



INSTRUCTION MANUAL ADDENDUM

Hessen Protocol 4.0

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TAPI Hessen Protocol Addendum

Version 4.0

Overview

This document briefly describes recent modifications to TAPI's implementation of the Hessen protocol, now referred to as version 4.0.

Traditionally, the Hessen protocol has served one group of users and has always operated in the manner described in the document titled "API Hessen Protocol.doc." In order to accommodate the needs of Teledyne Monitor Labs, which has slightly different requirements, the Hessen protocol has been significantly upgraded to support both groups of users.

In the process, the Hessen protocol has been made considerably more flexible as well. This new implementation of the Hessen protocol serves as a foundation for even more enhancements in the future, if necessary.

Readers may wonder why the Hessen protocol is treated here as if it's a separate entity from the instrument firmware. The reason is that it is a separate software module. This modular design not only makes it reusable in many instruments, but ensures that the implementation is the same in every instrument. The distinction between the instrument and the protocol also enforces a clean interface between the two software components.

Summary Of Changes

- Supports two different *long model* status responses.
- Adds a single-gas status response.
- Supports three different response modes.
- Supports any number of gases. Which gases are accessible and their order in the long model response is user-configurable.
- Adds a TAPI-specific "VER" command for future use.
- Supports two different RS-232 line parameter settings and TAPI's RS-232 multidrop hardware.

Hessen Protocol Configuration Menu

Because of all the new configuration options available in the Hessen protocol, a new **SETUP-MORE-COMM-HESN** menu has been created. This menu appears only when you enable the Hessen protocol on one of the comm. ports (**SETUP-MORE-COMM-COMx**). Furthermore, after enabling the Hessen protocol, you must power-cycle the instrument for it to start the Hessen protocol on the comm. port. You can configure the Hessen protocol before or after you power-cycle the instrument, however.

While you are editing the Hessen configuration, the Hessen protocol does not respond to any commands received from the RS-232 interface.

Protocol Variations

Menu: **SETUP-MORE-COMM-HESN-HESSEN VARIATION**

The two current variations of the protocol are identified as *Type 1* and *Type 2*. Type 1 is the original implementation and Type 2 is the new implementation. The terms Type 1 and Type 2 were deliberately chosen to be somewhat generic because they will be visible to many customers, and to establish a terminology convention that permits creating more variations in the future. The table below highlights the differences between the two variations.

Type 1	Type 2
When sending the DA<III> command, where <III> is the instrument ID, Type 1 returns the long model response containing all the gases.	Type 2 also returns the long model response, but it has a slightly different format (<i>see Commands And Responses below</i>).
When sending the DA<GGG> command, where <GGG> is a gas ID, Type 1 returns the same long model response as it does for the instrument ID.	Type 2, however, returns the new single-gas response. The concentration of any gas can be requested, regardless of whether it's included in the long model response.

Response Mode

Menu: **SETUP-MORE-COMM-HESN-HESSEN RESPONSE MODE**

The Hessen protocol supports two different message encodings for commands and responses: one that's delimited with <STX>, <ETX>, and terminated with a checksum; and one that's terminated with just a <CR>. Traditionally, users expect the instrument to respond using the same encoding convention that the command used. In other words, if the command was delimited with <STX> and <ETX>, then the response should be also. If the command was delimited with just <CR>, then the response should use that encoding.

However, Teledyne Monitor Labs uses <CR><NUL> to terminate commands, but expects responses to always be delimited with <STX> and <ETX>. So to accommodate these diverse requirements, the response mode can be set to one of the three options shown in the table below.

Response Mode	Description
BCC	Always delimit responses with <STX>, <ETX>, and a checksum (<i>Block Check Code</i>), regardless of the command encoding.
TEXT	Always delimit responses with <CR>, regardless of the command encoding.
CMD	Delimit responses using the same encoding as the command (traditional mode).

Gas Configuration

Menu: **SETUP-MORE-COMM-HESN-HESSEN GAS LIST**

Some of TAPI's instruments measure multiple gases. For example, the M200 instruments measure NO_x, NO, and NO₂. The M200 also has an option to measure O₂. Some M300 instruments have an option to measure CO₂ in addition to CO.

Traditionally, instruments reported all of the gases it measured in the long model format. However, with instruments being manufactured to measure more and more gases, and given that the Hessen protocol apparently supports a maximum of four gases, and considering that Teledyne Monitor Labs wants only two gases reported in its long model response, it has become necessary to give users the ability to customize the long model response for their needs.

Each instrument provides the Hessen protocol with a list of gases that the instrument supports when it initializes the Hessen protocol. For example, an M200EH with the O₂ option would give the Hessen protocol the following list of gases:

NOX
NO
NO2
O2

Basically, the instrument is telling the Hessen protocol that it can measure these gas types. It is up to the Hessen protocol to assign ID numbers to the gas types it wants to make visible to the outside world. When a status request command is received by the Hessen protocol, it resolves the ID number to a gas type, requests that particular gas concentration from the instrument, and formats and sends the response. The table below summarizes the properties of each entry in the Hessen protocol gas configuration.

