Data Rates and Response Times when using IDA and NRA in LAN/WAN Applications

With their Ethernet interfaces the NRA series but also the IDA 2 become predestined for remote operation. Corresponding applications cover all branches for example fixed spectrum analyzers in RF and EMC labs, rack mounted receivers in SATCOM vehicles, monitoring systems for in-building security, spectrum surveillance/SIGINT at borders. Still, one specific challenge always remains the same: Bandwidths and data rates in LAN or WAN networks or through the internet are critical to the overall performance of a distributed system. As ´bandwidth´ can be considered to be a limited resource, it is essential that all components in a network behave economically in the sense of occupying a low Ethernet bandwidth. Therefore this Technical Note gives an idea on the NRA and IDA series´ bandwidths, data rates, and response times when operating them remotely. This Note also highlights that in some modes Narda´s Test instruments behave extremely economically whereas there are also other operating modes requiring just typical network resources.

Remark: The results in this note have mainly been achieved with Narda´s free utility software (Fig. 1). The particular software tool requires the corresponding instrument software option if it is not already activated. Software options can be purchased/activated later on. Refer to datasheet of NRA or IDA for more information.

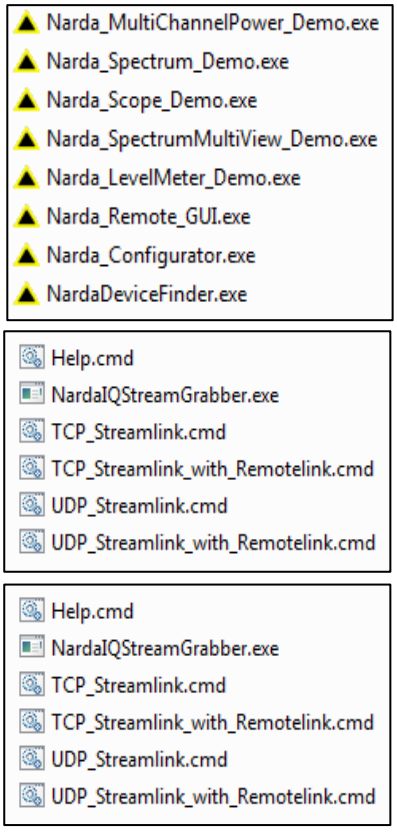

Fig. 1: Narda Utility Software for NRA/IDA

Content

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1 Network Bandwidth and Response Times when using Narda Utility Software

In various scenarios users have just a limited network bandwidth in order to operate measuring instruments remotely. Yet, a fluent data exchange and a quick response time when changing measuring settings is essential. As a consequence, Table 1 provides an overview of typical data rates when operating the NRA and the IDA remotely with the Narda Utility Software (particularly Spectrum, Multi View and Scope).

Remote Software	Setup	Trace / Detector	Data Format	Data Rate* [kByte/s]
Spectrum or Multi View	Fcent=3,000 MHz, Span=1,000 MHz RBW=200 kHz, VBW=20 kHz	Avg_RMS (fixed no. of points: 100)	Binary	3
Spectrum or Multi View	Fcent=800 MHz, Span=400 MHz RBW=20 kHz, VBW=1 kHz	Act	Binary	100
Spectrum or Multi View	Fcent=800 MHz, Span=200 MHz RBW=50 kHz, VBW=1 kHz	Act, Max, Avg, Min (fixed no. of points: 1,000)	ASCII	15
Spectrum or Multi View	Fcent=800 MHz, Span=5 MHz RBW=200 Hz, VBW=20 Hz	Act, Max_Avg, Avg	ASCII	270
Scope	Fcent=3,000 MHz, CBW=32 MHz, VBW=26.6 MHz, Time Span=5 s	Max, Avg_Min (Long Time Scope)	Binary	790
Scope	Fcent=3,000 MHz, CBW=32 MHz, VBW=3.2 kHz, Time Span=7.8 ms	IQ	Binary	1,100
Scope	Fcent=3,000 MHz, CBW=250 kHz, VBW=25 Hz, Time Span=512 µs	Max, Avg_Min (Long Time Scope)	ASCII	2
Scope	Fcent=945 MHz, CBW=16 MHz, VBW=Off, Time Span=10 ms	Act (High Res. Scope)	ASCII	290

