SY486K MICS Lecture 7

Modbus

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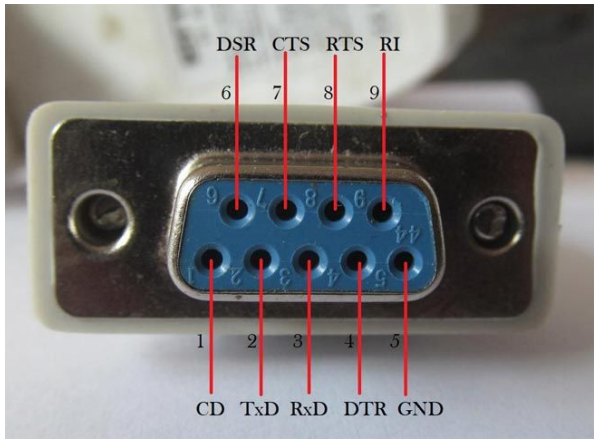
Outline

- History
- Intro
- Object Types
- Protocols
- Message Format
  - Function Codes
  - Data Format
  - CRC
- Physical Medium
- Examples
- Modbus on AB micro820



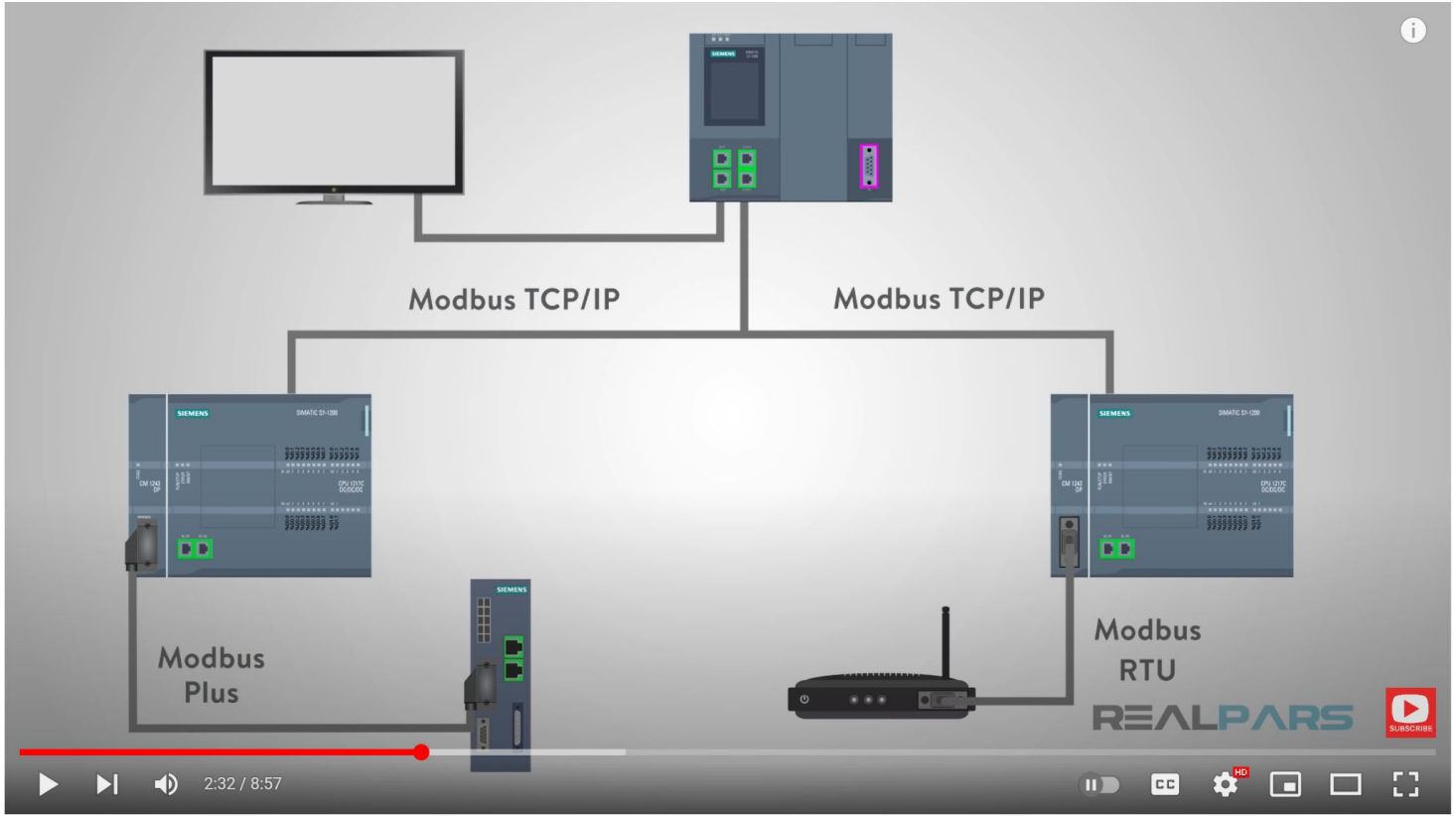
Where did Modbus come from?

