

Review of NTI's Speaker Test System

By Richard Honeycutt, VoiceCoil editor

The June 2002 issue of VC included my review of NTI's RT-2M multitone test instrument and its companion rub and buzz software. The review revealed that the rub/buzz test, using the patented transient steepness analysis, reliably detected all the defects for which a human "listen-tester" is commonly used. NTI recently released version 2.30 of their complete production test software RT-Speaker, including frequency response, resonance, impedance curve, dB SPL, and Thiele/Small parameter tests, as well as the rub/buzz test. RT-Speaker also includes statistical analysis software to permit evaluation of batches online.

The hardware needed for this package includes the RT-2M production line tester (formerly the RT-2M Multitone

Tester, but now with added stepped sweep capability; hence the new name), the RT-IB impedance box, a measurement microphone, and a power amplifier. NTI offers its 3384 measurement microphone and S-100 amplifier (100W), but you may use other microphones and amplifiers as well. Also, the NTI XLR adapter simplifies making connections and is a useful accessory.

You can program the RT-2M and impedance box to perform virtually any electroacoustical test necessary in the design or production of loudspeaker drivers or systems. You can send programming commands to the unit in ASCII format through either an IEEE-488 or RS-232 (slower) interface. For companies which choose to devote the time

Speaker Production Test System



PureSound™ is a complete solution for the ultimate quality control in high volume speaker production lines.

PureSound™ measures effectively any Rub & Buzz effects with an unmatched correlation to "Golden Ears".

More good reasons to go with NTI:

- Easy configuration for new speakers
- Fast and accurate
- Statistical process control including trend, histogram and CPK/PPK
- Thiele/Small parameter
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to defining in-house tests, this programmability is an excellent option. Many speaker producers, however, will find that the RT-Speaker software is easily configurable to meet their needs without investing engineering time to program the RT-2M. Setup of the system is simple and intuitive, although you should note that the computer screen must be set to 1024 × 768 resolution in order to display the control panel at the proper size. The computer system itself should be a Pentium III or better running Windows 95/98/2000/Me/XP/NT.

I evaluated the system on an old 300MHz computer using an RS-232 connection to the hardware, and even so, it completed a production test in less than three seconds. You can achieve shorter cycle times by carefully selecting the test parameters. You can monitor RT-Speaker either as a local test mode or remotely via a TCP/IP link.

Operation

Figure 1 is a flowchart showing the setup and operational steps for using RT-Speaker. The wiring and software installation are straightforward. Upon entering the program, you see a screen like Fig. 2. Initially, all options except “Configure RT-Speaker” are grayed out. Configuration includes setting the communication protocol, informing RT-Speaker of the mike sensitivity and impedance box characteristics, setting operator rights, and so on.

Next you enter the project administration function using the “Create New Project” button. This is where you select the tests to be performed: frequency response, impedance sweep, dB SPL, polarity, Thiele/Small measurements, and rub/buzz. You can also specify the parameters for each test. For example, the parameters for frequency response are start and stop frequencies, number of log-spaced measurement points (the test signal is a stepped sine sweep for maximum noise immunity), data smoothing (boxcar averaging) specified in percent octaves, absolute or relative dB SPL display, high noise immunity option, high precision option, sweep settling mode, and response tolerances for production speakers for various quality classes. You also choose the frequencies for the dB SPL measurement during project setup. Once you define project parameters, you can later edit using the “Edit Project” button.

The “Calibrate” button initiates automatic calibration of the hardware, which is completed rapidly and painlessly. Next, it makes reference measurements of a prototype or set of “golden samples.” These become the standards against which to set pass/fail tolerances for production units, again requiring little effort on the part of the project engineer or administrator. Once the reference measurements are completed, pressing the “Calculate Tolerances” button causes RT-Speaker to identify the limits for each test to be performed on production speakers.

