Honeywell

Total Coal Mine Automation System

Profibus FSK – Intrinsically Safe Equipment Specification and Technical Data

TCM05-100

Release 100

Revision Date: January 2005
Version 1.0

技术规格书

Revision Records and Approval/版本记录和批准

Rev.	Date	Description	Prepared by	Checked by	Approved by
1.0	Jan. 12, 2005			Patrick Wang	

Revision Description/版本描述

Section	Change	Description	Prepared by	Checked by	Approved by

Legend for Change column:

A -- Added

D -- Deleted

M – *Modified*

TABLE OF CONTENT(目录)

1. Overview

1.1 Architecture Overview

Total coal mine automation system comprises many different integrated hardware and software solutions depending upon the needs of the installation. Total Equipment's input and output signals of this technical specification description are Ex.&I.S. for coal mine.

全矿井自动化系统囊括了许多不同硬件和软件，这些都取决于现场的应用需求。全矿井自动化系统所有的信号均为隔爆近兼本安信号。

Figure 1 represents many of the possible nodes that can be utilized in an Total coal mine automation system architecture.图1表明各种不同的通讯设备都可以被集成到全矿井自动化系统中

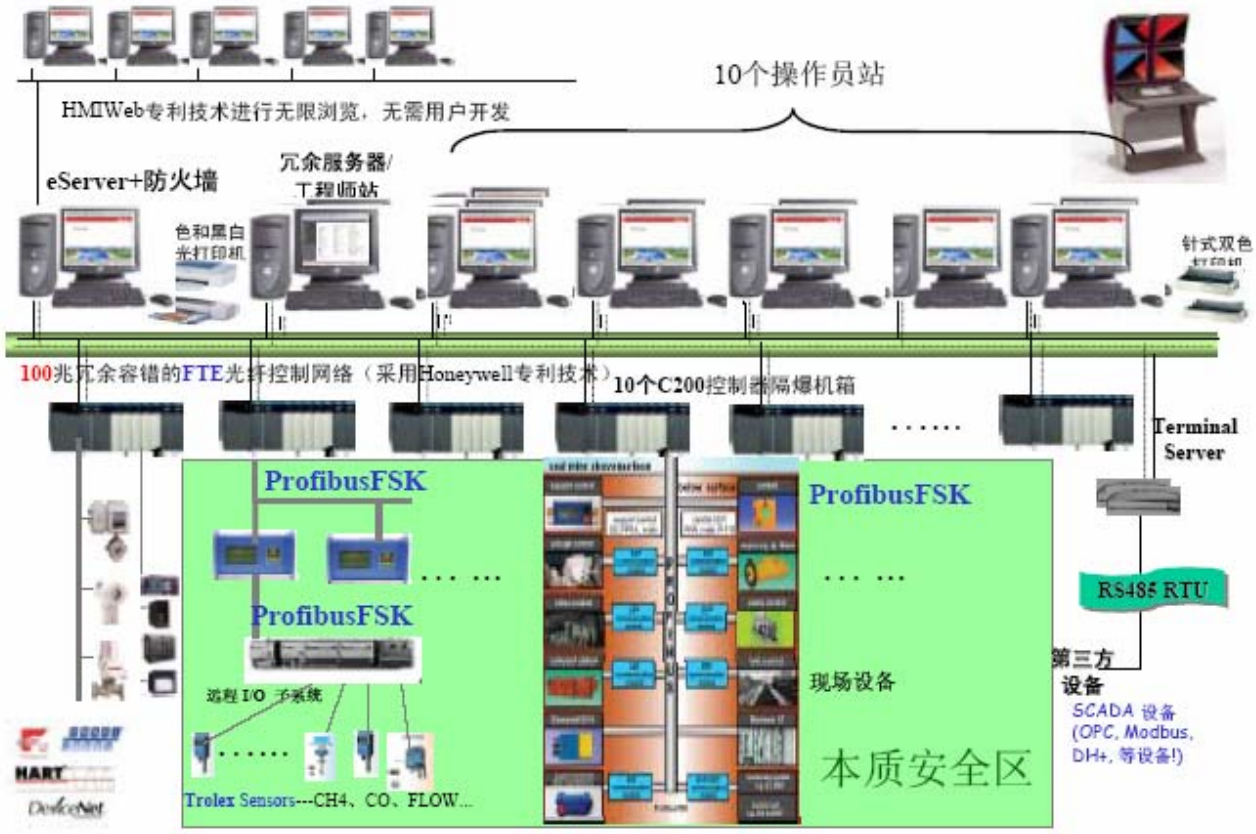


Figure 1. Sample Total coal mine automation system Architecture

1.2 General Environmental and Agency Certifications

Parameter	Specification
Environmental Conditions Altitude 海拔 Barometric Pressure 大气压 Operating Temperature工作温度 Relative Humidity 相对湿度 Grade Pollution 污染等级	Being explode Gas and grime 〈 2000m 80Kpa-106Kpa -10 to 40 °C 〈 95%±3%, (25°C ±3 °C) 3

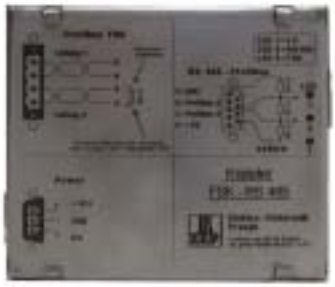
2. Ex. & I.S UPS Power Supply Specifications 隔爆兼本安型 UPS

Standard Power Supply

Parameter	Specification
Type 型号	KDW16
Description 描述	Explosion and Intrinsically Safe UPS
Explosion indicate 防爆标志	dibI
Working Mode 工作方式	Continuous Working
Input power voltage 输入电压	AC127V, 220V,380V or 660V; 50HZ
Input power change range	80%~115%
Output power: Voltage : Current :	Single circuit 18±8%, or 24±5%, or 15±5%, or 12±5%, 1.0A, 0.5A 1.0A 1.5A
UPS backup times	4 hours
Approval NO. MA 合格证号码	2001091-2004
Mechanical Dimensions, L x B x H mm 几何尺寸 ,	125x130x60 mm
Weight 重量：Kg	~32Kg

3. Intrinsically Safe Coupler Interface 本安型耦合器

FSK-RS485 , Profibus-DP

Parameter	Specification
Type 型号	TCM-1118/20
Description 描述	The module TCM-1118/20 serves data communications equipment and converts data telegrams (RS485) into Profibus telegrams (FSK). FSK to RS485, RS485 to FSK
Outline 外形	
Intrinsically Safe Power Supply 供电电源 Voltage（V） 电压 Current （mA） 电流	 12VDC 50mADC
Power Indication 电源指示	Red LED
Communication Working Indication 通讯指示	Tx and Rx 2 Greed LEDs / every side
Connection Mode 接线方式	Phoenix Terminal 端子
Protection 防护等级	IP54
Operating Temperature, °C 工作温度	T_a := - 20°C to +80°C
Relative Humidity 相对湿度	≤95%　(25°C)
Atmosphere Pressure 大气压力	80Kpa-106Kpa
Altitude 海拔高度	〈 2000m
mounting 固定	35mm DIN Rail
Intrinsically power circuit Profibus FSK 本安型 Profibus-FSK 回路参数 -Max. input/output voltage 最大输入/输出电压 -For connection to an data transmission circuit 所联接的数据传输电路	 U_0 =16V_{pp} Profibus---M EExI.
non-intrinsically safe power circuit (RS485) 非本安回路 (RS485) Max. input/output voltage 最大输入/输出电压	 U_0 =16V

Mechanical Dimensions, L x B x H mm 几何尺寸，	125x130x60 mm
Weight 重量：Kg	~0.5Kg

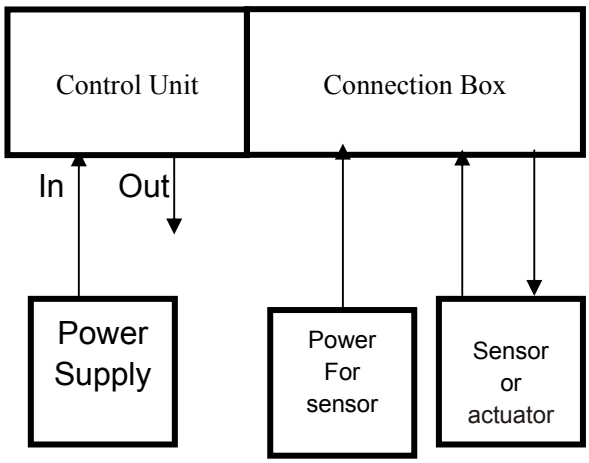
4. Intrinsically Safe Coupler Unit 本安型耦合单元