Modbus is a serial communication protocol developed by Modicon® in 1979 for use with its 084 programmable logic controllers (PLCs).

Modbus has become a de facto standard communication protocol and is now a commonly available means of connecting industrial electronic devices.

Modbus is popular in industrial environments because it is openly published and royalty-free. It was developed for industrial applications, is relatively easy to deploy and maintain compared to other standards, and places few restrictions on the format of the data to be transmitted.

https://www.youtube.com/watch?v=txi2p5_OjKU



What is Modbus and How does it Work?

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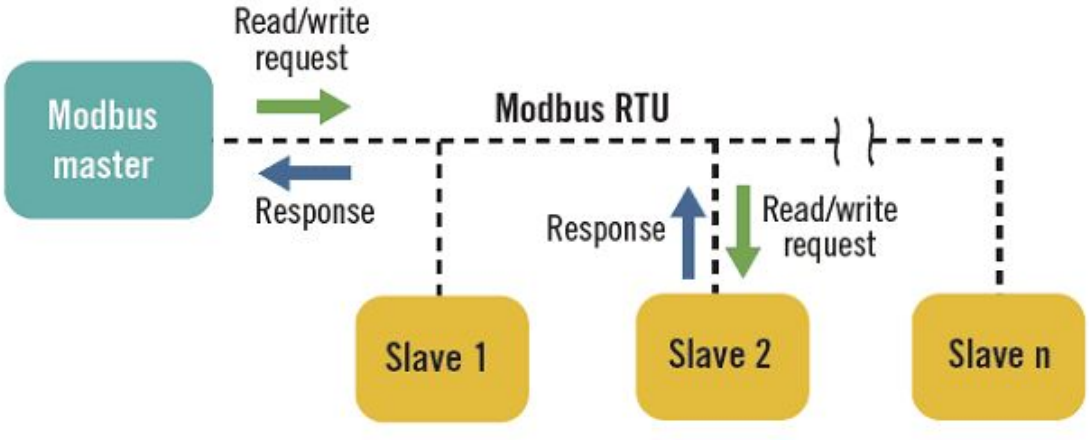
Philosophy of Modbus

Every message in Modbus deals with reading or writing one of only these four object types:

- Coils
- Discrete Inputs
- Input Registers
- Holding Registers

Single "Controller" that makes requests to "Peripheral" device responses.