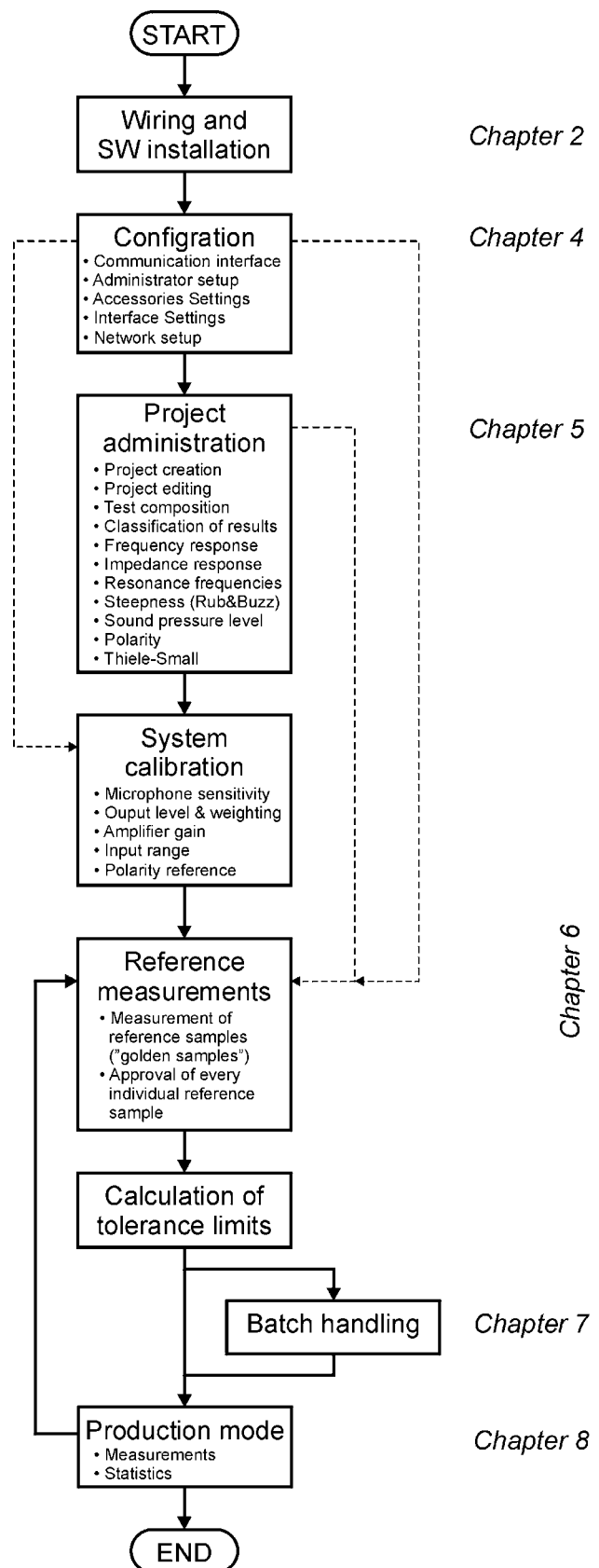


Figure 1: Flowchart showing setup and operational steps for using RT-Speaker.

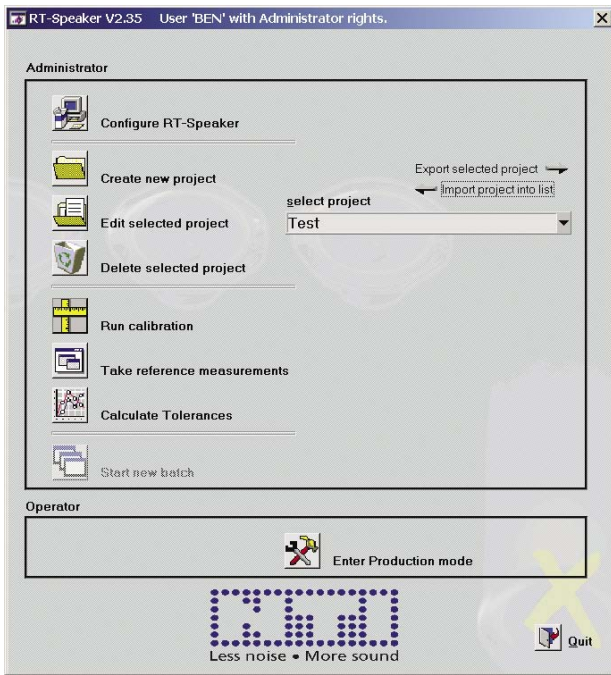


Figure 2: Initial RT-Speaker program screen.