FSK-RS485 , Profibus-DP

Parameter	Specification
Type 型号	TCM-1118/20A
Module Description 模块描述	The module TCM-1118/20 serves data communications equipment and converts data telegrams (RS485) into Profibus telegrams (FSK). FSK to RS485, RS485 to FSK
Outline 外形	
Intrinsically Safe Power Supply 供电电源 Voltage（V） 电压 Current （mA） 电流	 12VDC 100mADC
Diagnostics and Troubleshooting诊断显示	4 x 16 characters LCD (with Back Light)
Operation 操作	Metal Keyboard 金属键盘
Connection Mode 接线方式	Socket/Plug
Protection 防护等级	IP67
Operating Temperature, °C 工作温度	T_a := - 20°C to +80°C
Relative Humidity 相对湿度	≤95% (25°C)
Atmosphere Pressure 大气压力	80Kpa-106Kpa
Altitude 海拔高度	〈2000m
Intrinsically power circuit Profibus FSK 本安型 Profibus-FSK 回路参数 -Max. input/output voltage 最大输入/输出电压 -For connection to an data transmission circuit 所联接的数据传输电路	 U_0 =16V_{pp} Profibus---M EExI.
non-intrinsically safe power circuit (RS485) 非本安回路 (RS485) Max. input/output voltage 最大输入/输出电压	 U_0 =16V
Mechanical Dimensions, L x B x H mm 几何尺寸	70 x 220 x 125 mm
Operating Temperature, °C 工作温度	Ta := - 20°C to +80°C
Weight 重量：Kg	~5Kg

5. Intrinsically Safe Remote I/O Control Unit 本安型远程 I/O 控制单元

FSK → I/O Unit，Profibus-DP

Parameter	Specification
Type 型号	TCM-1118/36
Front view of the Controller Unit 前面板图	

Configure Outline

Power Supply And FSK Interface	I/O slot 1	I/O slot 2	I/O slot 3	I/O slot 4

1. Base Unit is power supply and FSK interface.
2. 4 I/O slots.
3. Chassis has I/O 4 slots (Non Include Base Unit).
4. Following I/O module Type can be Configured in I/O slot.
   TCM-1118/36-16DI24D, 24VDC Digital Input Module
   TCM-1118/36-8DO24DR, 8 Relay Digital Output Module.
   TCM-1118/36-8AI, 8 Analog Input Module.
   TCM-1118/36-4AO 4 Analog Output Module.

Intrinsically Safe Power Supply: 供电电源 · Rated Voltage（V）额定电压 · Voltage Fluctuating Range 电压波动范围 · Rated Current（mA）, Max. 所需电流 · Reversal Polarity Protection 反极性保护 · Short Protection 短路保护 · Isolation Voltage 绝缘测试电压 · Power Indication 电源指示	12VDC ± 10%（12VDC） 1000mADC OK Inner Fast Fuse, 250 V, 5A 500V DC Red LED
Protection 防护等级	IP67
Operating Temperature, °C 工作温度	T_a := - 20°C to +80°C

Relative Humidity 相对湿度	≤95%　(25°C)
Atmosphere Pressure 大气压力	80Kpa-106Kpa
Altitude 海拔高度	〈2000m
Mechanical Dimensions, L x B x H mm 几何尺寸	150 x 450 x 250 mm
Weight 重量：Kg	~10 Kg
Connection Terminal Blocks, Min. 端子数量	70
Connections Port 电源接线嘴 -Connection Port Type 接头类型 -Connection Port Material 材料 -Number of Connection Port 接头数量 -Cable Input Hole 电缆输入孔 -Cable Out Diameter (ϕmm) 电缆外径 -Location 电缆接头位置	螺纹固定式管接头 Screw Thread Fixed Pipe Connection Non-Burning and Non-Halogen 阻燃无卤 40 M20 x 1.5 ϕ6.5-13.5mm On Bottom of the Connection Box
I.S. RS485 FSK Interface 本安型 RS485 FSK	
Physical Interface 物理接口	RS485 FSK (Shield)
Interface Protocol 通讯协议	Profibus DP
Node Type 节点类型	Slave
Baud Rate 通讯速率	9.6K~12Mbps, Auto Adjust
Exchange data Between Slave & Slave 从站间直接数据交换	Yes
State and Diagnosis Display 诊断显示	4 x 16 characters LCD (Back Light)
Operation 操作	Metal Keyboard 金属键盘
Communication Distance, Max 通讯距离	5Km
Intrinsically power circuit Profibus FSK 本安型 Profibus-FSK 电路参数 · Max. input/output voltage 最大输入/输出电压 · For connection to an data transmission circuit 所联接的数据传输电路	U0 =16V_{ss} Profibus-M EExI.
Node Add Range 地址范围	0-125
Add Set Mode 地址设置方式	DIP Switch
Number of Gsd file Modules, Max 可配置最大模块	8
RAM Capability 内存容量 -Max Input Len -Max Output Len -Input Bytes + Output Bytes	 244 Bytes 244 Bytes 488 Bytes
Available Module in Gsd files 有效模块 · Module Digital In · Module Digital Out · Module Analog In	Input Bytes 2 bytes 1 bytes 16 bytes

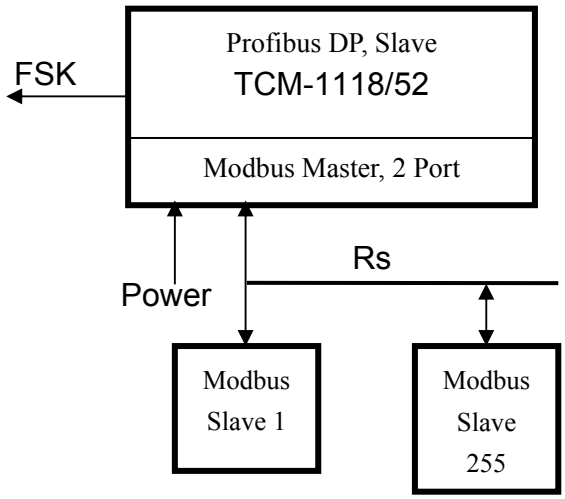
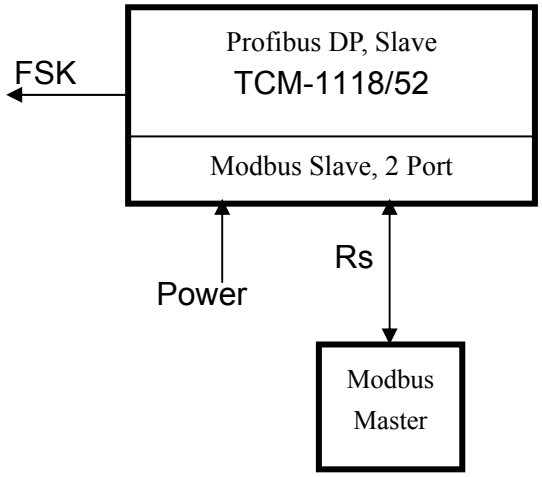
· Module Analog Out	8 bytes
Isolation Test Voltage 绝缘测试电压	500V DC
I.S. Discrete Input Module 本安型数字量输入模块	
Module Description 模块描述	24VDC Digital Input Module Current Sinking DC
Type 型号	TCM-1118/36-16DI24D
Number of Points 通道数	16 Channels (Individually isolated)
Channel Input State Indication 状态指示	Green LED, (Every Channel)
Isolation Between Channel & Channel 通道隔离	Yes
ON-State Voltage Range ON 状态电压范围 Nominal Input Voltage 额定输入电压	10-30 VDC 24 VDC
OFF-State Voltage (Maximum) OFF状态电压 (最大值)	5 VDC
On-State Current (Minimum) ON状态电流 (最小值)	2.0 mA @ 10 VDC
OFF-State Current (Maximum) OFF状态电流 (最大值)	1.5mA
Input Impedance (Maximum) 输入阻抗 (最大值)	31 K□ @ 60 HZ
Input Delay Time 输入延迟时间 · Off to On · On to Off	 4 ms maximum plus filter time 4 ms maximum plus filter time
Isolation Test Voltage 绝缘测试电压	500V DC
Cable Len 电缆长度 · Non Shield 非屏蔽 · Shield 屏蔽	 600m 1000m
I.S. Discrete Output Module 本安型数字量输出模块	
Module Description模块描述	8 Relay Digital Output Module
Type 型号	TCM-1118/36-8DO24DR
Number of Points 通道数	8 N.O. (Contacts individually isolated)
Output Voltage Range输出电压范围	5-30V dc @ 2.0A resistive
Channel output State Indication 状态指示	 Red LED, (ON, Every Channel)
Isolation Between Channel & Channel 通道隔离	Yes
Switching Frequency 接点切换频率 · Resistance Load · Inductance Load	 1 HZ Maximum, 0.5HZ Maximum,
Relay Contact Life (24VDC) 触电寿命	2A：0.05x1000000
Isolation Test Voltage绝缘测试电压	500V DC
Cable Len 电缆长度 · Non Shield 非屏蔽 · Shield 屏蔽	 600m 1000m

