COMMUNICATION CONTROLLER
WITH IP SERVICES
FOR LEASED LINES AND RADIO LINKS

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1 GENERAL DESCRIPTION

RA-MD1 is a Communication Controller composed of an embedded audio modem and a high performances RISC processor, equipped with LINUX operating system, which manages the whole device and handles the HW/SW communication interfaces needed for serial and LAN (Ethernet) data ports.

The typical application is the TCP/IP network extension toward remote networks or single network devices operating process control (electrical production, surging sites...).

The embedded audio modem is designed to work on a standard 4 wire interface on a leased line, using the V.34 standard; it is optimized to transport the data flow over analogic radio links, on which it assures great performances. For this option we recommend to use TRXs of the RA-450D family, which have excellent radio electric characteristics, adapted to realize high-speed data point-to-point links.

On this subject, should be noted that the RA-450D TRXs process the signal through Digital Signal Processing (DSP) devices, permitting lots of functions not performed by the traditional analogic TRXs. In particular, the link established by these TRXs, even with a 12.5KHz channelling, guarantees a 300-3400 Hz bandwidth with very low levels for group delay and distortion, and a high S/N level.

Available on the RA-MD1 are:
- an asynchronous serial V.24 port (DTE) destined to the remote control system, permitting the monitoring and the surveillance of both the “local” and the “remote” device
- an asynchronous serial V.24 port (DTE) for the data communication
- a 10/100 BT LAN Ethernet port for the data communication

The RA-MD1 handles the communications between the serial ports, the LAN port and the embedded modem. It has its own configurable IP Address, and carries the data on a 4 wire leased line using a full-duplex PPP protocol.

The RA-MD1 can transfer data on a point-to-point radio link, realized with a couple of RA-450D TRXs, at a speed up to 26.4Kbps, assuring a 19.2Kbps net bandwidth and using the extra band for diagnostic signalling, error correction and network services.

Using a RISC processor with an embedded LINUX operating system assures a great flexibility for configuration and use, permitting either homogenous LAN-to-LAN or V.24-to-V.24 and mixed LAN-to-V.24 connections.
### Device 1 data interface
- V.24 asynchronous serial port ➔
- 10/100 BT Ethernet (TCP/IP) ➔
- 10/100 BT Ethernet (RAW) ➔

### Device 2 data interface
- ➔ V.24 asynchronous serial port
- ➔ 10/100 BT Ethernet (TCP/IP)
- ➔ V.24 asynchronous serial port
- ➔ 10/100 BT Ethernet (TCP/IP)
- ➔ 10/100 BT Ethernet (RAW)

The power supplying is compliant with the greater part of the Telecom Companies Standards, at 19-65V floating ground.
2 APPLICATIONS

2.1 REFERENCE DRAWING

The RA-MD1 typical function is to perform a full-duplex point-to-point data transfer through an analogic audio transport network, as shown below:

The data interfaces can be a 10/100 BT Ethernet port or a V.24 asynchronous serial port (DTE). The control port is a V.24 asynchronous serial (DTE) port, and can be connected through the usual diagnostic channels transport network.

Through the control port the user can carry out the complete configuration of the device and perform remote monitoring and surveillance, on both the “local” and the “remote” devices.

All the data transport configurations specified in the next sections are available on the RA-MD1.

2.2 ANALOGIC RADIO LINK CONNECTIONS THROUGH RA-450D TRX

A full-duplex point-to-point radio link can be used as transport network; this can be easily built with a couple of RA-450D TRX, which is the best for a data flow transport.

Moreover, the analogic data flow on a standard 4 wire interface can easily be carried on an existent audio transport network, in the case of a long distance between the TRX and the RA-MD1.

The next figure shows a possible extended version of the Reference Drawing.
A couple of RA-MD1 can be connected directly through the RA-450D audio channel and/or an audio transport network with 4 wire phone channels, w/ or w/o E&M signalling.

The RA-450D TRX permits strong data links on a distance of tens of Kilometres because of both its sensivity (26.4 Kbps @ -80 dBm / 19.2Kbps @ -90 dBm) and its available RF power (up to +43 dBm).
3 DATA INTERFACES CONFIGURATION

3.1 SERIAL-TO-SERIAL CONNECTION

This is the RA-MD1 basic operating mode: it realizes a “transparent” serial data transfer.

The LAN is not involved, therefore no IP Addresses or other LAN parameters are required.

The serial ports can be configured with:
- Speed (1.2 Kbps to 115 Kbps)
- Character length (7 or 8 bit)
- Parity (none, even, odd)
- Flow control (Hw - RTS/CTS - or none)

All the data transmitted over the data serial port are transparently transferred to the data serial port of the other device. The amount of communication delay is mainly due to the transport network. Both the devices must be configured as “Serial Forwarder”.