Table 1. Data Rates of NRA/IDA in Remote Mode with Narda Utility Software (Spectrum, Multi View, Scope)

** The data rates in Table 1 were measured with the software NetLimiter Version 4.*

It is important to notice that the measuring results in Table 1 are not exclusively related to the Utility Software but mainly correspond to the configuration (setup, trace/detector, data format). Also, 3rd Party Software making use of a similar command structure leads to comparable results!

Fig. 2. Narda Utility Software: Spectrum, Multi View, Scope

Apart from the measurement results shown in Table 1, one can say: Operating the NRA or IDA with the Narda Spectrum Software in usual configurations leads typically to a required network bandwidth between 150 and 200 kByte/s. It can increase up to 600 kByte/s but it can also decrease down to 3 kByte/s in special or rather unusual configurations. Furthermore it is important to notice that the required network bandwidth strongly depends on the Span, the RBW and the VBW. One can also say that the required bandwidth decreases with increasing Sweep Time.

In contrast to the Utility Software mentioned above (Spectrum, Multi View, Scope) the Remote GUI tool works differently. It does not retrieve measuring data from the instrument but it basically retrieves screenshots. As a consequence the data rate does not depend on measuring parameters as indicated by Table 2 below.

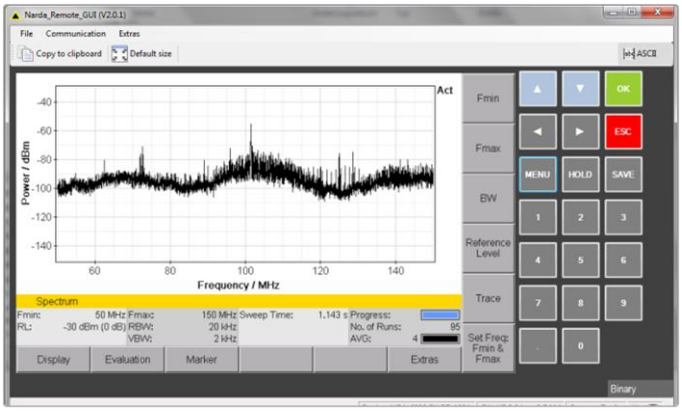

Fig. 3. Narda Utility Software: Remote GUI with IDA

Remote Software	**Setup**	**Trace**	**Data Format**	**Data Rate* [kByte/s]**
Remote GUI (Spectrum Mode)	Fcent=20 MHz, Span=500 kHz RBW=2 kHz, VBW=50 Hz	Act, Max Avg, Min	Binary	1,100
Remote GUI (Level Meter Mode)	Fcent=1,500 MHz, CBW=5 MHz VBW=Off	Peak, RMS	Binary	1,100
Remote GUI (Spectrum Mode)	Fcent=800 MHz, Span=5 MHz RBW=200 kHz, VBW=20 kHz	Act	ASCII	50
Remote GUI (Scope Mode)	Fcent=1,500 MHz, RBW=5 MHz VBW=Off	IQ	ASCII	50

Table 2. Data Rates of NRA/IDA in Remote Mode with Narda Utility Software (Remote GUI)

** The occupied data rates in Table 1 were measured with the software NetLimiter Version 4.*

Table 2 shows that the data rates in combination with the Remote GUI are not related to the active operating mode or the measuring setup. They only depend on the data format i. e. whether the ´screenshots´ are sent in binary or in ASCII format from the instrument to the computer.
Users may also realize that the display update rate of the Remote GUI is not extremely high. As a consequence the Remote GUI is suited for demonstrations and trainings best but may be insufficient in case of dynamic spectrum surveillance assignments.