I.S. Analog Input Module 本安型模拟量输入模块	
Module Description模块描述	8 PointsHigh Level Analog, Voltage and Current
Type 型号	TCM-1118/36-8AI,
Number of Points通道数	8 Channels (Individually isolated)
Channel Input State Indication 通道指示	Green LED, (Every Channel)
Isolation Between Channel & Channel 通道隔离	Yes
Input Voltage Range 输入电压范围 Input Current Range 输入电流范围	± 10 volts, 0 to 10 volts, 0 to 5 volts 4 to 20 mA (internal 250 Ω resistor)
Voltage Resolution电压分辨率 · ± 10 volt range · 0 to 10 volt range · 0 to 5 volt range Current Resolution 4 to 20mA 电流分辨率	16 bits (all following) 320 μV 160 μV 80 μV 320 ηA
Input Impedance 输入阻抗 · Voltage · Current	 Greater than 1.0 MΩ 250 Ω
Normal Mode Noise Rejection 正常模式下噪声抑制比 Common Mode Rejection 共模抑制比	Greater than 33 dB @ 50 Hz Greater than 60 dB @ 60 Hz 100 dB @ 50/60 Hz
Channel Bandwidth带宽	20 Hz(-3dB)
Over voltage Capability 过电压能力	Continuous at room temperature (both) 在持续室温条件下 35 VDC (Voltage) 40Madc (Current)
Input Offset Drift with Temperature 温漂	<90 μV/°C(Voltage) <360 ηA/°C typical (Current)
Gain Drift with Temperature 增益漂移	15 ppm/°C (Voltage); 20 ppm/°C (Current)
Isolation Test Voltage绝缘测试电压	500V DC
Cable Len, Shield, Max 电缆长度	200m
I.S. Analog Output Module 本安型模拟量输出模块	
Module Description 模块描述	4 Analog Output Module. Voltage or Current
Type 型号	TCM-1118/36-4AO
Number of Points 通道数	4 Channels (Individually isolated)
Channel output State Indication 状态指示	Red LED, (ON, Every Channel)
Isolation Between Channel & Channel 通道隔离	Yes
Voltage Output Range 输出电压范围 Current Output Range 输出电流范围	0 to 10 V 4 to 20 mA
Drive Capability带载容量	>2000 Ω (Voltage) 0-750Ω (Current)

Short Circuit Protection 短路保护 · Short Circuit Current Max. 短路电流，最大	Yes 40MA
Open Circuit Voltage 开路电压，最大	18V
Resolution 分辩率	16 位
Module Update Rate for All Channels 转换速度	25ms
Output Settling Time 输出时间	Less than 2 ms to 95% of final value with resistive loads
Output Offset Drift with Temperature 输出温漂	50 µV/°C typical (voltage) 100 nA/°C typical (current)
Output Gain Drift with Temperature 输出增益温漂	25 ppm/°C maximum (voltage) 50 ppm/°C maximum (current)
Output Error Over Full Temp. Range 输出误差	0.15% of range(Voltage) 0.3% of range (Current)
Isolation Test Voltage绝缘测试电压	500V DC
Cable Len, Shield, Max, 电缆长度	200m

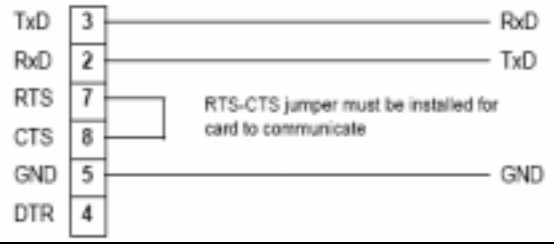
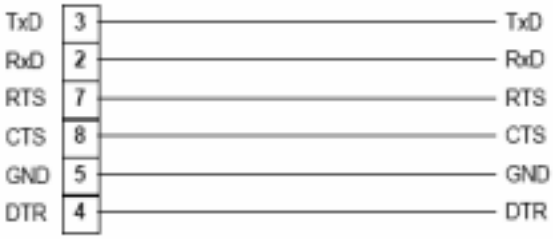
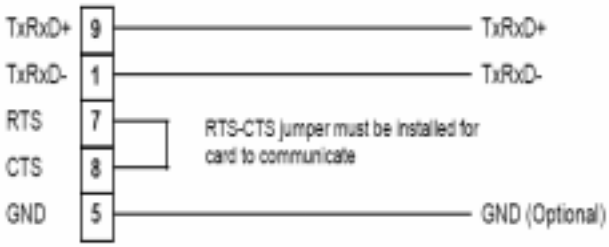
6. Intrinsically Safe Modbus Unit 本安型 Modbus 单元

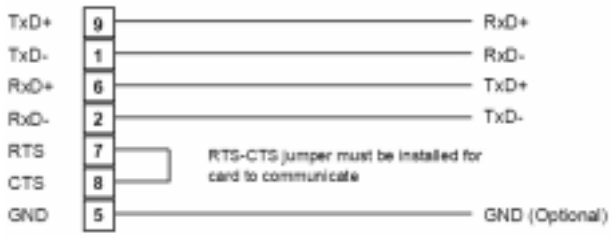
FSK → Modbus，Profibus-DP

Parameter	Specification
Type 型号	TCM-1118/52
Front view of the Controller Unit, Master Mode 前面板图	
Front view of the Controller Unit, Slave Mode 前面板图	
Module Description 模块描述	The Unit converts Modbus Interface to Profibus FSK/DP Interface.
Profile Support 支持接口	FSK Profibus, Modbus
Number of FSK Interface	1
Number of Modbus Port	2
Intrinsically Safe Power Supply: 供电电源 -Rated Voltage（V）额定电压 -Voltage Fluctuating Range 电压波动范围 -Rated Current（mA）, Max. 所需电流 -Reversal Polarity Protection 反极性保护 -Short Protection 短路保护	 12VDC ± 20%（12VDC） 1000mA Yes Inner Fast Fuse, 250 V, 5A

-Isolation Voltage 绝缘测试电压	500V DC
Diagnostics and Troubleshooting 诊断显示	4 x 16 characters LCD (with Back Light)
Operation 操作	Metal Keyboard 金属键盘
Protection 防护等级	IP67
Operating Temperature, °C 工作温度	Ta := - 20°C to +60°C
Relative Humidity 相对湿度	≤95%　(25°C)
Atmosphere Pressure 大气压力	80Kpa-106Kpa
Altitude 海拔高度	〈 2000m
Mechanical Dimensions, L x B x H　mm 几何尺寸	120 x 300 x 250 mm
Weight 重量：Kg	~10 Kg
Connection Terminal strips, Min. 端子数量	30, by Phoenix
Connections Port 电源接线嘴 -Connection Port Type 接头类型 -Connection Port Material 材料 -Number of Connection Port 接头数量 -Cable Input Hole 电缆输入孔 -Cable Out Diameter (ϕmm) 电缆外径 · Location 电缆接头位置	螺纹固定式管接头 Screw Thread Fixed Pipe Connection Non-Burning and Non-Halogen 阻燃无卤 5 M20 x 1.5 ϕ6.5-13.5mm On Bottom of the Control Unit housing
I.S. RS485 FSK Interface 本安型 RS485 FSK 接口	
Physical Interface 物理接口	RS485 FSK (Shield)
Interface Protocol 通讯协议	Profibus DP
Profibus Node Type 节点类型	Slave
Baud Rate 通讯速率	9.6K~12Mbps, Auto Adjust
Communication Distance, Max 通讯距离	5Km
Intrinsically power circuit Profibus FSK 本安型 Profibus-FSK 电路参数 -Max. input/output voltage 最大输入/输出电压 -For connection to an data transmission circuit 所联接的数据传输电路	 U0 =16V_{ss} Profibus-M EExI.
Profibus Node Add Range 地址范围	0-125
Profibus Add Set Mode 地址设置方式	DIP Switch
GSD File Description of Profibus to Modbus Master	
Profibus Node Add Range 地址范围	0-125
Number of Modules, Max 可配置最大模块	100
RAM Capability 内存容量 -Max Input Len -Max Output Len -Input Bytes + Output Bytes	 244 Bytes 244 Bytes 488 Bytes