The previously mentioned items require administrator rights, and so are not accessible to production personnel who have only operator rights. (You can set up operator rights during configuration, as mentioned earlier.) Operators can initiate production testing using the “Enter Production Mode” button.

After the software has initialized itself in the production mode, the operator is prompted to key the first measurement. By default, pressing the computer’s F1 key does this, but using autodetect can also commence measurement or a digital command applied through the computer’s LPT port or digital I/O card. Autodetect is a function through which RT-Speaker notices when a new speaker has been connected, waits for an administrator-defined delay time, and then begins the measurement.

Measurement results log automatically as they are displayed on-screen. You can configure the screen to show the combined results of all measurements (Fig. 3). Also single measurement (Fig 4) can be shown. You can save screenshots to disk or print them using on-screen buttons - an extremely handy feature!

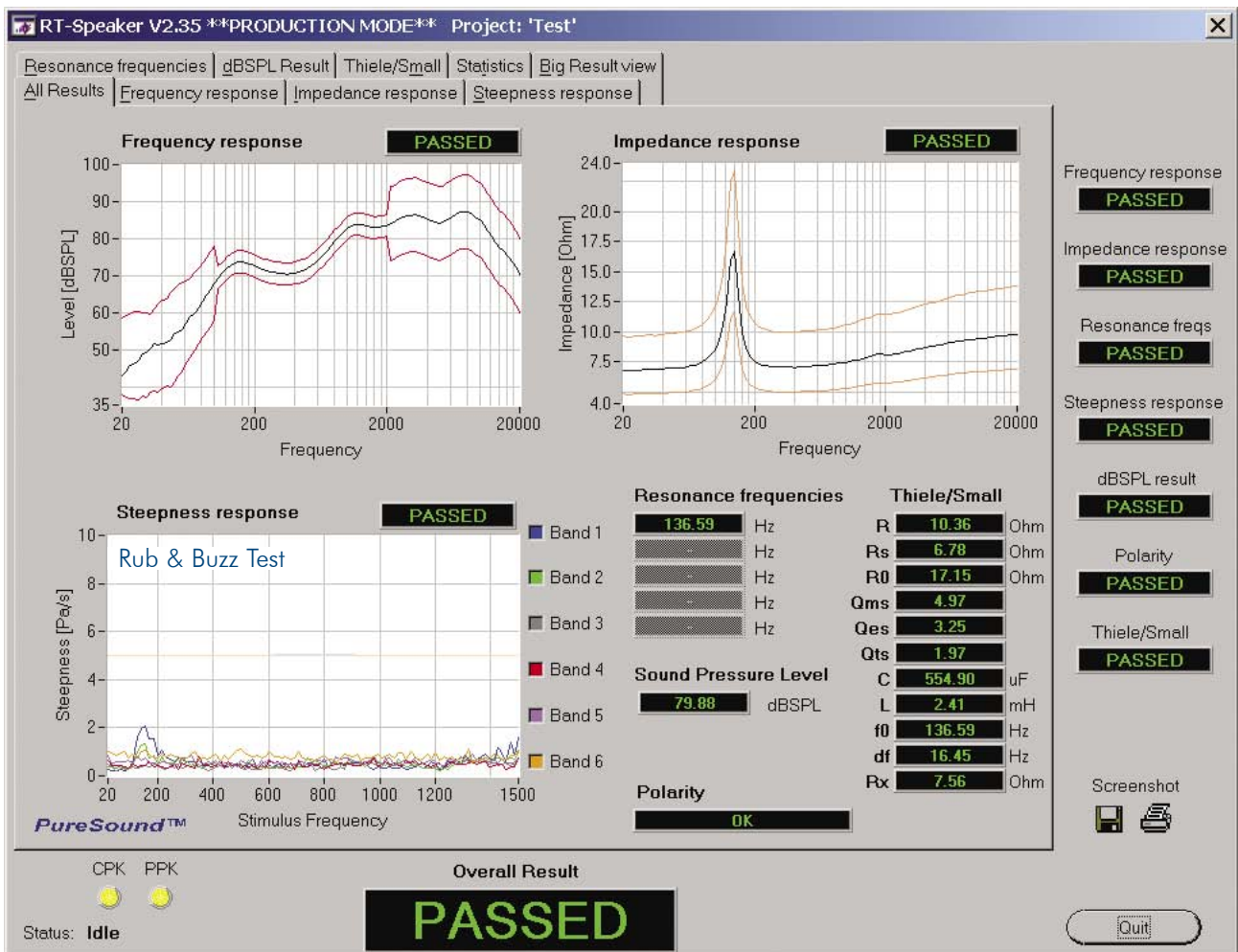


Figure 3: Screen configured to show results of several measurements.

Batch processing is automatic, and tabulated statistical results (Fig. 5) are available at the touch of a button. (For my tests, I used a variety of speakers of similar, but not identical design. Thus you will see a few with Class 1 results, some with Class 2 results, and many failures. Also, the failure of this motley batch is announced at the bottom of the screen in large, friendly red letters.

Comments

The combination of the RT-2M and RT-Speaker provides a fast, comprehensive, and user-friendly package for the evaluation of speakers in production environments. You could also use the system in R&D to evaluate frequency response, impedance, and/or rub and buzz of defective samples. Setup and project administration are quick and smooth, with only two minor exceptions.