Additionally, it´s also useful to compare the data rates of the Multi Channel Power Mode and the Spectrum Mode. Due to the NRA´s or IDA´s internal preprocessing the data rates in the Multi Channel Power Mode Software are much lower in comparison to the Spectrum Mode Software.

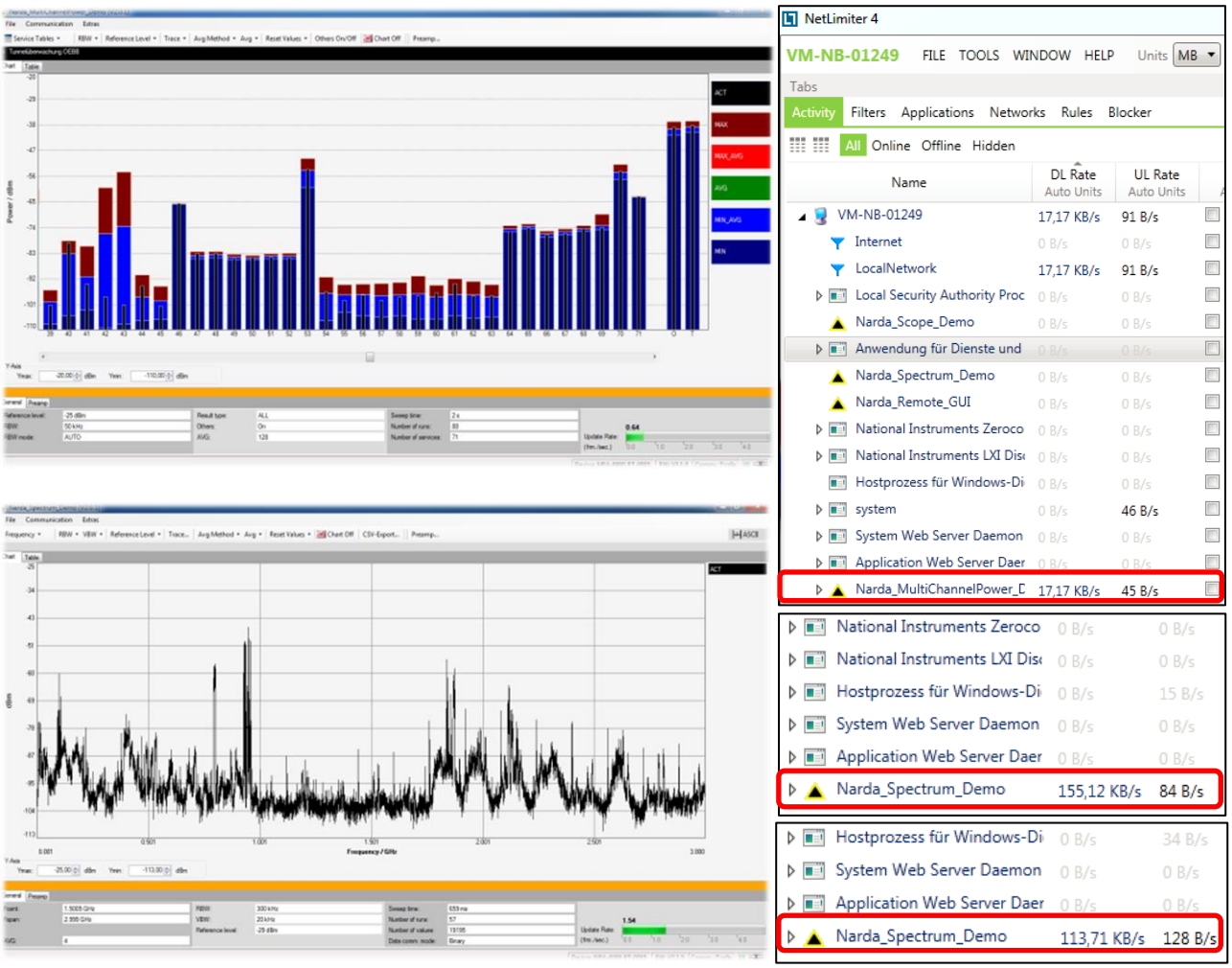

Figure 4: Comparison of Data Rates in Multi Channel Power Mode (17 kByte/s) and Spectrum Mode Software (avg. 130 kByte/s)

