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QTS-8000

RS-485 Data Communication Protocols

82050-005-000

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Revision:	1	2	3	A	B
Date:	00-05-15				
ECN No.:	Fisrt Issue				
Approved:	GL				

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1. Scope

This document specifies the protocols supported by QTS-8000 for data communication.

2. Applicable Documents

2.1 Government Documents

None.

2.2 Non-Government Documents

- Modicon Modbus Protocol Reference Guide
- OPTOMUX B1 and B2 Digital and Analog Brain Boards Operation Manual

2.3 Internal Documents

- QTS-8000 Development Specification(QEL 82010.001)
- QTS-8000 Software Development Specification(QEL 82040.001)

3. Protocols

QTS-8000 supports Modbus and OPTO22 data communication protocols.

3.1. Physical layer

QTS-8000 uses RS-485 interface as physical layer to support multidrop data communication network. Each device has an unique device address which is settable in the Configuration Menu.

3.2. Data link layer

The data link layer is completely compatible with OPTO22 and Modbus protocols.

3.3. Application layer

In application layer, only a subset of OPTO22 and Modbus Protocol is supported, and some commands are expanded from OPTO 22 and Modbus Protocol for the special purpose. The supported commands and responds are listed in detail in the appendix A and appendix B.

4. Note

None.

Appendix A: OPTO22 Protocol Supported by QTS-8000

1. Serial Transmission Mode:

- OPTO22 Slave Mode, 2 Pass OPTO protocol compatible.
- Baud rate: 9600, 4800, 2400 or 1200, selectable from Baud Rate Setting Menu..
- Data format: One start bit, 8 data bit, no parity, one stop bit, LSB first.
- Frame check: Checksum specified by OPTO22 protocol.

2. Commands Supported by QTS-8000

Command Name:	Power up clear
Command Format:	**A**
Function in OPTO:	Prevent OPTOMUX from returning a Power-up Expected error message in response to the first instruction following application of power.
Function in QEL:	Same as the function in OPTO.
Respond:	**A.**
Remark:	The command can be used for monitor to ask for acknowledge from sensors.

Command Name:	Reset
Command Format:	**B**
Function in OPTO:	Reset OPTOMUX to power-up condition.
Function in QEL:	Reset the transmitter to power-up condition.
Respond:	**A.**
Remark:	

Command Name:	Identify OPTOMUX type
Command Format:	**F**
Function in OPTO:	Instructs OPTOMUX to identify itself as either digital or analog controller.
Function in QEL:	Identify Transmitter type and gas type.
Respond:	**A** (*lk)*.
Remark:	In position area, *lk* contain 2 ASCII-Hex digits. *l* represents the transmitter type, *k* represents gas type.

When $l = 0$, for toxic gas transmitter:

$k = 0$,	for Oxygen
$k = 1$,	for CO
$k = 2$,	for H2S
$k = 3$,	for SO2
$k = 4$,	for NO

k = 5,	for NO2
k = 6,	for Hydrogen
k = 7,	for HCN
k = 8,	for HCL
k = 9,	for NH3
k = A,	for MMH
k = B,	for O3
k = C,	for C2H4O
k = D,	for Cl2
k = E,	for ClO2

When *l* =1, for combustible gas transmitter:

k = 0,	for Methane
k = 1,	for Propane
k = 2,	for Hydrogen
k = 3,	for other combustible gases

Command Name: Digital output ON/OFF

Command Format: **J***(position)*

Function in OPTO: Turn all digital output modules ON or OFF, depending on 1 or 0 in the *(position)* area.

Function in QEL: Turn output relays ON or OFF, depending on 1 or 0 in the *(position*) area.

Respond: **A**.

Remark: *(position)* contains 4 ASCII-hex digits. Each digit in the position area specifies the ON/OFF status of four relays. Relay positions corresponding to 1 bits in the position area are turned ON, Relay positions corresponding to 0 bits are turned OFF. In QTS-8000, only last two bits in last digit are legal.

Example:

J*0001*	Turn Warning relay ON, Alarm relay OFF.
J*0002*	Turn Alarm relay ON, Warning relay OFF.
J*0003*	Turn Warning relay ON, Alarm relay ON.
J*0000*	Turn Warning relay OFF, Alarm relay OFF

Command Name: Read status

Command Format: **M**

Function in OPTO: Return the current ON/OFF state of all 16 module position, input or output. 1 for ON and 0 for OFF.

Function in QEL: Return transmitter status.

Respond: **A** (*position)*

Remark: *(position)* contains 4 ASCII-hex digits. Each digit in the position area specifies the ON/OFF status of four relays. Relay positions corresponding to 1 bits in the position area indicate ON, Relay positions corresponding to 0 bits indicate OFF. In QTS-8000, only last three bits in last digit are legal.