Modbus Port Configure 1. - Modbus Node Type 节点类型 -Protocol Module -Baud Rate 通讯速率 -Data Bits -Parity -Stop Bits -RTS to TXD Delay -RTS Off Delay -Message Response Timeout -Inter-character Timeout -Data Update mode, Between profibus & modbus	Master Modbus RTU 300~115200 bps 7 or 8 No parity, Odd parity, Even parity 1 or 2 0 to 65535 ms 0 to 65535 ms 0 to 65535 ms, and Waiting…… 0 to 65535 ms At one module scan End (default) or At total module scan End		
Modbus Slave address Range/ Module	0-247		
Modbus Communication Status of every Module	Port is Tx or Rx; CRC error; Parity Checkout error Overtime of timeout Etc.		
Modbus Communication Control Word	Start module scan Modus read enable Modbus write enable Reset Modbus Scan		
Available Modbus Function code, Min. 有效的 Modbus 功能码, 必需的	01, Read Coils 02, Read Discrete Inputs 03, Read Holding Registers 04, Read Input Registers 05, Write Single Coil 06, Write Single Register 07, Read Exception Status 15, Write Multiple Coils 16, Write Multiple Register Empty Module: Fill in address		
Modbus RTU ERROR CHECK	CRC 循环冗余校验		
Modbus Master Message Format **Modbus 主站报文格式**	**Data Start Point**	**Data Count**	**GSD Bytes**
01, Read Coils, bit	000000 – 065535	1 –256	IN: 1 - 32
02, Read Discrete Inputs, bit	100000 – 165535	1 –256	In: 1 - 32
03, Read Holding Registers, word	400000 – 465535	1 –60	In: 2-120
04, Read Input Registers, word	300000 – 365535	1 –60	In: 2-120
05, Write Single Coil, bit	000000 – 065535	1	Out: 1-2
06, Write Single Register, word	400000 – 465535	1	Out: 2
07, Read Exception Status			
15, Write Multiple Coils, bit	000000 – 065535	1-256	Out: 1-32
16, Write Multiple Register, word	400000 – 465535	1-32	Out: 2-64
Empty Module			In: 1-244 Out: 1-244

Polling Time Preset/ Every Module	0-65535ms
I.S. Modbus Interface 本安型 Modbus 接口	
Application Interface 应用接口	RS485,RS422, RS232
Number of Port / Modbus Module 每个 Modbus 模块上的接口数量	2, Port 1 and Port 2,
Node Type 节点类型	Master or Slave (set by DIP switch)
Port Select: RS485 or RS422 or RS232 RS485,RS422, RS232 端口选择	Jumper
Communication Distance, RS485&RS422 通讯距离 RS485&RS422	1200m, Max
Communication Distance, RS232 通讯距离 RS232	15m, Max
Rx. & Tx. State Indication 状态指示	2 Green LEDs / Port
Isolation Port each other 通讯口隔离	Yes
Isolation Voltage 绝缘测试电压	500VDC
Cable Connection Diagrams	
RS-232 w/ No Hardware Handshaking Port Connection with another communication port	TCM-1118/52 DB-9 Pin Male PC or Device 
RS-232 w/ Hardware Handshaking Port Connection with a modem or other similar device	TCM-1118/52 DB-9 Pin Male Modem or other Comm Device 
RS-485/2-Wire Connection The jumper on the module must be set in the RS-485 position for all 2-wire applications	TCM-1118/52 DB-9 Pin Male RS-485 Device 

RS-422/4-Wire Connection The jumper on the module must be in the RS-422 position for all 4-wire applications	TCM-1118/52 DB-9 Pin Male RS-485 Device 

7. Intrinsically Safe FDL Coupler Unit 本安型 FDL 耦合器单元

FDL →FSK，Profibus-DP

Parameter	Specification
Type 型号	TCM-1107
Module Description 模块描述	Converting signals from TTY interface or serial RS232 Profibus FDL interface into Profibus FSK
Outline 外形	
Profile Support 支持接口	Profibus DP/FSK, Profibud FDL/TTY or RS232
Number of FSK Interface	1
Number of Profibus FDL Interface Profibus FDL接口数目	2
Intrinsically Safe Power Supply: 供电电源 *Rated Voltage（V）额定电压 *Voltage Fluctuating Range 电压波动范围 *Rated Current（mA）, Max. 所需电流 *Reversal Polarity Protection 反极性保护 *Short Protection 短路保护 *Isolation Voltage 绝缘测试电压	 12VDC ± 20%（12VDC) 200mA Yes Inner Fast Fuse, 250 V, 5A 500V DC
Diagnostics and Troubleshooting诊断显示	4 x 16 characters LCD (with Back Light)
Operation 操作	Metal Keyboard 金属键盘
Protection 防护等级	IP67
Operating Temperature, °C 工作温度	Ta := - 20°C to +60°C
Relative Humidity 相对湿度	≤95% (25°C)
Atmosphere Pressure 大气压力	80Kpa-106Kpa
Altitude 海拔高度	〈2000m
Mechanical Dimensions, L x B x H mm 几何尺寸	120 x 300 x 250 mm
Weight 重量：Kg	~5 Kg
Connection Terminal strips, Min. 端子数量	30, by Phoenix
Connections Port 接线嘴 *Connection Type 接头类型 *Connection Material 材料 *Number of Connection 接头数量 *Cable Input Hole 电缆输入孔 *Cable Out Diameter (ϕmm) 电缆外径 *Location 电缆接头位置	螺纹固定式管接头 Screw Thread Fixed Pipe Connection Non-Burning and Non-Halogen 阻燃无卤 5 M20 x 1.5 ϕ6.5-13.5mm On Bottom of the Control Unit housing

I.S. TTY or RS232 Serial Interface 本安型 Serial 接口	
Available Interface 应用接口	TTY or RS232
Number of Interface 接口数量	2
Port Configure *Protocol Module *Baud Rate 通讯速率 *Data Bits *Parity *Stop Bits *Prior to choice *Transmitter/receiver active or passive	 Profibus FDL 300~38400 bps, adjustable via DIP switch 7 or 8 No parity, Odd parity, Even parity 1 or 2 High or low , (DIP switch) Adjustable
Cable type	L-2YYC(ZG)Y
I.S. RS485 FSK Interface 本安型 RS485 FSK 接口	
Physical Interface 物理接口	RS485 FSK (Shield)
Interface Protocol 通讯协议	Profibus DP
Node Type 节点类型	Slave
Baud Rate 通讯速率	9.6K~12Mbps, Auto Adjust
Communication Distance, Max 通讯距离	5Km
Intrinsically power circuit Profibus FSK 本安型 Profibus-FSK 电路参数 · Max. input/output voltage 最大输入/输出电压 · For connection to an data transmission circuit 所联接的数据传输电路	 U0 =16V_{ss} Profibus-M EExI.
Node Add Range 地址范围	0-125
Add Set Mode 地址设置方式	DIP Switch
Number of Modules in Gsd File, Max 可配置最大模块	20
RAM Capability 内存容量 -Max Input Len -Max Output Len -Input Bytes + Output Bytes	 244 Bytes 244 Bytes 488 Bytes
Available Module of FDL in Gsd File, Min. 有效的模块, 必需的	