The measurement view on the top in Figure 4 shows the Multi Channel Power Mode. The table includes frequencies between 1 MHz and 3 GHz. All in all the measurement setup contains a list of more than seventy channels. Each of these channels has a distinct span, some just 200 kHz wide a few others 50 MHz or even 600 MHz wide. As a consequence, each of these channels will be analyzed with a distinct RBW, in this case between 50 kHz and 20 MHz. In this scenario the required network bandwidth by the NRA to transfer the measurement information to a PC amounts to 17 kByte/s. On the other hand the Spectrum Mode Software requires a bandwidth of an average of 130 kByte/s when setting the same global frequency span (1 MHz to 3 GHz) and selecting 300 kHz as an RBW.

2 Response Times when using Narda Utility Software

Sometimes the network infrastructure where measuring devices are used is not very powerful, i. e. has a very limited bandwidth. This may be due to very many devices being involved in a network requesting or transmitting a lot of information. But it may also be due to dedicated solutions where an IDA or an NRA has to be operated remotely at a far, abandoned location where a powerful network infrastructure is simply not possible.
As a logic consequence update rates / response times deteriorate when network operated instruments as the NRA or the IDA are not provided with the bandwidth which they actually need. Table 3 shows that circumstance in detail.

- The first three columns in the table clarify which Remote Software was in use and which measuring setup and the data format that was chosen.
- That leads to a typical bandwidth depicted in the fourth column.
- The fifth column depicts the new, significantly decreased bandwidth provided in the network for that application.
- In the sixth column, the operator´s action in order to change the measuring setup is described. For example in the first row the Center Frequency was changed from 950 MHz (see column 2) to 900 MHz (see column 6).
- Ultimately the seventh column reveals the Response Time, i. e. the duration between the moment a command was transmitted to the moment at which the screen was correspondingly updated with the new setting.

Remote Software	Setup & Trace	Data Format	Typical Data Rate (kByte/s)	New Network Limit * (kByte/s)	Operator Action	Response Time
Spectrum	Fcent=950 MHz, Span=200 MHz, RBW=200 kHz, VBW=10 kHz, Traces: Act, Max	Binary	190	50	Fcent → 900 MHz	< 1 s
Spectrum	Fcent=2,000 MHz, Span=2,300, MHz RBW=200 kHz, VBW=20 kHz, Traces: Act, Max, Min (fixed no. of points: 2,000)	Binary	50	10	Span → 2,400 MHz	< 1 s
Spectrum	Fcent=950 MHz, Span=200 MHz, RBW=200 kHz, VBW=10 kHz, Traces: Act, Max	ASCII	190	50	Fcent → 900 MHz	< 2 s
Remote GUI	Fcent=950 MHz, Span=200 MHz RBW=200 kHz, VBW=10 kHz, Traces: Act, Max	Binary	1,100	100	Fcent → 900 MHz	14 s
Remote GUI	Fcent=600 MHz, Span=800 MHz, RBW=50 kHz, VBW=2 kHz, Traces: Act, Avg	Binary	1,100	10	RBW → 100 kHz	174 s
Remote GUI	Fcent=950 MHz, Span=200 MHz, RBW=200 kHz, VBW=10 kHz, Traces: Act, Max	ASCII	50	5	Fcent → 900 MHz	28 s