First, since most of us think in terms of both a free-air and a mass-loaded or enclosed measurement for Thiele/Small parameter determination, using a single measurement is somewhat of a mystery, leading to questions as to whether the speaker should be enclosed for the measurement. The answer is “no,” but you must sift through the manual until you locate the parameter definition for f_0 (resonance frequency) in order to find this answer. (NTI considered that since the T/S parameters are measured as a part of the same process that includes the other tests, it should be obvious that no change of physical setup - i.e., adding an enclosure - is involved.)

Second, no guidelines are given for the gain setting of the power amplifier. This setting is compensated to some extent by the calibration process, but there are bound to be limits, and it would be helpful if these were stated in the setup instructions.

A competent engineer easily determines most of the parameters set during project administration, but the number of test points used for the frequency sweep may hold a “gotcha.” I initially used 100 points, but RT-Speaker was then not able to determine resonant frequency of my speakers, giving me a “503” error. Upon checking the manual for the definition of a 503 error, I was advised to check several things, including the number of points.

When I increased this setting to 500, all worked as expected. Some sort of guideline, at least in the manual, but preferably as an on-screen note in the software, would help administrators to set this value correctly without resorting to trial and error. Incidentally, doubling the number of measurement points did not noticeably slow cycle time on my computer.

The set of tests included is well thought out. My initial reaction was that a harmonic distortion test should be included, for two reasons. The first is that it was not clear to me that the rub/buzz test would identify axially miscentered



Figure 4: Frequency Response Test - PASSED.

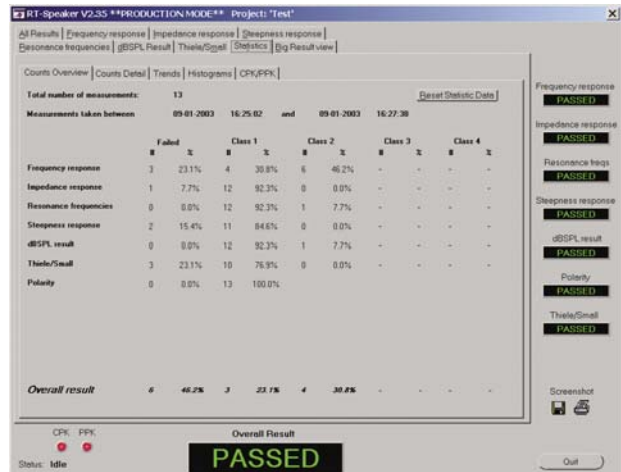


Figure 5: Tabulated statistical results.

voice coils, since the traditional human-operator rub/buzz test focuses specifically on identifying waveforms produced when there are - how shall I say - rubs and buzzes! The literature on the NTI rub/buzz test emphasizes the system's use to replace such human tests. The second reason is that some manufacturers do specify harmonic distortion limits for their speakers.