8. FSK Profibus DP Repeater，FSK 中继器

FSK ←→FSK，Profibus-DP

Parameter	Specification
Type 型号	TCM-1130A
Module Description 模块描述	The repeater is used to amplify and pass on incoming signals. Extending intrinsically safe underground Profibus networks without loss caused by the resistance of the cable.
Outline 外形	
Profile Support 支持接口	Profibus DP/FSK
Intrinsically Safe Power Supply: 供电电源 -Rated Voltage（V）额定电压 -Voltage Fluctuating Range 电压波动范围 -Rated Current（mA）, Max. 所需电流 -Reversal Polarity Protection 反极性保护 -Short Protection 短路保护 -Isolation Voltage 绝缘测试电压	 12VDC ± 20%（12VDC） 200mA Yes Inner Fast Fuse，250 V, 5A 500V DC
Diagnostics and Troubleshooting诊断显示	4 x 16 characters LCD (with Back Light)
Operation 操作	Metal Keyboard 金属键盘
Baud Rate 通讯速率	9.6K~12Mbps, Auto Adjust
Physical Interface 物理接口	RS485 FSK (Shield)
Communication Distance, Max 通讯距离	5Km
Intrinsically power circuit Profibus FSK 本安型 Profibus-FSK 电路参数 · Max. input/output voltage 最大输入/输出电压 · For connection to an data transmission circuit 所联接的数据传输电路	 U0 =16V_{ss} Profibus-M EExI.
Protection 防护等级	IP67
Operating Temperature, °C 工作温度	Ta := - 20°C to +60°C
Relative Humidity 相对湿度	≤95%　(25°C)
Atmosphere Pressure 大气压力	80Kpa-106Kpa
Altitude 海拔高度	〈2000m
Mechanical Dimensions, L x B x H mm 几何尺寸	120 x 300 x 250 mm

Weight 重量：Kg	~5 Kg
Connections Port 接线嘴 *Connection Type 接头类型 *Connection Material 材料 *Number of Connection 接头数量 *Cable Input Hole 电缆输入孔 *Cable Out Diameter (ϕmm) 电缆外径 *Location 电缆接头位置	螺纹固定式管接头 Screw Thread Fixed Pipe Connection Non-Burning and Non-Halogen 阻燃无卤 3 M20 x 1.5 ϕ6.5-13.5mm On Bottom of the Repeater housing
Connection Terminal strips, Min. 端子数量	10, by Phoenix
I.S. Interface parameters 本安型接口参数	
Input parameters -Intrinsically safe input circuit protection -Max. inner conductivity C -Max. inner Inductivity L	 with EEx ib I negligible 可忽略 15μH

9. Cable Parameter for FSK Profibus DP Cable 电缆规格

Beldon 3079A

Parameter	Specification
Type 型号	Beldon 3079A
Description 描述	Profibus DP, 22 AWG solid bare copper conductors, flame retardant foamed polyethylene insulation, Beldfoil® shield (100% coverage) + 65% tinned copper braid shield, PVC jacket.
Conductor :导线 Number of Pairs: 电缆对数 Total Number of Conductors:电缆芯数 AWG:导线截面 Conductor Diameter: 导线直径 Conductor Material:导线材料	 1 2 22 0.026in. BC - Bare Copper
Insulation :绝缘 Insulation Material:绝缘材料 Lay Length: Pair Diameter:芯线对直径 Pair Color :芯线颜色	FRFPE-Flame Retardant Foam Polyethylene 聚乙烯 2.75 in. .198 in. Red & Green
Inner Shield :内屏蔽层 Inner Shield Material Trade Name: 屏蔽材料 Inner Shield Type:屏蔽层型号 Inner Shield Material: as following sheet: 屏蔽层材料见下表	 Beldfoil® Tape/Braid

Layer Number/ Description	Material Trade Name	Type	Material	% Coverage (%)	Stranding	Diameter (in.)	Conductor Material
1	Beldfoil®	Tape	Aluminum Foil-Polyester Tape	100			
2		Braid	TC - Tinned Copper	65			

Outer Shield Material: 内屏蔽层材料	Unshielded
Outer Jacket Material:电缆外套材料	PVC - Polyvinyl Chloride， PVC 聚乙烯
Overall Nominal Diameter:电缆直径	.315 in.
Applicable Standards :标准 NEC/(UL) Specification: CEC/C(UL) Specification:	 PLTC, CMG CMG
Flame Test :认证 UL Flame Test: CSA Flame Test:	 UL1581 Vertical Tray FT4
Electrical Characteristics :电气参数	

Fitted Impedance:阻抗				
Description	Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Fitted Impedance (Ω)
		3	20	150
Nom. Mutual Capacitance @ 1 KHz:电容		8.5 pF/ft		
Nominal Velocity of Propagation:传播速度		78 %		
Nom. Conductor DC Resistance @ 20 Deg. C: 电阻		16.0 Ω/1000 ft		
Ind. Pair Nominal Shield DC Resistance @ 20 Deg. C: 屏蔽电阻		3.9 Ω/1000 ft		
Nom. Attenuation (dB/100 ft): 衰减				
Description	Frequency (MHz)	Start Frequency (MHz)	Stop Frequency (MHz)	Nom. Attenuation (dB/100 ft.)
	.2			.27
	4.0			.67
	16.0			1.37
	100.0			3.75
	300.0			6.52
Max. Operating Voltage - UL: 最大工作电压		300 V RMS		
Max. Recommended Current, Max. 最大工作电流		2.3 Amps		

10. Appendix - Modbus Protocol Specification, Modbus 协议规格

10.1 Modbus Protocol Introduction Modbus 协议简介

This protocol defines a message structure that controllers will recognize and use, regardless of the type of networks over which they communicate. It describes the process a controller uses to request access to another device, how it will respond to requests from the other devices, and how errors will be detected and reported. It establishes a common format for the layout and contents of message fields.
此协议定义了一个控制器能认识使用的消息结构,而不管它们是经过何种网络进行通信的。它描述了一控制器请求访问其它设备的过程，如何回应来自其它设备的请求，以及怎样侦测错误并记录。它制定了消息域格局和内容的公共格式。

During communications on a Modbus network, the protocol determines how each controller will know its device address, recognize a message addressed to it, determine the kind of action to be taken. If a reply is required, the controller will construct the reply message and send it using Modbus protocol. On other networks, messages containing Modbus protocol are imbedded into the frame or packet structure that is used on the network. This conversion also extends to resolving node addresses, routing paths, and error–checking methods specific to each kind of network.
当在一 Modbus 网络上通信时，此协议决定了每个控制器须要知道它们的设备地址，识别按地址发来的消息，决定要产生何种行动。如果需要回应，控制器将生成反馈信息并用 Modbus 协议发出。在其它网络上，包含了 Modbus 协议的消息转换为在此网络上使用的帧或包结构。这种转换也扩展了根据具体的网络解决节地址、路由路径及错误检测的方法。

Transactions on Modbus Network 在 Modbus 网络上转输

Standard Modbus ports use an RS–232C compatible serial interface that defines connector pinouts, cabling, signal levels, transmission baud rates, and parity checking. Controllers can be networked directly or via modems.
标准的 Modbus 口是使用一 RS-232C 兼容串行接口，它定义了连接口的针脚、电缆、信号位、传输波特率、奇偶校验。控制器能直接或经由 Modem 组网。

Controllers communicate using a master–slave technique, in which only one device (the master) can initiate transactions (called ‘queries’). The other devices (the slaves) respond by supplying the requested data to the master, or by taking the action requested in the query. Typical master devices include host processors and programming panels. Typical slaves include programmable controllers.
控制器通信使用主—从技术，即仅一设备（主设备）能初始化传输（查询）。其它设备（从设备）根据主设备查询提供的数据作出相应反应。典型的主设备：主机和可编程仪表。典型的从设备：可编程控制器。

The master can address individual slaves, or can initiate a broadcast message to all slaves. Slaves return a message (called a ‘response’) to queries that are addressed to them individually. Responses are not returned to broadcast queries from the master.
主设备可单独和从设备通信，也能以广播方式和所有从设备通信。如果单独通信，从设备返回一消息作为回应，如果是以广播方式查询的，则不作任何回应。Modbus 协议建立了主设备查询的格式：设备（或广播）地址、功能代码、所有要发送的数据、一错误检测域。

The Modbus protocol establishes the format for the master’s query by placing into it the device (or broadcast) address, a function code defining the requested action, any data to be sent, and an error–checking field. The slave’s response message