Table 3. Analyzing Response Times of NRA/IDA when reducing network bandwidth

** The bandwidth limits mentioned in the table were set by the software NetLimiter Version 4.*

Table 3 on the previous page indicates that the response time is directly related to both the originally required network bandwidth and new (limited) network bandwidth. In the first three rows, the response times amount to one or two seconds. In these cases the bandwidth was decreased by the factor of four or five.
In the last three rows the network bandwidth was even decreased by the factor ten or one hundred. As a consequence, Response Times significantly increased to dozens of seconds.
Apart from the original and the provided network bandwidth and the data format, the Remote Software in use needs to be taken into account. Typically the Spectrum Remote Software is much more robust towards bandwidth issues than for example the Remote GUI Software.
Of course, similar situations may occur when the NRA/IDA is operated with 3rd party software. However, this won´t be discussed any further in this document.

3 IQ Streaming / IQ Stream Grabber *(corresponding instrument option required)*

The NRA (only NRA-3000 RX & NRA-6000 RX) and the IDA can stream IQ data continuously from 100 Hz up to a maximum RF bandwidth of 400 kHz. Moreover, it is also possible to retrieve IQ data with the amount of 250,000 pairs (I & Q) in a discontinuous, blockwise way up to a bandwidth of 32 MHz. This leads to the fact that depending on bandwidth IQ blocks represent corresponding time spans as indicated by the table below.

Bandwidth	Time Span
32 MHz	7.8125 ms
16 MHz	15.625 ms
1 MHz	0.250 s
500 kHz	0.5 s
100 kHz	2.5 s
10 kHz	25 s
1 kHz	250 s
250 Hz	1,000 s

Table 4: Overview Bandwidths and block wise Time Spans NRA/IDA IQ Streaming

In SIGINT applications it is common to stream IQ data continuously. As mentioned, in this case the NRA and the IDA can provide a bandwidth of up to 400 kHz. There´s in fact an easy way with which users can calculate the required network bandwidth for IQ streaming. It depends on the applied RF bandwidth and the bit depth.
Example: If the RF bandwidth is 40 kHz and the bit depth is 32 bit, the required bandwidth results to 1,280 kbit/s or 160 kByte/s.

Formula. 1: Calculating / Estimating Ethernet Bandwidth based on bit depth and RF bandwidth

In the NRA and IDA the bit depth for IQ streaming does in fact depend on the RF bandwidth. If the bandwidth equals or is greater than 40 kHz, the bit depth is 32 bit. RF bandwidths smaller than 40 kHz lead to a bit depth of 64 bit.

The mentioned bit depth and Formula 1 on the previous page are only referring to the IQ content inside the stream. As a consequence, in practice deviations may appear caused by additional information (headers) being transmitted as part of the protocol. This issue is also indicated by Table 5. It shows how the Ethernet data rate changes depending on the RF bandwidth and how the file size depends on the RF bandwidth and the recording time.

RF Bandwidth	Data Rate	Recording Time	File Size
400 kHz	1.54 MByte/s	40 s	61 MByte
250 kHz	986 kByte/s	20 s	10 MByte
200 kHz	790 kByte/s	40 s	30.5 MByte
100 kHz	395 kByte/s	10 s	4 MByte
50 kHz	200 kByte/s	20 s	4 MByte
1 kHz	12 kByte/s	40 s	320 kByte

Table 5: Data Rates and File Size in case of IQ Data Recording

Narda provides the ´IQ Stream Grabber´ for free. It is a simple application which allows the user to get familiar with IQ streaming from the NRA or IDA. It is applicable for 3rd party software suppliers and system integrators in particular. It does not depict a real user application as the ´IQ Stream Grabber´ obtains IQ streams as ´.wav´ file recordings being stored on a computer. In real applications (e. g. SIGINT) the software in use typically has a driver which connects to the instrument and directly (i. e. without creating a separate ´.wav´ file) evaluates the obtained/streamed IQ data.