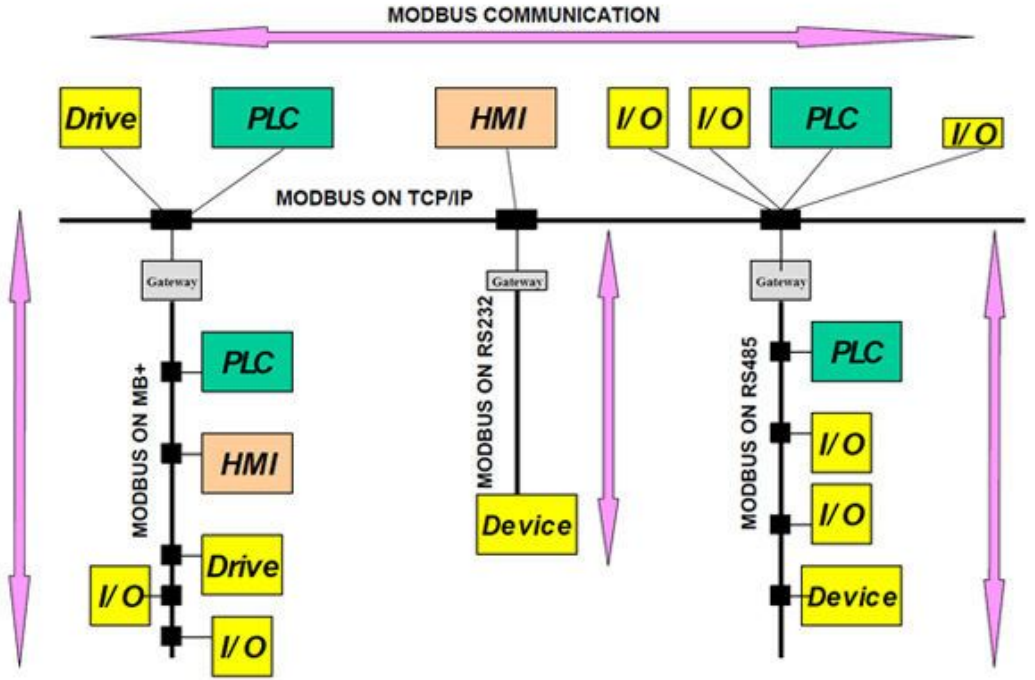
Object type	Access	Size	Address Space
Coil	Read-write	1 bit	00001 – 09999
Discrete input	Read-only	1 bit	10001 – 19999
Input register	Read-only	16 bits	30001 – 39999
Holding register	Read-write	16 bits	40001 – 49999



Modbus Protocols

There are four different protocols that are all called Modbus:

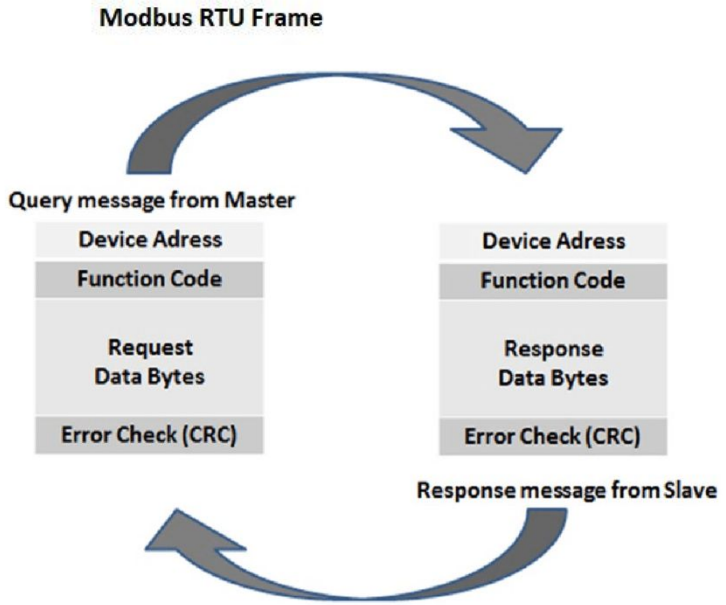
- Modbus RTU
- Modbus ASCII
- Modbus TCP
- Modbus Plus*



Mb RTU Message Format

		Protocol Data Unit (PDU)			
Start	Slave ID	Function code	Data	CRC error check	Stop
3.5 Bytes	1 Byte	1 Byte	n Bytes	2 Bytes	3.5 Bytes
	Application Data Unit (ADU)				

1. There are 3.5 Bytes of of quiet before or after a message is sent
2. An ID of the slave device is next (1 byte)
3. Then a Function Code (1 byte)
4. Then a variable amount of Data
5. Lastly, a CRC error check (2 bytes)



PDU = FC + Data
ADU = Entire message

Function Codes

Each message sent from the Master will use one and only one of these codes to either read or manipulate a particular value in the Slave's memory tables.

If the slave needs to send back an error code, they will change the first (MSB) of the FC to "1" during the reply.