Property	Description
GAS TYPE	The type of gas to measure, such as NOX, NO, NO2. The list of available gases is instrument-dependent.
GAS ID	A 3-digit ID number assigned to the gas.
REPORTED	A flag indicating whether the gas is reported in the long model response. ON means it is reported, OFF means it is not reported.

As an example of a gas configuration, consider the following printout that was obtained by pressing the **PRNT** button in the gas configuration menu.

NOX, 211, REPORTED
NO, 212, REPORTED
NO2, 213
O2, 214

What this printout shows is the gases that are available through the Hessen protocol, their ID numbers, and implicitly, the format of the long model response. Since only NOX and NO have the *REPORTED* attribute set, only these gases are reported in the long model response, in the order of NOX, NO. However, all the gases shown above are accessible individually in the Type 2 variation, but not in the Type 1 variation.

When you press **EDIT** to edit the properties of a gas, you are prompted for all the properties. Since there are currently only three properties for each gas, simply prompting for all of them is more convenient than requiring users to scroll to each property and press **EDIT**. If more properties, such as high or low range, are added in the future, we can change the menu to allow editing individual properties instead of prompting for all of them.

You can assign multiple ID numbers to the same gas, if that's useful. For example, you could create two entries for NOX, assigning ID numbers 212 and 213 to the entries. This might be useful if you wanted ID number 212 to be reported in the long model response, but you wanted to use ID number 213 to request just NOX. Of course, you can also request just NOX in this example using ID number 212. This ability to assign multiple ID numbers to the same gas type is really only useful when the Type 2 variation is used. When the Type 1 variation is used, only gases that are included in the long model format are visible through the protocol, so there's no advantage to creating multiple entries for the same gas.

Instrument ID

Menu: **SETUP-MORE-COMM-ID**

Although the gas IDs are managed by the Hessen protocol, every instrument also has a global ID number. This instrument ID is used by both the Hessen protocol and the native TAPI protocol to uniquely identify the instrument as a whole. The instrument ID also has special meaning in the Hessen protocol when the Type 2 variation is used. As mentioned above, using the instrument ID with the Type 2 variation requests the long model response, whereas using a gas ID requests the single-gas response. In the Type 1 variation, either the instrument ID or a gas ID requests the long model response.

Status Flag Configuration

Menu: **SETUP-MORE-COMM-HESN-HESSSEN STATUS FLAGS**

In order to more fully customize the Hessen protocol, users can even customize the status bit assignments in both the failure byte and status byte of the Hessen protocol status response. The most significant byte of each status flag maps to the operational status byte of a Hessen protocol response, while the least significant byte of each status flag maps to the failure status byte of a Hessen protocol response.

Although this is not a new feature, it has been moved into the new Hessen protocol configuration menu so that all the related settings are in one place.

Version Command

A new, TAPI-specific extension of the protocol is the “VER” command. The syntax of the command and response is described below in *Commands And Responses*. This command might be used by connecting computers in the future to determine the specific capabilities of the protocol in an instrument.

RS-232 Configuration

Menu: **SETUP-MORE-COMM-COMx**

Traditionally, the Hessen protocol has used 1200 baud, even parity, 7 data bits, and 1 stop bit for its RS-232 communications. TAPI’s instruments have always supported changing the baud rate in the Hessen protocol, but the other line parameters have been always been hard-coded.

In order to accommodate more users, there is a new RS-232 parameter setting that selects even parity, 7 data bits, and 1 stop bit; the default setting is always no parity, 8 data bits, and 1 stop bit.

The Hessen protocol originally operated in a network in which multidrop was accomplished in a manner that was transparent to the instrument. As far as the instrument was concerned, it had an exclusive connection to the network. Since Teledyne Monitor Labs wishes to use TAPI’s RS-232 multidrop hardware, the instrument now has to be aware that it has a shared connection to the network.

There is already an RS-232 configuration setting to enable multidrop support. Previously, however, this setting was ignored by the Hessen protocol. Now, the Hessen protocol uses this setting.

The new RS-232 line parameter setting and the multidrop setting are part of the settings for each comm. port, and not part of the Hessen protocol itself.

Concentration Units

The original specification of the Hessen protocol referred to only two concentration units: PPM and mg/m^3 . TAPI’s implementation defined two more concentration units: PPB and $\mu\text{g/m}^3$. These four are indicated using two bits in the status byte of the status response. With the advent of new concentration units, such as weight percent, there are not enough unassigned bits in the status byte to indicate additional concentration units.

So, at present, a generalized approach to indicating concentration units does not exist. If a gas, such as O_2 , uses concentration units other than the four defined above, the units are implied by the gas type. In the case of O_2 , the units are weight percent.