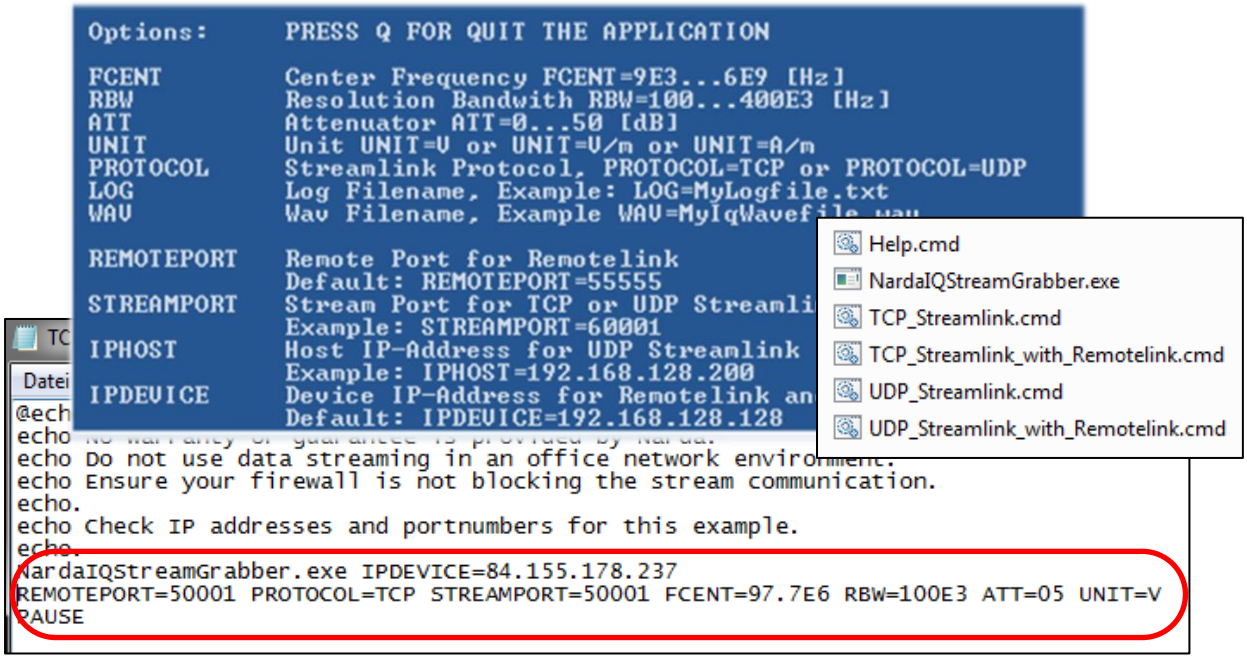

Fig. 5: Progam files for Narda IQ Stream Grabber

4 Audio Streaming / Audio Stream Grabber *(corresponding option on IDA required)*

The Narda Audio Stream Grabber makes use of the NRAs and IDAs internal demodulation functions. The advantage of this function is that the required ethernet bandwidth can be significantly reduced in contrast to Audio content created by IQ data processing on the computer´s side.
Table 6 depicts these benefits: On one hand it shows significantly decreased data rates in comparison to Table 5. On the other hand it also shows that the Ethernet data rate is not depending on the chosen RF bandwidth but it only depends on the demodulation type, the selected sampling rate and the selected data format.

Demodulation	Bandwidths [kHz]	Sampling Rate [kHz]	Format	Data Rate [kByte/s]
FM / AM / CW	200 / 100 / 50 / 10	32	PCM_INT16	67
LSB / USB	50 / 10 / 5 / 1	32	PCM_INT16	35
FM / AM / CW	200 / 100 / 50 / 10	32	PCM_INT8	35
LSB / USB	50 / 10 / 5 / 1	32	PCM_INT8	20
FM / AM / CW	200 / 100 / 50 / 10	16	PCM_INT16	35
LSB / USB	50 / 10 / 5 / 1	16	PCM_INT16	20
FM / AM / CW	200 / 100 / 50 / 10	16	PCM_INT8	20
LSB / USB	50 / 10 / 5 / 1	16	PCM_INT8	12

Table 6: Date Rates in case of Audio Streaming (making use of IDA/NRA internal demodulation)

Similarly to the ´IQ Stream Grabber´ mentioned in the previous chapter, also the ´Audio Stream Grabber´ is more applicable for software integration or demonstrations than for real applications.