Function Code	Action	Table Name
01 (01 hex)	Read	Discrete Output Coils
05 (05 hex)	Write single	Discrete Output Coil
15 (0F hex)	Write multiple	Discrete Output Coils
02 (02 hex)	Read	Discrete Input Contacts
04 (04 hex)	Read	Analog Input Registers
03 (03 hex)	Read	Analog Output Holding Registers
06 (06 hex)	Write single	Analog Output Holding Register
16 (10 hex)	Write multiple	Analog Output Holding Registers

https://www.youtube.com/watch?v=JBGaInI-TG4

Data Format

The length and content of the data portion will depend on the type of message (FC) being sent.

It will typically start with the address within the appropriate address block then count of how many values are to be read or written to.

Coil/Register Numbers	Data Addresses	Type	Table Name
1-9999	0000 to 270E	Read-Write	Discrete Output Coils
10001-19999	0000 to 270E	Read-Only	Discrete Input Contacts
30001-39999	0000 to 270E	Read-Only	Analog Input Registers
40001-49999	0000 to 270E	Read-Write	Analog Output Holding Registers

FC 0x01 = Read Coils

Request

Function code	1 Byte	**0x01**
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of coils	2 Bytes	1 to 2000 (0x7D0)

Response

Function code	1 Byte	**0x01**
Byte count	1 Byte	**N***
Coil Status	**n** Byte	n = N or N+1

Here is an example of a request to read discrete outputs 20–38:

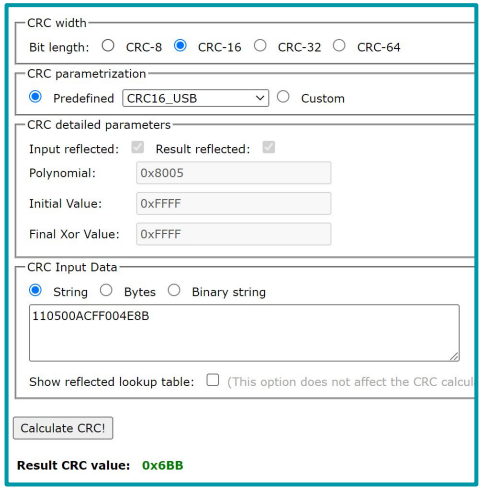
Request		**Response**	
Field Name	*(Hex)*	*Field Name*	*(Hex)*
Function	**01**	Function	**01**
Starting Address Hi	**00**	Byte Count	**03**
Starting Address Lo	**13**	Outputs status 27-20	**CD**
Quantity of Outputs Hi	**00**	Outputs status 35-28	**6B**
Quantity of Outputs Lo	**13**	Outputs status 38-36	**05**

Cyclic Redundancy Check (CRC)

A cyclic redundancy check is an error-detecting code commonly used in digital networks and storage devices to detect accidental changes to digital data. Blocks of data entering these systems get a short check value attached, based on the remainder of a polynomial division of their contents. On retrieval, the calculation is repeated and, in the event the check values do not match, corrective action can be taken against data corruption. CRCs can be used for error correction.

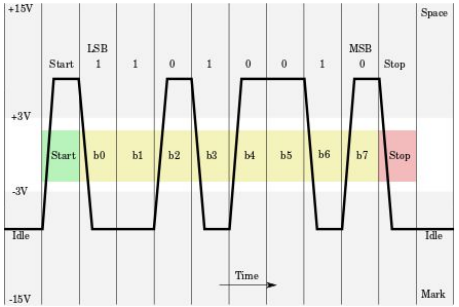
CRC-16-IBM	Bisync, Modbus, USB, ANSI X3.28, SIA DC-07, many others; also known as *CRC-16* and *CRC-16-ANSI*	0x8005
		$x^{16} + x^{15} + x^2 + 1$