Commands And Responses

This section briefly summarizes the commands and responses, with a particular emphasis on highlighting the differences between the Type 1 and Type 2 status responses. More detailed information can be found in “API Hessen Protocol.doc.” The table below is a

legend for the command and response message fields. The responses shown as examples use the BCC response mode. The actual delimiting characters depend on the response mode setting.

Command And Response Message Field Legend		
Field	Length (bytes)	Description
<NUL>	1	ASCII NUL character (0x00 hex).
<STX>	1	ASCII start-of-text character (0x02 hex).
<ETX>	1	ASCII end-of-text character (0x03 hex).
<SP>	1	ASCII space character (0x20 hex).
DA	2	Status request command.
MD	2	Header for status request response.
ST	2	Calibration command.
VER	3	Version request command and header for version request response.
<aa>	2	2-digit decimal number of gases being reported in the message. In a standard M200E it would appear as "03."
<ggg>	3	3-digit decimal gas ID number. This number is usually different for each gas.
<iii>	3	3-digit decimal instrument ID number. This number is usually different from the gas ID numbers.
<snmnsee>	8	Gas concentration in scientific notation. Bits in the status flag indicate the concentration units. s = sign ('+' or '-') nnnn = significand (without decimal point) ee = exponent
<oo>	2	8 operational status bits, formatted as a two-digit hexadecimal number. These are fairly uniform for all instruments. See "API Hessen Protocol.doc" for a complete list.
<ff>	2	8 failure status bits, formatted as a two digit hexadecimal number. These vary from one instrument to another. See Appendix A for a complete list.
<c>	1	Calibration command. One of: 'M' = Measure (sample) mode 'N' = Zero calibration 'K' = Span calibration
<xxxxxx>	6	6 characters of spare data, all zeros ('0')
<xxxxxxxxxx>	10	10 characters of spare data, all zeros ('0')
<version>	variable	Variable length version string, such as "4.0".
<attributes>	4	4-digit hexadecimal attributes. 0x0001 = Type 2 (0 = Type 1)

		0x0002 = BCC response mode 0x0004 = TEXT response mode
<bb>	2	2-digit hexadecimal block check code. XOR of all bytes from <STX> through <ETX>, inclusive.
[...]	variable	Optional data for additional gases (repeat underlined sections of response for each gas).

DA Command

Type 1

Command

```
<STX>DA<iii><ETX><bb>
DA<iii><CR>
```

Response

```
<STX>MD<aa><SP>
<ggg><SP><snnnnsee><SP><oo><SP><ff><SP><iii><SP><xxxxxx><SP>
[...]
```

```
<ETX><bb>
```

Type 2, Long Model Response

Command

```
<STX>DA<iii><ETX><bb>
DA<iii><CR><NUL>
```

Response

```
<STX>MD<aa><SP>
<ggg><SP><snnnnsee><SP><oo><SP><ff><SP><xxxxxxxxxx><SP>
<iii><SP><snnnnsee><SP><oo><SP><ff><SP><xxxxxxxxxx><SP>
[...]
```

```
<ETX><bb>
```

Type 2, Single-Gas Response

Command

```
<STX>DA<ggg><ETX><bb>
DA<ggg><CR><NUL>
```

Response

```
<STX>MD<aa><SP>
<ggg><SP><snnnnsee><SP><oo><SP><ff><SP><iii><SP><xxxxxx><SP>
<ETX><bb>
```

ST Command

Command

```
<STX>ST<iii><SP><c><ETX><bb>  
ST<iii><SP><c><CR>
```

There is no response to this command.

VER Command

Command

```
<STX>VER<iii><ETX><bb>  
VER<iii><CR>
```

Response

```
<STX>VER<SP><iii><SP><version><SP><attributes><ETX><bb>
```

Recommended TML Setup

The table below shows the recommended setup for Teledyne Monitor Labs to make the M200EH with the O₂ option emulate the ML 9841 NO_x analyzer.

Menu / Property	Setting
SETUP-MORE-COMM-COMx-COMx MODE	Value: 51 QUIET MODE: ON COMPUTER MODE: ON HESSEN PROTOCOL: ON ¹ MULTIDROP MODE: ON
SETUP-MORE-COMM-COMx-COMx BAUD RATE	<baud rate>
SETUP-MORE-COMM-ID	<instrument id>
SETUP-MORE-COMM-HESN-HESSEN VARIATION	TYP2
SETUP-MORE-COMM-HESN-HESSEN RESPONSE MODE	BCC
SETUP-MORE-COMM-HESN-HESSEN GAS LIST	NO, <id>, REPORTED NOX, <id>, REPORTED NO2, <id> O2, <id>
SETUP-MORE-COMM-HESN-HESSEN STATUS FLAGS	See note 2
¹ After enabling the Hessen protocol, you must power-cycle the instrument for it to be started. Any changes to the Hessen protocol configuration take effect immediately, without the need to power-cycle.	
² For more detailed emulation, you can also change the status flag assignments (<i>refer to Status Flag Configuration above</i>).	