Example:

A*0001*	Indicate Warning relay is ON, Alarm relay and Fault indicator are OFF.
A*0002*	Indicate Alarm relay is ON, Warning relay and Fault indicator are OFF.
A*0004*	Indicate Fault indicator is ON, Warning relay and Alarm relay are OFF.
A*0000*	Indicate Warning relay, Alarm relay and Fault indicator are OFF

Command Name: Read and clear peak value
Command Format: **f***(position)*
Function in OPTO: Instructs OPTOMUX to read and clear the peak values for specified analog input position.
Function in QEL: Instructs the transmitter to return gas concentration value.
Respond: **A(***kkkk)*
Remark: In command, *(position)* contains 4 ASCII-Hex digits that specify to return gas concentration or decimal position.

f*0001* -- 0001h for gas concentration;
f*0002* -- 0002h for decimal position;

In respond, (*kkkk)* contains 4 ASCII-Hex digits that represents the gas concentration or decimal position.
The concentration is a signed integer returned by *f0001* command with a unsigned integer for the decimal position returned by *f002* command.
The unit of concentration is % for Oxygen, ppm for other toxic gases or LEL for combustible gases.

Example:
Command: **f***0001*;
Respond: **A***07CF*;
Command: **f***0002*;
Respond: **A***0003*;
The gas concentration is 1.999, because *07CF=1999* and decimal position is 3.

Command Name: Set Calendar and clock
Command Format: q*(yymmddhhmmss).*
Function in OPTO: None.

Function in QEL: Write calendar and clock to transmitter.
Respond: **A**
Remark: *(yymmddhhnnss)* contains 12 ASCII-Hex digits which represents calendar and clock.

yy	0 to 99	00 to 63H
mm	1 to 12	01 to 0CH
dd	1 to 31	01 to 1FH
hh	0 to 23	00 to 17H
nn	0 to 59	00 to 3BH
ss	0 to 59	00 to 3BH

This command is an extended command and used by QEL only.

Example: Command: **q***630C1F170000*;
Respond: **A**;
This command sets the transmitter to 2099-12-31, 23:00:00.

Command Name: Read the last error
Command Format: **z**
Function in OPTO: None.
Function in QEL: Indicate the transmitter to return the last recorded error.
Respond: **A***(aa)*.
Remark: 1). This command indicates the sensor to return the last recorded error specified by *(aa)*.
2). *(aa)* contains 2 ASCII-Hex digits which represents one char error code(1 byte).
(aa) = 00 -- no error.
(aa) = 01 -- EEPROM1 error.
(aa) = 02 -- EEPROM2 error
(aa) = 04 -- A/D
(aa) = 08 -- signal output error
(aa) = 10 -- combustible gas sensor dead
(aa) = 20 -- sensor zero calibration error
(aa) = 40 -- sensor span calibration error
(aa) = 80 -- reserved
3). This command is an extended command and used by QEL only.

Example: Command: **z**;
Respond: **A**01;
The respond reports there is a EEPROM1 error in the transmitter.

Command Name: Read the date of last calibration.
Command Format: **o***(FF)*
Function in OPTO: None.
Function in QEL: Indicate the transmitter to return the date of last calibration.
Respond: **A***(yymmddhh)***.**
Remark: *(yymmddhh)* contains 8 ASCII-Hex digits which represents the date of last calibration.

yy	0 to 99	00 to 63H
mm	1 - 12	01 to 0CH
dd	1 to 31	01 to 1FH
hh	x	x

x -- don't care

This command is an extended command and used by QEL only.

Example: Command: **o***FF;*
Respond: **A***01021F00*;
The date of last calibration is 2001-02-31.

Appendix B: MODBUS Protocol Supported By QTS-8000

1. Serial Transmission Mode:

- Modbus RTU Slave Mode
- Baud rate: 9600, 4800, 2400 or 1200, selectable from Baud Rate Setting Menu.
- Byte parity: Even parity.
- Data format: One start bit, 8 data bit, one parity bit, one stop bit, LSB first..
- Frame Check: CRC check.

2. Function Code Supported by QTS-8000:

- #01 Read Coil Status:
  Function in QTS-8000: To read warning and alarm relay's status.
  Broadcast is not supported.

  Query:

Slave Addr.:	xxH
Function code:	01H
Starting addr. Hi:	00H
Starting addr. Lo:	00H
No. of points Hi:	00H
No. of points Lo:	02H
CRC check:	xxxxH

  Note: Starting relay's addr. = 00H, quantity of relays = 02H, so only addr. 0000H, 0001H are legal. 0000H is for warning relay, 0001H for alarm relay.

  Response:

Slave addr.:	xxH
Function code:	01H
Byte count:	01H
Data:	b7 b6 b5 b4 b3 b2 b1 b0
CRC check:	xxxxH

  Note: b0 = 1, if warning relay is ON, otherwise OFF.
  b1 = 1, if alarm relay is ON, otherwise OFF.

- #03 Read Holding Registers
  Function in QTS-8000: To read the date of last calibration.
  Broadcast is not supported.

Query:

Slave Addr.:	xxH	
Function code:	03H	
Starting addr. Hi:	00H	
Starting addr. Lo:	00H	
No. of points Hi:	00H	
No. of points Lo:	03H	
CRC check:	xxxxH	

Response:

Slave addr.:	xxH	
Function code:	03H	
Byte count:	06H	
Year:		(0 to 99)
Month:		(1 to 12)
Date:		(1 to 31)
CRC check:	xxxxH	

Note:
Msec, Seconds, Hour, Date, Month and year are all 16-bit unsigned integer.