http://www.sunshine2k.de/coding/javascript/crc/crc_js.html

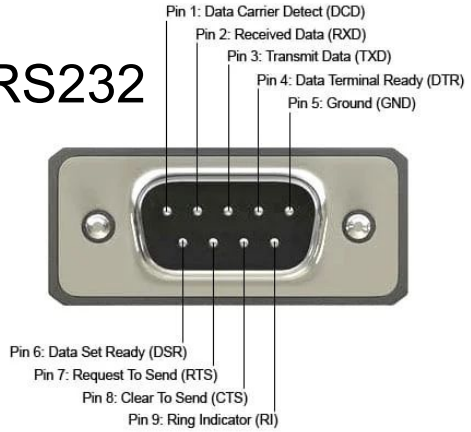


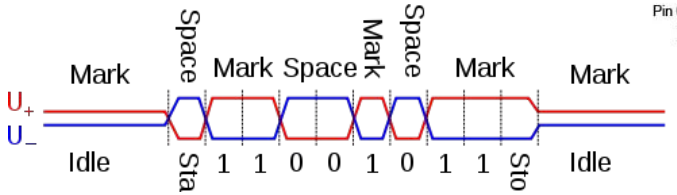
Physical Layer

- RS-232
  - Three wires (Tx, Rx, Gnd)
  - +V for "0", -V for "1"
- RS-485
  - Two wires (A, B)
  - Differential Voltage
    - A>B for "0", B>A for "1"
- RS-422
  - Four wires (twisted pairs) 2x Tx + Rx
  - Differential Voltage (0-5V)



RS232

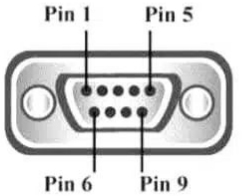




RS422/485

Pin 1	TXD-
Pin 2	TXD+
Pin 3	RTS-
Pin 4	RTS+
Pin 5	GND
Pin 6	RXD-
Pin 7	RXD+
Pin 8	CTS
Pin 9	CTS+

RS422/485 Pinout (9 Pin)



https://www.optcore.net/difference-between-rs-232-rs-422-and-rs-485/

Example Messages

- 11 05 00AC FF00 4E8B
- 06 0F 0013 000A 02 CD01 BF0B
- 13 01 0013 0025 0E84 (13 01 05 CD6BB20E1B 45E6)
- 03 06 0001 0003 9A9B

AB Micro820 Communications

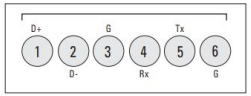
Micro820 controllers support communication through the embedded RS232/RS485 serial port as well as any installed serial port plug-in modules. In addition, Micro820 controllers also support communication through the embedded Ethernet port, and can be connected to a local area network for various devices providing 10 Mbps/100 Mbps transfer rate.

These are the communication protocols supported by Micro820 controllers:

- Modbus RTU Master and Slave
- CIP Serial Client/Server (RS232 only)
- ASCII
- EtherNet/IP Client/Server
- Modbus TCP Client/Server
- CIP Symbolic Client/Server
- DHCP Client
- Sockets Client/Server TCP/UDP

https://literature.rockwellautomation.com/idc/groups/literature/documents/um/2080-um005_-en-e.pdf

Serial Port Terminal Block

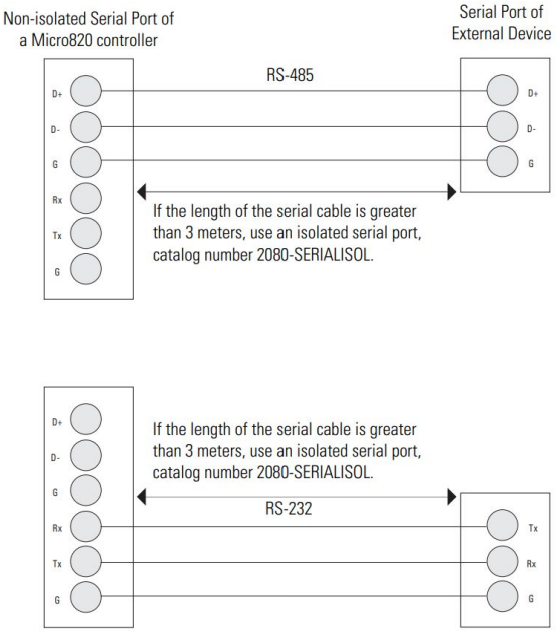


(View into terminal block)

Pin 1	RS485	Data +
Pin 2	RS485	Data -
Pin 3	RS485	Ground(1)
Pin 4	RS232	Receive
Pin 5	RS232	Transmit
Pin 6	RS232	Ground(1)

(1) Non-isolated.

