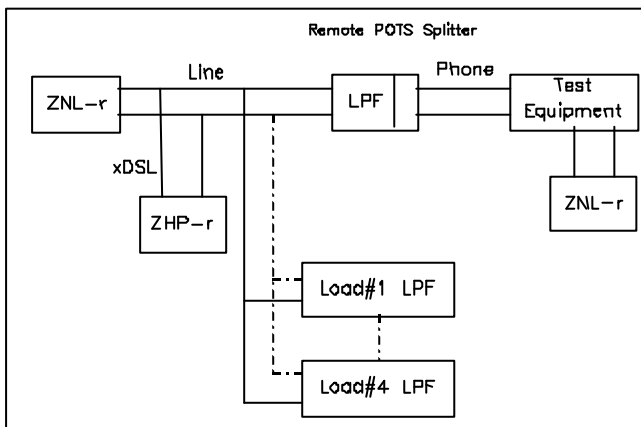
$$\text{Return loss} = 20 \log \left| \frac{Z_L + Z_M}{Z_L - Z_M} \right| \text{ dB}$$

Where  $Z_L$  = the reference impedance

$Z_M$  = the measured impedance

The test setup is shown in drawing below.

**5.5.2.1. Complex\* return loss with ATU-R :**



ZNL-r definition:

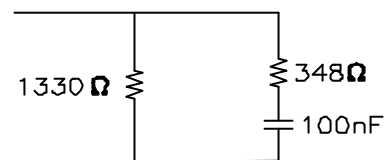


Figure 3.

**5.5.2.2. 600 ohm return loss with ATU-R :**

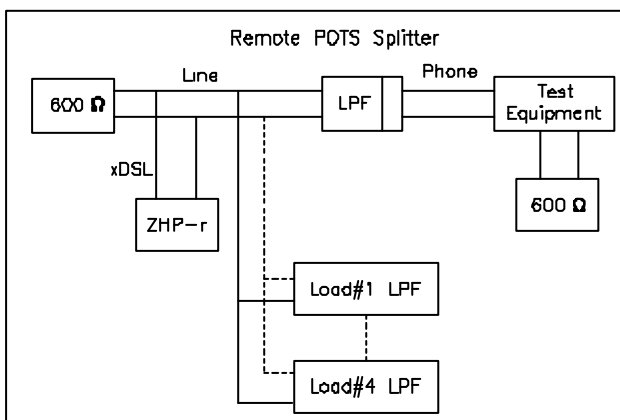


Figure 4.

## 5. Environmental condition :

### 5.1. Resistibility to overvoltages and overcurrents :

The splitter has to comply with requirements as per ITU-T K.20.

### 5.2. Climatic conditions :

#### 5.2.1. Operating temperature :

Application indoor  
Long time operation guarantee temperature ( 5 to 40 °C )  
Short time operation guarantee temperature ( 0 to 50 °C )  
( According to ETS 300 019, class 3.2 )

#### 5.2.2. Storage and transport :

Low ambient temperature - 20 °C  
High ambient temperature +85 °C  
( According to MIL-STD-202 method 107 )

#### 5.2.3. Operation humidity :

Long time operation guarantee humidity ( 5 to 85 % )  
Short time operation guarantee humidity ( 5 to 90 % )  
Short time : within 72 continuous hours and 15 days in a year

## 6. Reliability conditions :

### 6.1. Thermal shock :

Temperature from -20 °C to +85 °C for 5 cycles  
(According to MIL-STD-202 , method 107)

### 6.2. Temperature humidity exposure :

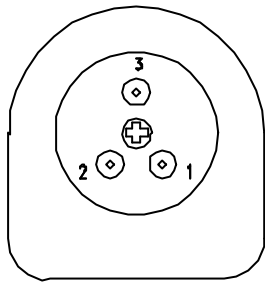
+50 °C /95RH , 96hrs  
(According to MIL-STD-202 , method 103)

### 6.3. Vibration test :

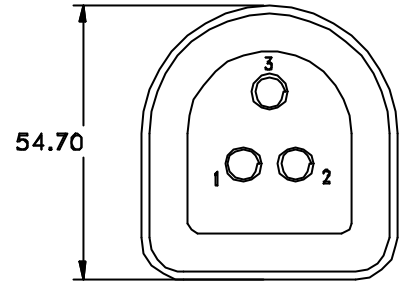
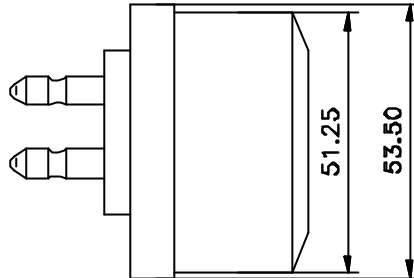
Random vibration , frequency 5-500Hz , sweep time : 1 hr / axis /  
Force : 2.4grams (According to MIL-STD-202 , method 204)

**8. Mechanical conditions :**

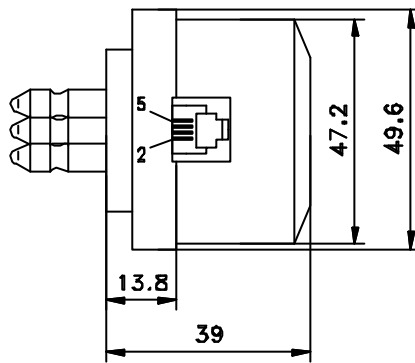
**8.1. Mechanical :**



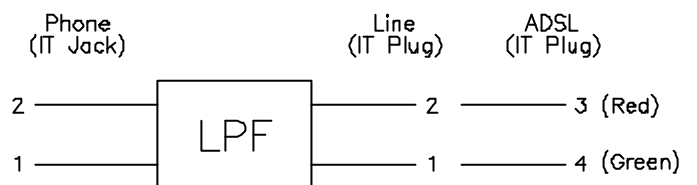
IT PLUG



IT JACK



US JACK



Note :

Unit : mm

**8.2. Connector information:**

| Position | Type      | Tip | Ring |
|----------|-----------|-----|------|
| Phone    | IT Jack   | 2   | 1    |
| Line     | IT Plug   | 2   | 1    |
| ADSL     | RJ11 Jack | P3  | P4   |