3.2 ETHERNET-TO-ETHERNET CONNECTION

Two RA-MD1s linked through a transport network can perform a direct connectivity between two LANs.

The following operating modes are possible.

Unfiltered LAN Extender

With this operating mode, both the RA-MD1s don’t need a specific IP Address or a Subnet Mask. All the data packets on the Ethernet port are transparently transferred to the Ethernet port of the other device in RAW mode.
Because of the limited bandwidth (with respect to Ethernet speed) of the 4 wire data channel, interposing a device like a switch or a gateway or a router between the Local Host and the RA-MD1 is a better choice.

The reference drawing is as follows:

The Remote Target is visible as it were a local device, so the Local Host will make a direct connection to the Remote Target, to its IP Address; the Host and the Target IP Addresses must belong to the same Network Address.

**Filtered LAN Extender**

The reference drawing and the main settings are the same as for the above mode (Unfiltered LAN Extender); the only difference is that both the RA-MD1s can filter the Ethernet Addresses, just like a network switch. Therefore, a data packet will be transferred only if the Ethernet Address of the addressee is included in the MAC dynamic tables of the RA-MD1 connected to the sender.

This operating mode is similar to the above (Unfiltered LAN Extender), but filtering the Ethernet Addresses dramatically reduces the traffic on the data channel and increases the bandwidth available for the data. A little portion on the band is anyway required for network signalling.

**GATEWAY (not yet implemented)**

This operating mode requires that both the RA-MD1s must have their own IP Address and Subnet Mask configured, as well as all the routing informations needed to route the data packets. Specifically, every RA-MD1 must have IP Address, Subnet Mask, and the destination Network Address also, so the Local Host will use the IP Address of the attached RA-MD1 as the gateway address toward the Remote Target network.

The Network Addresses must be different one from each other for all the subnets of the data path. Routing informations must be provided on both the RA-MD1s and all the LAN devices involved in the connection.
The GATEWAY operating mode optimizes the transfer speed over the data channel by sending only the packets to be routed and minimizing the network signalling.

The routing informations should be as follow:

In this example the IP Addresses of the Local Host and the Device A belong to a same Network Address, as well as the IP Addresses of the Device B and the Remote Target belong to a same Network Address. The PPP IP Addresses of both the RA-MD1s must belong to a same Network Address, which must be different from those of the Local Host and the Remote Target.

The routing informations should be as follow:

- Local Host ➔ Remote Target: Route Add 10.2.1.0/24 GW 10.1.1.1
- RA-MD1 A ➔ RA-MD1 B:....... Route Add 10.2.1.0/24 GW 10.100.1.2
- Remote Target ➔ Local Host: Route Add 10.1.1.0/24 GW 10.2.1.1
- RA-MD1 B ➔ RA-MD1 A:....... Route Add 10.1.1.0/24 GW 10.100.1.1

**LAN Forwarding**

This operating mode leads the connection to a good level of efficiency, similar to the GATEWAY mode.

The reference drawing is as follow:
The Local Host makes a TCP/IP connection on the Device A, acting as a network server and listening on the port \texttt{xxxx}.

The Device B acts as a network client, and makes a TCP/IP connection on the Remote Target on the port \texttt{yyyy}.

Once the LAN connection is established, the network packets going from the Local Host to the Device A on the port \texttt{xxxx} will be transferred to the Remote Target on the port \texttt{yyyy}, so the Local Host look at the Device A as it were the Remote Target.

The RA-MD1s should belong to different Network Addresses.

### 3.3 \textbf{Ethernet-to-Serial Connection}

Two RA-MD1s can operate as cross-connectors between LAN-connected and serial-connected devices. The operating mode is quite similar to the described above “LAN Forwarding” mode.

Two operating modes are available: serial-connected Remote Target or serial-connected Local Host.

**Serial-Connected Remote Target**

The Remote Target is equipped with an asynchronous V.24 serial port, and it has to be connected to a LAN.

The reference drawing is as follow:
The Local Host makes a TCP/IP connection on the Device A, acting as a network server and listening on the port \textit{xxxx}; the Device B is connected to the serial port of the Remote Target.

Once the LAN connection is established, the network packets going from the Local Host to the Device A on the port \textit{xxxx} will be transferred to the Remote Target on the serial port, which "answers" to the Local Host through the serial port; so the Local Host look at the Device A as if it were the Remote Target.

\textbf{Serial-Connected Local Host}

This is a very unusual case. The local Host is equipped with an asynchronous V.24 serial port, and it has to be connected to a Remote Target equipped with an Ethernet port.

The reference drawing is as follow:
4 REMOTE MONITORING AND SURVEILLANCE

The RA-MD1 is equipped with an asynchronous V.24 serial port destined to the remote control, status monitoring and surveillance.