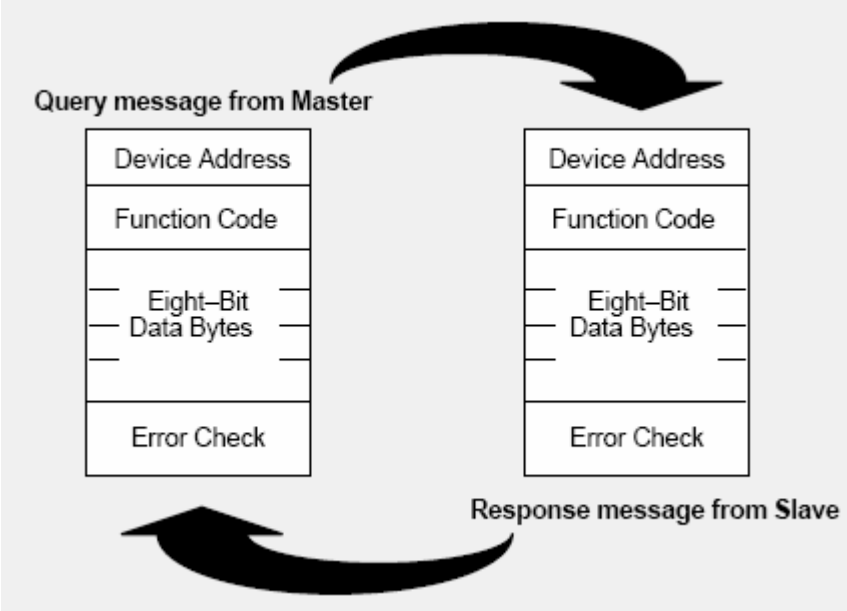
is also constructed using Modbus protocol. It contains fields confirming the action taken, any data to be returned, and an error–checking field. If an error occurred in receipt of the message, or if the slave is unable to perform the requested action, the slave will construct an error message and send it as its response.
从设备回应消息也由 Modbus 协议构成，包括确认要行动的域、任何要返回的数据、和一错误检测域。如果在消息接收过程中发生一错误，或从设备不能执行其命令，从设备将建立一错误消息并把它作为回应发送出去。

Transactions on Other Kinds of Networks在其它类型网络上转输

On these networks, the controllers communicate using a peer–to–peer technique, in which any controller can initiate transactions with the other controllers. Thus a controller may operate either as a slave or as a master in separate transactions. Multiple internal paths are frequently provided to allow concurrent processing of master and slave transactions.
在其它网络上，控制器使用对等技术通信，故任何控制都能初始和其它控制器的通信。这样在单独的通信过程中，控制器既可作为主设备也可作为从设备。提供的多个内部通道可允许同时发生的传输进程。

At the message level, the Modbus protocol still applies the master–slave principle even though the network communication method is peer–to–peer. If a controller originates a message, it does so as a master device, and expects a response from a slave device. Similarly, when a controller receives a message it constructs a slave response and returns it to the originating controller.
在消息位，Modbus 协议仍提供了主—从原则，尽管网络通信方法是“ 对等 ”。如果一控制器发送一消息，它只是作为主设备，并期望从从设备得到回应。同样，当控制器接收到一消息，它将建立一从设备回应格式并返回给发送的控制器。

The Query–Response Cycle查询—回应周期



The Query: The function code in the query tells the addressed slave device what kind of action to perform. The data bytes contain any additional information that the slave will need to perform the function. For example, function code 03 will query the slave to read holding registers and respond with their contents. The data field must contain the information telling the slave which register to start at and how many registers to read. The error check field provides a method for the

slave to validate the integrity of the message contents.

查询：查询消息中的功能代码告之被选中的从设备要执行何种功能。数据段包含了从设备要执行功能的任何附加信息。例如功能代码 03 是要求从设备读保持寄存器并返回它们的内容。数据段必须包含要告之从设备的信息：从何寄存器开始读及要读的寄存器数量。错误检测域为从设备提供了一种验证消息内容是否正确的方法。

The Response: If the slave makes a normal response, the function code in the response is an echo of the function code in the query. The data bytes contain the data collected by the slave, such as register values or status. If an error occurs, the function code is modified to indicate that the response is an error response, and the data bytes contain a code that describes the error. The error check field allows the master to confirm that the message contents are valid.
如果从设备产生一正常的回应, 在回应消息中的功能代码是在查询消息中的功能代码的回应. 数据段包括了从设备收集的数据: 象寄存器值或状态。如果有错误发生，功能代码将被修改以用于指出回应消息是错误的，同时数据段包含了描述此错误信息的代码。错误检测域允许主设备确认消息内容是否可用。

10.2 The Two Serial Transmission Modes 两种传输方式

Controllers can be setup to communicate on standard Modbus networks using either of two transmission modes: ASCII or RTU. Users select the desired mode, along with the serial port communication parameters (baud rate, parity mode, etc), during configuration of each controller. The mode and serial parameters must be the same for all devices on a Modbus network .

控制器能设置为两种传输模式（ASCII 或 RTU）中的任何一种在标准的 Modbus 网络通信。用户选择想要的模式，包括串口通信参数（波特率、校验方式等），在配置每个控制器的时候，在一个 Modbus 网络上的所有设备都必须选择相同的传输模式和串口参数。

The selection of ASCII or RTU mode pertains only to standard Modbus networks. It defines the bit contents of message fields transmitted serially on those networks. It determines how information will be packed into the message fields and decoded. On other networks like MAP and Modbus Plus, Modbus messages are placed into frames that are not related to serial tranasmission.
所选的 ASCII 或 RTU 方式仅适用于标准的 Modbus 网络，它定义了在这些网络上连续传输的消息段的每一位，以及决定怎样将信息打包成消息域和如何解码。在其它网络上（象 MAP 和 Modbus Plus）Modbus 消息被转成与串行传输无关的帧。

ASCII Mode

Here is not description

RTU Mode

When controllers are setup to communicate on a Modbus network using RTU (Remote Terminal Unit) mode, each 8–bit byte in a message contains two 4–bit hexadecimal characters. The main advantage of this mode is that its greater character density allows better data throughput than ASCII for the same baud rate.
当控制器设为在Modbus网络上以RTU（远程终端单元）模式通信，在消息中的每个8Bit字节包含两个4Bit的十六进制字符。这种方式的主要优点是：在同样的波特率下，可比ASCII方式传送更多的数据。

The format for each byte in RTU mode is:
Coding System: 代码系统:

8–bit binary, hexadecimal 0–9, A–F

8位二进制，十六进制数0...9，A...F

Two hexadecimal characters contained in each 8–bit field of the message

消息中的每个8位域都是一个两个十六进制字符组成每个字节的位

Bits per Byte:

1 start bit

1个起始位

8 data bits, least significant bit sent first

8个数据位，最小的有效位先发送

1 bit for even/odd parity; no bit for no parity

1个奇偶校验位，无校验则无

1 stop bit if parity is used; 2 bits if no parity

1个停止位（有校验时），2个Bit（无校验时）

Error Check Field: 错误检测域:

Cyclical Redundancy Check (CRC)

CRC(循环冗长检测)

10.3 Modbus Message Framing

In either of the two serial transmission modes (ASCII or RTU), a Modbus message is placed by the transmitting device into a frame that has a known beginning and ending point. This allows receiving devices to begin at the start of the message, read the address portion and determine which device is addressed (or all devices, if the message is broadcast), and to know when the message is completed. Partial messages can be detected and errors can be set as a result.

两种传输模式中（ASCII或RTU），传输设备以将Modbus消息转为有起点和终点的帧，这就允许接收的设备在消息起始处开始工作，读地址分配信息，判断哪一个设备被选中（广播方式则传给所有设备），判知何时信息已完成。部分的消息也能侦测到并且错误能设置为返回结果。

ASCII Framing, ASCII帧

Here is not description

RTU Framing, RTU帧

In RTU mode, messages start with a silent interval of at least 3.5 character times. This is most easily implemented as a multiple of character times at the baud rate that is being used on the network (shown as T1–T2–T3–T4 in the figure below). The first field then transmitted is the device address.

使用RTU模式，消息发送至少要以3.5个字符时间的停顿间隔开始。在网络波特率下多样的字符时间，这是最容易实现的(如下图的T1-T2-T3-T4所示)。传输的第一个域是设备地址。

The allowable characters transmitted for all fields are hexadecimal 0–9, A–F.Networked devices monitor the network bus continuously, including during the ‘silent’ intervals. When the first field (the address field) is received, each device decodes it to find out if it is the addressed device.