So I built two identical speakers, except that one had an axially miscentered voice coil. As expected, with a swept sine harmonic distortion test, the speaker with the miscentered coil produced significantly more second-harmonic distortion in the low-frequency range, as well as a lower level of third-harmonic distortion. The differences were such that a guitar player would have had a significant preference for one or the other of the two speakers.

However, Mr. Berno Nigsch of NTI was able to take the test results using the NTI rub/buzz function and demonstrate that the tolerance limits could be set to reject either of the two speakers (centered or miscentered) that was identified as being defective. (In some musical instrument speakers, too little harmonic distortion is not a good thing!) Based upon this experience, I believe that you could find a correlation to the rub/buzz tolerances that would reject speakers with too much (or too little) harmonic distortion from any cause (e.g. see Rub&Buzz results at Fig. 6+7).

The presentation of results is exceptionally clear and easy to read. The default colors are well chosen, and the layout is clear and uncluttered. However, the format of the Thiele/Small parameters is unusual. Table 1 shows the results of a comparison of T/S parameters on a 6 1/2" prototype speaker: the left-hand columns show the lab data on the speaker, with conventional parameter names, and the right-hand columns show the data and names as presented by RT-Speaker. The software also shows df , the difference in Hertz between the resonance frequency and the frequency where the response is 3dB below that at resonance.

Most of the values measured by RT-Speaker are pretty close to the lab values, with the exception of Q_{MS} , which is a bit wide of the mark. Multiple measurements of the same speaker, with no changes in connections, yielded differences of a few percent in the T/S values. I have noticed this behavior in other computer-based systems for measuring T/S parameters as well.

For production evaluation, I believe that the accuracy and repeatability of the T/S measurements is sufficient. NTI informed me that the emphasis was on providing an indication of T/S parameters while eliminating the need for the unskilled test operator to make any critical adjustments,

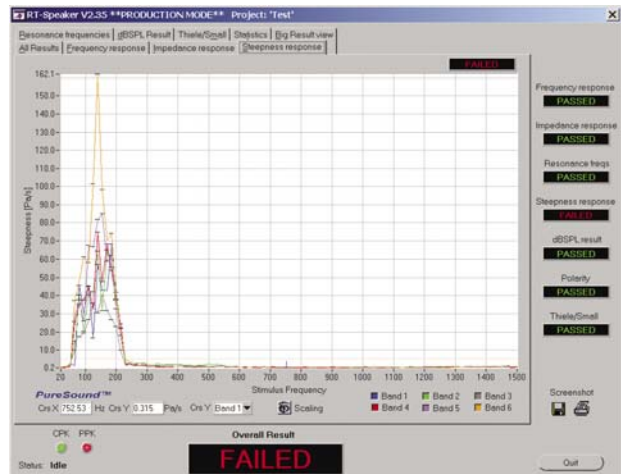


Figure 6: Failed Rub & Buzz of rubbing coil.

such as mike-to-speaker distance. (Of course, if dB SPL is to be tested, mike-to-speaker distance must be controlled anyway). At any rate, in order to avoid dependence upon the mike-to-speaker distance, NTI chose to transform the mechanical parameters to their mobility-electrical equivalents.

Since the T/S parameters of the “golden samples” are automatically entered during calibration, they are already present in the format that NTI chose during production tests, so the presentation format of the parameters is not important.

If you must investigate deviations of T/S parameters of production samples in the lab, you can obtain the mechanical parameters by multiplying the “C” value by B^2L^2 , and dividing the “L” and “R” values by B^2L^2 . In my opinion, including Bl determination should have been a simple matter.