The serial port can be configured with:
- Speed (1.2 Kbps to 115 Kbps)
- Character length (7 or 8 bit)
- Parity (none, even, odd)
- Flow control (Hw - RTS/CTS - or none)

Through this port the RA-MD1 can be totally configured. The remote device (the one at the other end of the data channel) is visible on the same connection. The service communications between the interconnected RA-MD1s use the extra band of the data flow.

Through this port, controls on operating parameters and status and diagnostic tasks can be activated:
- General Settings and Operating Mode
- Measurement and adjustment of transmitted audio levels
- Check of received audio level and S/N
- Check of the embedded modem speed connection
- Local and Remote Data Loop, for checking the Service Quality (not yet implemented)
- Generating and Decoding MF tones on the audio line (not yet implemented)

More RA-MD1s, grouped at the same level (local or remote) can be accessed as shown in figure:
The control port is mirrored on a connector through which all the devices can be connected by a BUS cable. This mirror port goes to Hi-Z when the device is off.
5 COUPLING THE RA-MD1 TO A TRX RA-450D

The RA-MD1 is designed to work on leased lines, so the data flow can be well transported by point-to-point full-duplex analogic radio links: therefore the RA-MD1 coupled to an RA-450D TRX creates the optimal working condition for a wireless connection.

This TRX has excellent characteristics to perform a point-to-point high-speed radio link:
- extremely low values for noise, distortion and group delay;
- very high RX sensivity;
- true 300-3400Hz audio bandwidth;
- 12.5 or 25KHz channelling;
- analogic signal processed by a DSP device, which permits lots of functions not performed by the traditional analogic TRXs

The coupling of an RA-MD1 to an RA-450D can be done by connecting a 4 wire cable (two twisted pairs is the best) between the “LINE” connector of the RA-MD1 and the “Laux0” connector of the RA-450D; on this connector a jumper must be inserted on the “E” signal contacts, to force the transmission status active.

At last, using the appropriate control software programs, the following settings must be applied:
- RA-MD1 audio TX level: -10dBm
- RA-MD1 audio RX sensivity: -38dBm
- RA-450D audio input level on “Line 1”: -6dBm
- RA-450D audio output level on “Line 1”: -6dBm
- RA-450D modulation: FM
- RA-450D RF Power: to be adjusted to have a field strength between -55dBm and -75dBm on the receiver at the other end of the link
6 TECHNICAL DATA

6.1 EMBEDDED MODEM CHARACTERISTICS

<table>
<thead>
<tr>
<th>Used audio bandwidth</th>
<th>300-3400 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulation</td>
<td>V.90 / V.34 / V.32</td>
</tr>
<tr>
<td>Error correction</td>
<td>ITU-T V.42 LAPM or MNP 2-4</td>
</tr>
<tr>
<td>Data transmission speed on a radio link performed by a couple of RA-450D TRXs</td>
<td>Depending from radio electric characteristics of the link (typical values): 26.4 Kbps @ &gt; -80dBm 19.2Kbps @ -90dBm 9.6Kbps @ -100dBm</td>
</tr>
</tbody>
</table>

6.2 PORTS AND CONNECTORS

<table>
<thead>
<tr>
<th>LAN Port</th>
<th>Ethernet 10/100 BT, RJ45 connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data serial Port</td>
<td>RS232 asynchronous V.24 1.2-115Kbps, DB9 female connector (DTE)</td>
</tr>
<tr>
<td>Control serial Port</td>
<td>RS232 asynchronous V.24 1.2-115Kbps, DB9 female connector (DTE)</td>
</tr>
<tr>
<td>Control BUS Port</td>
<td>TTL, dual-in-line 10 pins male connector</td>
</tr>
</tbody>
</table>

6.3 ENVIRONMENTAL PARAMETERS

<table>
<thead>
<tr>
<th>Operating Temperature</th>
<th>-20 / +55 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storing Temperature</td>
<td>-40 / +70 °C</td>
</tr>
</tbody>
</table>

6.4 POWER SUPPLYING

<table>
<thead>
<tr>
<th>Nominal voltage</th>
<th>19-65 Vcc floating ground</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max ripple</td>
<td>30 mVpp</td>
</tr>
<tr>
<td>Overvoltage protection treshold</td>
<td>70V differential 300V common mode</td>
</tr>
<tr>
<td>Polarity reversal protection</td>
<td>-100 V</td>
</tr>
<tr>
<td>Short-circuit protection</td>
<td>Electronic protection with automatic restore and double fuse on input line</td>
</tr>
<tr>
<td>Power consumption</td>
<td>&lt;6 W</td>
</tr>
</tbody>
</table>
6.5 **MECHANICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>210 x 120 x 50 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>500 g</td>
</tr>
</tbody>
</table>
7 EQUIPEMENTS

The RA-MD1 is equipped with line and power supply plugs. Available is the Software Program “MD1_Manager”, which can set all the parameters and operating modes of the device and perform remote monitoring and surveillance.