可以使用的传输字符是十六进制的 `0...9,A...F`。网络设备不断侦测网络总线，包括停顿间隔时间内。当第一个域（地址域）接收到，每个设备都进行解码以判断是否发往自己的。

Following the last transmitted character, a similar interval of at least 3.5 character times marks the end of the message. A new message can begin after this interval.
在最后一个传输字符之后，一个至少3.5个字符时间的停顿标定了消息的结束。一个新的消息可在此停顿后开始。

The entire message frame must be transmitted as a continuous stream. If a silent interval of more than 1.5 character times occurs before completion of the frame, the receiving device flushes the incomplete message and assumes that the next byte will be the address field of a new message.
整个消息帧必须作为一连续的流转输。如果在帧完成之前有超过 1.5 个字符时间的停顿时间，接收设备将刷新不完整的消息并假定下一字节是一个新消息的地址域。

Similarly, if a new message begins earlier than 3.5 character times following a previous message, the receiving device will consider it a continuation of the previous message. This will set an error, as the value in the final CRC field will not be valid for the combined messages. A typical message frame is shown below.
同样地，如果一个新消息在小于3.5个字符时间内接着前个消息开始，接收的设备将认为它是前一消息的延续。这将导致一个错误，因为在最后的CRC域的值不可能是正确的。一典型的消息帧如下所示：

START	ADDRESS	FUNCTION	DATA	CRC CHECK	END
T1-T2-T3-T4	8Bit	8Bit	n 个 8Bit	16Bit	T1-T2-T3-T4

RTU Message Frame RTU消息帧

How the Address Field is Handled 如何处理地址域

The address field of a message frame contains two characters (ASCII) or eight bits (RTU). Valid slave device addresses are in the range of 0 – 247 decimal. The individual slave devices are assigned addresses in the range of 1 – 247. A master addresses a slave by placing the slave address in the address field of the message. When the slave sends its response, it places its own address in this address field of the response to let the master know which slave is responding.
消息帧的地址域包含两个字符（ASCII）或 8Bit（RTU）。可能的从设备地址是 0...247 (十进制)。单个设备的地址范围是 1...247。主设备通过将要联络的从设备的地址放入消息中的地址域来选通从设备。当从设备发送回应消息时，它把自己的地址放入回应的地址域中，以便主设备知道是哪一个设备作出回应。

Address 0 is used for the broadcast address, which all slave devices recognize. When Modbus protocol is used on higher level networks, broadcasts may not be allowed or may be replaced by other methods.
地址 0 是用作广播地址，以使所有的从设备都能认识。当 Modbus 协议用于更高水准的网络，广播可能不允许或以其它方式代替。

10.4 How the Function Field is Handled 如何处理功能域

The function code field of a message frame contains two characters (ASCII) or eight bits (RTU). Valid codes are in the range of 1 – 255 decimal. Of these, some codes are applicable to all Modicon controllers, while some codes apply only to certain models, and others are reserved for future use.
消息帧中的功能代码域包含了两个字符（ASCII）或 8Bits（RTU）。可能的代码范围是十进制的 1...255。当然，有些代码是适用于所有控制器，有此是应用于某种控制器，还有些保留以备后用。

When a message is sent from a master to a slave device the function code field tells the slave what kind of action to perform. Examples are to read the ON/OFF states of a group of discrete coils or inputs; to read the data contents of a group of

registers; to read the diagnostic status of the slave; to write to designated coils or registers; or to allow loading, recording, or verifying the program within the slave.
当消息从主设备发往从设备时，功能代码域将告之从设备需要执行哪些行为。例如去读取输入的开关状态，读一组寄存器的数据内容，读从设备的诊断状态，允许调入、记录、校验在从设备中的程序等。

When the slave responds to the master, it uses the function code field to indicate either a normal (error–free) response or that some kind of error occurred (called an exception response). For a normal response, the slave simply echoes the original function code. For an exception response, the slave returns a code that is equivalent to the original function code with its most–significant bit set to a logic 1.
当从设备回应时，它使用功能代码域来指示是正常回应(无误)还是有某种错误发生（称作异议回应）。对正常回应，从设备仅回应相应的功能代码。对异议回应，从设备返回一等同于正常代码的代码，但最重要的位置为逻辑 1。

For example, a message from master to slave to read a group of holding registers would have the following function code:
例如：一从主设备发往从设备的消息要求读一组保持寄存器，将产生如下功能代码：

0000 0011 (Hexadecimal 03)

If the slave device takes the requested action without error, it returns the same code in its response. If an exception occurs, it returns:
对正常回应，从设备仅回应同样的功能代码。对异议回应，它返回：

1000 0011 (Hexadecimal 83)

In addition to its modification of the function code for an exception response, the slave places a unique code into the data field of the response message. This tells the master what kind of error occurred, or the reason for the exception.
除功能代码因异议错误作了修改外，从设备将一独特的代码放到回应消息的数据域中，这能告诉主设备发生了什么错误。

The master device's application program has the responsibility of handling exception responses. Typical processes are to post subsequent retries of the message, to try diagnostic messages to the slave, and to notify operators.
主设备应用程序得到异议的回应后，典型的处理过程是重发消息，或者诊断发给从设备的消息并报告给操作员。

Contents of the Data Field数据域

The data field is constructed using sets of two hexadecimal digits, in the range of 00 to FF hexadecimal. These can be made from a pair of ASCII characters, or from one RTU character, according to the network's serial transmission mode.
数据域是由两个十六进制数集合构成的，范围00...FF。根据网络传输模式，这可以是由一对ASCII字符组成或由一RTU字符组成。

The data field of messages sent from a master to slave devices contains additional information which the slave must use to take the action defined by the function code. This can include items like discrete and register addresses, the quantity of items to be handled, and the count of actual data bytes in the field.
从主设备发给从设备消息的数据域包含附加的信息：从设备必须用于进行执行由功能代码所定义的所为。这包括了象不连续的寄存器地址，要处理项的数目，域中实际数据字节数。

For example, if the master requests a slave to read a group of holding registers (function code 03), the data field specifies the starting register and how many registers are to be read. If the master writes to a group of registers in the slave (function code

10 hexadecimal), the data field specifies the starting register, how many registers to write, the count of data bytes to follow in the data field, and the data to be written into the registers.
例如，如果主设备需要从设备读取一组保持寄存器（功能代码 03），数据域指定了起始寄存器以及要读的寄存器数量。如果主设备写一组从设备的寄存器（功能代码 10 十六进制），数据域则指明了要写的起始寄存器以及要写的寄存器数量，数据域的数据字节数，要写入寄存器的数据。

If no error occurs, the data field of a response from a slave to a master contains the data requested. If an error occurs, the field contains an exception code that the master application can use to determine the next action to be taken.
如果没有错误发生，从从设备返回的数据域包含请求的数据。如果有错误发生，此域包含一异议代码，主设备应用程序可以用来判断采取下一步行动。

The data field can be nonexistent (of zero length) in certain kinds of messages. For example, in a request from a master device for a slave to respond with its communications event log (function code 0B hexadecimal), the slave does not require any additional information.
在某种消息中数据域可以是不存在的（0 长度）。例如，主设备要求从设备回应通信事件记录（功能代码 0B 十六进制），从设备不需任何附加的信息。

Contents of the Error Checking Field错误检测域

Two kinds of error–checking methods are used for standard Modbus networks. The error checking field contents depend upon the method that is being used.
标准的Modbus网络有两种错误检测方法。错误检测域的内容视所选的检测方法而定。

ASCII
When ASCII mode is used for character framing, the error checking field contains two ASCII characters. The error check characters are the result of a Longitudinal Redundancy Check (LRC) calculation that is performed on the message contents, exclusive of the beginning ‘colon’ and terminating CRLF characters. The LRC characters are appended to the message as the last field preceding the CRLF characters
当选用ASCII模式作字符帧，错误检测域包含两个ASCII字符。这是使用LRC（纵向冗长检测）方法对消息内容计算得出的，不包括开始的冒号符及回车换行符。LRC字符附加在回车换行符前面。

RTU
When RTU mode is used for character framing, the error checking field contains a 16–bit value implemented as two 8–bit bytes. The error check value is the result of a Cyclical Redundancy Check calculation performed on the message contents.
The CRC field is appended to the message as the last field in the message. When this is done, the low–order byte of the field is appended first, followed by the high–order byte. The CRC high–order byte is the last byte to be sent in the message.
当选用RTU模式作字符帧，错误检测域包含一16Bits值(用两个8位的字符来实现)。错误检测域的内容是通过对消息内容进行循环冗长检测方法得出的。CRC域附加在消息的最后，添加时先是低字节然后是高字节。故CRC的高位字节是发送消息的最后一个字节。