- #04 Read Input Registers

Function in QTS-8000: Read gas concentration in registers.
Broadcast is not supported.

Query:

Slave Addr.:	xxH
Function code:	04H
Starting addr. Hi:	00H
Starting addr. Lo:	00H
No. of points Hi:	00H
No. of points Lo:	02H
CRC check:	xxxxH

Note:
Starting register's addr. = 00H, quantity of registers = 02H, so only addr. 0000H, 0001H are legal. Each register is 16-bit wide.

Response:

Slave addr.:	xxH
Function code:	04H
Byte count:	04H
Reg. 00H Hi:	
Reg. 00H Lo:	
Reg. 01H Hi:	

Reg. 01H Lo:
CRC check: xxxxH

Note:
The gas concentration is a signed integer in Reg. 0000H with an unsigned integer in Reg. 0001H for the decimal position. e.g.

Reg. 0000H = 1999, Reg. 0001H = 3, the gas concentration is 1.999.

The unit of gas concentration is % for Oxygen, ppm for other toxic gases or LEL for combutible gases..

- #05 Force Single Coil
Function in QTS-8000: To force single relay to either ON or OFF.
Broadcast is not supported.

Query:

Slave Addr.:	xxH
Function code:	05H
Relay addr. Hi:	
Relay addr. Lo:	
Force data Hi:	
Force data Lo:	
CRC check:	xxxxH

Note:
1).Only relay addresses 0000H and 0001H are legal. 0000H is for warning relay, 0001H for alarm relay.
2).Force data = FF00H for ON, force data = 0000H for OFF.

Response:

Slave addr.:	xxH
Function code:	05H
Relay addr. Hi:	
Relay addr. Lo:	
Force data Hi:	
Force data Lo:	
CRC check:	xxxxH

Note:
The relay address and force data are echo of the query.

- #17(11H) Report Slave ID
Function in QTS-8000: To report transmitter type(combustible or toxic) and gas type.
Broadcast is not supported.

Query:

Slave Addr.:	xxH	
Function code:	11H	
CRC check:	xxxxH	

Response:

Slave addr.:	xxH	
Function code:	11H	
Byte count:	03H	
Slave ID:		
Run Indicator status:	FFH	(always ON)
Gas type:		
CRC check:	xxxxH	

Note:
1). Slave ID = 70H for toxic transmitter, Slave ID = 71H for combustible transmitter.
2). Gas type:

Toxic		Combustible	
Oxygen	00H	Methane	00H
CO	01H	Propane	01H
H2S	02H	Hydrogen	02H
SO2	03H	Others	03H
NO	04H		
NO2	05H		
Hydrogen	06H		
HCN	07H		
HCL	08H		
NH3	09H		
MMH	0AH		
O3	0BH		
C2H4O	0CH		
Cl2	0DH		
ClO2	0EH		

- #08 Diagnostics
  Function in QTS-8000: To report self check results.
  Broadcast is not supported.

Query:

Slave Addr.:	xxH

Function code:	08H
Subfunction Hi:	
Subfunction Lo:	
Data Hi:	
Data Lo:	
CRC check:	xxxxH

Response:

Slave addr.:	xxH
Function code:	08H
Subfunction Hi:	
Subfunction Lo:	
Data Hi:	
Data Lo:	
CRC check:	xxxxH

Note:
Subfunction supported by QST-8000:

Subfunction	Data(in Query)	Data(in Response)
0000H	any	echo of Query Data
0002H	0000H	Fault Flag Reg.

Fault Flag Reg.	b0 = 1,	EEPROM 1 error
	b1 = 1,	EEPROM 2 error
	b2 = 1,	A/D error
	b3 = 1,	signal output error
	b4 = 1,	combustible gas sensor dead
	b5 = 1,	sensor zero calibration error
	b6 = 1,	sensor span calibration error
	b7	reserved
	b8	reserved
	b9	reserved
	b10	reserved
	b11	reserved
	b12	reserved
	b13	reserved
	b14	reserved
	b15	reserved

- #016(10H) Preset Multiple Registers:
  Function in QTS-8000: To set calendar and clock.

Broadcast is supported.

Query:

Slave Addr.:	xxH	
Function code:	10H	
Starting addr. Hi:	00H	
Starting addr. Lo:	00H	
No. of registers Hi:	00H	
No. of registers Lo:	06H	
Byte count:	0CH	
Year:		(0 to 99)
Month:		(1 to 12)
Date:		(1 to 31)
Hours:		(0 to 23)
Minutes		(0 to 59)
Seconds:		(0 to 95)
CRC check:	xxxxH	

Note:
Msec, Seconds, Hours, Date, Month and Year are all 16-bit unsigned integer.

Response:

Slave addr.:	xxH
Function code:	10H
Starting addr. Hi:	00H
Starting addr. Lo:	00H
No. of registers Hi:	00H
No. of registers Lo:	06H
CRC check:	xxxxH

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