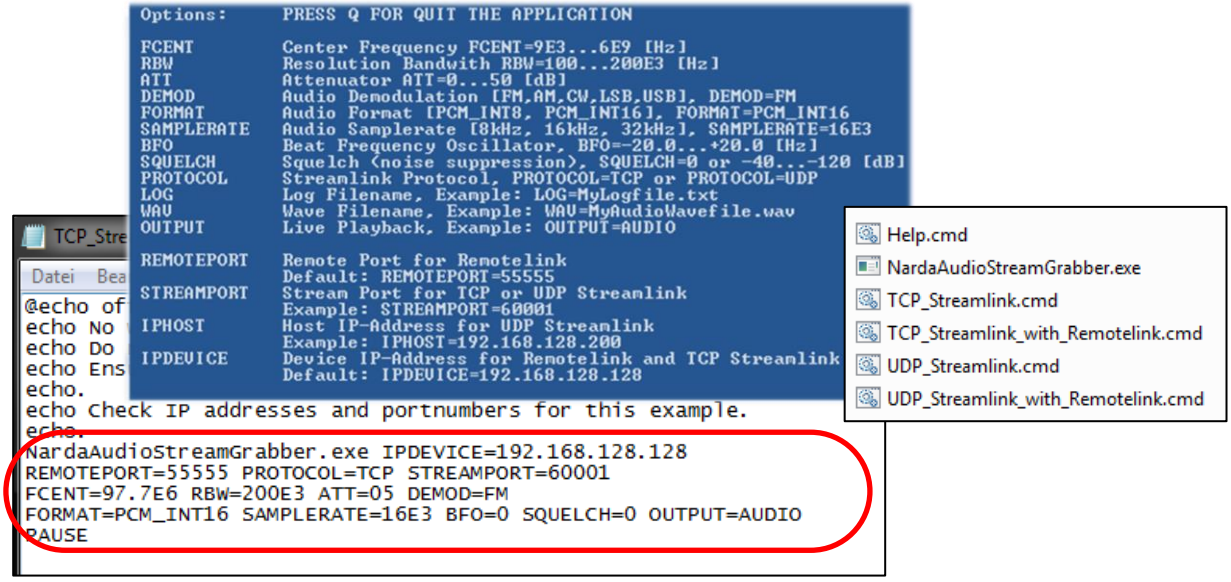

Fig. 6: Program files for Narda Audio Stream Grabber

5 More Literature References

Narda STS provides more documents helping users to put customized solutions in practice. The subsequent list provides a brief overview on the documents which are supplied on a CD with a purchased NRA / IDA set and which are also available on request:

- The ´Command Reference Guides´ contain the basic operating commands for the IDA and NRA series. These commands are used in the background of any compatible 3rd party software. They can also be used manually with the use of any terminal software. That can be useful for service reasons or when users need to establish individual remote functions on their IDA or NRA.

- In addition to chapters 3 and 4, Narda STS will provide further documentation on the software modules ´Audio Stream Grabber´ and ´IQ Stream Grabber´ on request

- The ´Narda Utility Programs Description´ provides an overview and some operating hints on the Narda Software Modules which have been described in chapters 1 and 2. It also mentions system requirements, explains how to connect a device via LAN and shows how transmitted commands and device responses can be saved in a Logfile.

- For additional information please refer to another Application Note called ´IDA & NRA Utility Software´ (Application Note 1105). It refers to the Narda Utility Software from a more general application stand point and it also gives an overview on available 3rd party drivers.

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