Serial Port Wiring

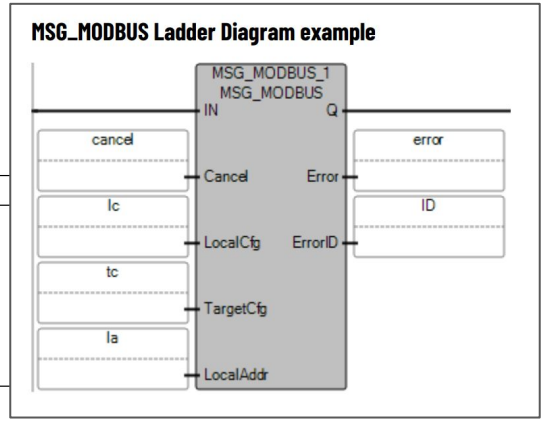


IMPORTANT Do not connect G terminals of the serial port to Earth/Chassis ground.

Modbus RTU on AB micro820

Parameter	Parameter Type	Data Type	Description
IN	Input	BOOL	Rung input state. TRUE - Rising Edge detected, start the instruction block with the precondition that the last operation has been completed. FALSE - Rising Edge not detected, not started.
Cancel	Input	BOOL	TRUE - Cancel the execution of the instruction block. FALSE - when IN is TRUE. Cancel input is dominant.
LocalCfg	Input	MODBUSLOCPARA	Define structure input (local device). Define the input structure for the local device using the MODBUSLOCPARA data type on page 179.
TargetCfg	Input	MODBUSTARPARA	Define structure input (target device). Define the input structure for the target device using the MODBUSTARPARA data type on page 182.
LocalAddr	Input	MODBUSLOCADDR	MODBUSLOCADDR is a 125 Word array that is used by Read commands to store the data (1-125 words) returned by the Modbus slave and by Write commands to buffer the data (1-125 words) to be sent to the Modbus slave.
Q	Output	BOOL	Outputs of this instruction are updated asynchronously from the program scan. Output Q cannot be used to re-trigger the instruction since IN is edge triggered. TRUE - MSG instruction finished successfully. FALSE - MSG instruction is not finished.
Error	Output	BOOL	Indicates an error occurred. TRUE - An error is detected. FALSE - No error.
ErrorID	Output	UINT	A unique numeric that identifies the error. The errors for this instruction are defined in MSG_MODBUS error codes.

Parameter	Data type	Description
Channel	UINT	Micro800 PLC serial port number: • 2 for the embedded serial port, or • 5-9 for serial port plug-ins installed in slots 1 through • 5 for slot 1 • 6 for slot 2 • 7 for slot 3 • 8 for slot 4 • 9 for slot 5
TriggerType	USINT	Represents one of the following: • 0: Msg Triggered Once (when IN goes from False to True) • 1: Msg triggered continuously when IN is True • Other value: Reserved
Cmd	USINT	Represents one of the following: • 01: Read Coil Status (0xxxx) • 02: Read Input Status (1xxxx) • 03: Read Holding Registers (4xxxx) • 04: Read Input Registers (3xxxx) • 05: Write Single Coil (0xxxx) • 06: Write Single Register (4xxxx) • 15: Write Multiple Coils (0xxxx) • 16: Write Multiple Registers (4xxxx)



https://literature.rockwellautomation.com/idc/groups/literature/documents/rm/2080-rm001_-en-e.pdf

https://www.youtube.com/watch?v=ARg2QHn3IB0

Mapping Address Space and supported Data Types

Since Micro800 uses symbolic variable names instead of physical memory addresses, a mapping from symbolic Variable name to physical Modbus addressing is supported in Connected Components Workbench software, for example, InputSensorA is mapped to Modbus address 100001.

By default Micro800 follows the six-digit addressing specified in the latest Modbus specification. For convenience, conceptually the Modbus address is mapped with the following address ranges. The Connected Components Workbench mapping screen follows this convention.

Variable Data Type	0 - Coils 000001 to 065536		1 - Discrete Inputs 100001 to 165536		3 - Input Registers 300001 to 365536		4 - Holding Registers 400001 to 465536	
	Supported	Modbus Address Used	Supported	Modbus Address Used	Supported	Modbus Address Used	Supported	Modbus Address Used
BOOL	Y	1	Y	1				
SINT	Y	8	Y	8				
BYTE	Y	8	Y	8				
USINT	Y	8	Y	8				
INT	Y	16	Y	16	Y	1	Y	1
UINT	Y	16	Y	16	Y	1	Y	1