TABLE 1 PARAMETER	LAB MEASUREMENT	NOTES	RT-SPEAKER PARAMETER	RT-SPEAKER MEASUREMENT
R_E	6.18Ω	RT-S 5.5% higher	R_s	6.47Ω
L_E	0.86mH		N/A	N/A
Q_{MS}	4.20	RT-S 11.2% lower	Q_{MS}	3.73
Q_{ES}	0.3	exact match	Q_{ES}	0.3
Q_{TS}	0.28	exact match	Q_{TS}	0.28
X_{MAX}	4.3mm		N/A	N/A
Bl	9.03 T×m		N/A	N/A
f_s	40.19Hz	RT-S 2.2% lower	f_0	39.3Hz
M_{MS}	15.7g	Transforms to 15.4g, 1.9%lower	C	188.25μF
C_{MS}	0.9971mm/N	Transforms to 1.066mm/N, 6.9% higher	L	86.96mH
R_{MS}	0.9450N×s/m	Transforms to 0.9826 N×s/m, 4% higher	R	80.12Ω
V_{AS}	24.81 liters	Calculates (from transformed L value) as 23.63 liters, 4.8% lower	N/A	N/A
Z_{MAX}	92.5Ω	RT-S 7% lower	R_0	86.06Ω

Then the system could have provided the option of stating T/S parameters in mechanical form. But perhaps this change would have only added minor convenience for the engineers.

While it would perhaps be nice if the blocked-coil inductance were added to the list of parameters measured, that value is certainly not needed for production tests. The same can perhaps be said for a measurement of X_{max} : you can calibrate the rub/buzz test to reject speakers with insufficient x_{max} . This is good, because measuring x_{max} electrically can involve rather high SPLs.

Likewise, V_{AS} measurement is not needed in production testing if C_{MS} is given, since they differ only by the factors of two constants plus the effective cone area. So the bottom line on the T/S parameter tests is that they can be quite useful for production testing, although I would like to see a BL measurement added, plus the option for expressing results in mechanical form, rather than transformed mobility-electrical form, but as I previously stated, these would be small enhancements.

Conclusions

The NTI Speaker Test system is a fine piece of engineering, well designed for rapid production evaluation of loudspeaker drivers and systems. Its inclusion of the transient rub/buzz analysis is an especially strong selling point. The price is in line with other quality systems designed for the same purpose. While I have mentioned a few improvements that I would like to see in the next software version, the unit performs excellently with the current version. You certainly should strongly consider the NTI production testing solution including RT-Speaker when your company makes purchase decisions on such a system.

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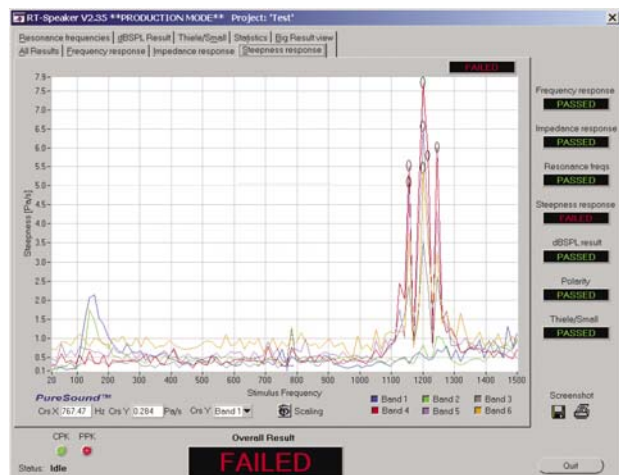


Figure 7: Failed Rub & Buzz of mis-centered coil.

Manufacturer Response

The test report highlights that neither guidelines for the amplifier setting, nor an error indication during the first reference measurement are included. NTI has taken up these suggestions and will implement appropriate solutions in the next software release. We've included the measurement of Thiele/Small parameters at the production line to allow monitoring of the production process, based on PPK and CPK analysis. Since this analysis requires single measurement results, NTI introduced the acquisition of core T/S parameters to the RT-Speaker software.

The PPK and CPK analysis provides accurate information on the production process stability (such as the quality consistency of the manufactured drivers). As soon as one of these values drops below the user-defined tolerances, the production line quality is rated "OUT OF CONTROL." The Thiele/Small measurements can differ from other R&D test instruments by few percent. However, this minor deviation is less important for production testing than getting stable and repeatable T/S results.

NTI thanks Voice Coil for the detailed system evaluation, which supports our customers in taking advantage of NTI's user-friendly and simple speaker test solution.

Nigsch Berno
Product Manager of NTI AG

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