10.5 How Characters are Transmitted Serially字符的连续传输

When messages are transmitted on standard Modbus serial networks, each character or byte is sent in this order (left to right):

当消息在标准的 Modbus 系列网络传输时，每个字符或字节以如下方式发送（从左到右）：

Least Significant Bit (LSB) . . . Most Significant Bit (MSB)
最低有效位...最高有效位

With ASCII character framing, the bit sequence is:
使用ASCII字符帧时，位的序列是：

With Parity Checking有奇偶校验

Start	1	2	3	4	5	6	7	Par	Stop

Without Parity Checking

Star	1	2	3	4	5	6	7	Stop	Stop

Bit Order (ASCII) 位顺序（ASCII）

With RTU character framing, the bit sequence is:
使用RTU字符帧时，位的序列是：

With Parity Checking有奇偶校验

Start	1	2	3	4	5	6	7	Par	Stop

Without Parity Checking

Star	1	2	3	4	5	6	7	Stop	Stop

Bit Order (RTU) 位顺序（RTU）

. Error Checking Methods错误检测方法

Standard Modbus serial networks use two kinds of error checking. Parity checking (even or odd) can be optionally applied to each character. Frame checking (LRC or CRC) is applied to the entire message. Both the character check and message frame check are generated in the master device and applied to the message contents before transmission. The slave device checks each character and the entire message frame during receipt.
标准的 Modbus 串行网络采用两种错误检测方法。奇偶校验对每个字符都可用，帧检测（LRC 或 CRC）应用于整个消息。它们都是在消息发送前由主设备产生的，从设备在接收过程中检测每个字符和整个消息帧。

The master is configured by the user to wait for a predetermined timeout interval before aborting the transaction. This interval is set to be long enough for any slave to respond normally. If the slave detects a transmission error, the message will not be acted upon. The slave will not construct a response to the master. Thus the timeout will expire and allow the master's program to handle the error. Note that a message addressed to a nonexistent slave device will also cause a timeout.
用户要给主设备配置一预先定义的超时时间间隔，这个时间间隔要足够长，以使任何从设备都能作为正常反应。如果从设备测到一传输错误，消息将不会接收，也不会向主设备作出回应。这样超时事件将触发主设备来处理错误。发往不存在的从设备的地址也会产生超时。

10.6 Parity Checking奇偶校验

Users can configure controllers for Even or Odd Parity checking, or for No Parity checking. This will determine how the parity

bit will be set in each character.
用户可以配置控制器是奇或偶校验，或无校验。这将决定了每个字符中的奇偶校验位是如何设置的。
If either Even or Odd Parity is specified, the quantity of 1 bits will be counted in the data portion of each character (seven data bits for ASCII mode, or eight for RTU).
如果指定了奇或偶校验，“ 1”的位数将算到每个字符的位数中（ASCII模式7个数据位，RTU中8个数据位）。

For example, these eight data bits are contained in an RTU character frame:
例如RTU字符帧中包含以下8个数据位：

1 1 0 0 0 1 0 1

The total quantity of 1 bits in the frame is four. If Even Parity is used, the frame's parity bit will be a 0, making the total quantity of 1 bits still an even number (four). If Odd Parity is used, the parity bit will be a 1, making an odd quantity (five).
整个 “ 1”的数目是4个。如果便用了偶校验，帧的奇偶校验位将是0，便得整个“1”的个数仍是4个。如果便用了奇校验，帧的奇偶校验位将是1，便得整个“1”的个数是5个。

If No Parity checking is specified, no parity bit is transmitted and no parity check can be made. An additional stop bit is transmitted to fill out the character frame.
如果没有指定奇偶校验位，传输时就没有校验位，也不进行校验检测。代替一附加的停止位填充至要传输的字符帧中。

LRC Checking　　LRC校验

In ASCII mode, messages include an error–checking field that is based on a Longitudinal Redundancy Check (LRC) method. The LRC field checks the contents of the message, exclusive of the beginning ‘colon’ and ending CRLF pair.
使用ASCII模式，消息包括了一基于LRC方法的错误检测域。LRC域检测了消息域中除开始的冒号及结束的回车换行号外的内容。

The LRC field is one byte, containing an 8–bit binary value. The LRC value is calculated by the transmitting device, which appends the LRC to the message. The receiving device calculates an LRC during receipt of the message, and compares the calculated value to the actual value it received in the LRC field. If the two values are not equal, an error results. The LRC is calculated by adding together successive 8–bit bytes of the message, discarding any carries,
LRC域是一个包含一个8位二进制值的字节。LRC值由传输设备来计算并放到消息帧中，接收设备在接收消息的过程中计算LRC，并将它和接收到消息中LRC域中的值比较，如果两值不等，说明有错误。 LRC方法是将消息中的8Bit的字节连续累加，丢弃了进位。

CRC Checking　　CRC校验

In RTU mode, messages include an error–checking field that is based on a Cyclical Redundancy Check (CRC) method. The CRC field checks the contents of the entire message.
使用RTU模式，消息包括了一基于CRC方法的错误检测域。CRC域检测了整个消息的内容。

The CRC field is two bytes, containing a 16–bit binary value. The CRC value is calculated by the transmitting device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.
CRC域是两个字节，包含一16位的二进制值。它由传输设备计算后加入到消息中。接收设备重新计算收到消息的CRC，并与接收到的CRC域中的值比较，如果两值不同，则有误。

The CRC is started by first preloading a 16–bit register to all 1's. Then a process begins of applying successive 8–bit bytes of the message to the current contents of the register. Only the eight bits of data in each character are used for generating the CRC. Start and stop bits, and the parity bit, do not apply to the CRC.
CRC是先调入一值是全"1"的16位寄存器，然后调用一过程将消息中连续的8位字节各当前寄存器中的值进行处理。仅每个字符中的8Bit数据对CRC有效，起始位和停止位以及奇偶校验位均无效。

During generation of the CRC, each 8–bit character is exclusive ORed with the register contents. Then the result is shifted in the direction of the least significant bit (LSB), with a zero filled into the most significant bit (MSB) position. The LSB is extracted and examined. If the LSB was a 1, the register is then exclusive Ored with a preset, fixed value. If the LSB was a 0, no exclusive OR takes place. This process is repeated until eight shifts have been performed. After the last (eighth) shift, the next 8–bit byte is exclusive ORed with the register's current value, and the process repeats for eight more shifts as described above. The final contents of the register, after all the bytes of the message have been applied, is the CRC value.
CRC产生过程中，每个8位字符都单独和寄存器内容相或（OR），结果向最低有效位方向移动，最高有效位以0填充。LSB被提取出来检测，如果LSB为1，寄存器单独和预置的值或一下，如果LSB为0，则不进行。整个过程要重复8次。在最后一位（第8位）完成后，下一个8位字节又单独和寄存器的当前值相或。最终寄存器中的值，是消息中所有的字节都执行之后的CRC值。

When the CRC is appended to the message, the low-order byte is appended first, followed by the high-order byte.
CRC添加到消息中时，低字节先加入，然后高字节。

ModBus功能码

功能码	名称	作用
01	Read Coil Status 读取线圈状态	取得一组逻辑线圈的当前状态（ON/OFF）
02	Read Input Status 读取输入状态	取得一组开关输入的当前状态（ON/OFF）
03	Read Holding Registers 读取保持寄存器	在一个或多个保持寄存器中取得当前的二进制值
04	Read Input Registers 读取输入寄存器	在一个或多个输入寄存器中取得当前的二进制值
05	Force Single Coil 强置单线圈	强置一个逻辑线圈的通断状态
06	Preset Single Register 预置单寄存器	把具体二进值装入一个保持寄存器
07	Read Exception Status 读取异常状态	取得8个内部线圈的通断状态，这8个线圈的地址由控制器决定，用户逻辑可以将这些线圈定义，以说明从机状态，短报文适宜于迅速读取状态
15	Force Multiple Coils 强置多线圈	强置一串连续逻辑线圈的通断
16	Preset Multiple Registers 预置多寄存器	把具体的二进制值装入一串连续的保持寄存器

10.7 Function Codes Description

10.7.1 Read Output Status (Function Code 01)

Query

This function allows the user to obtain the ON/OFF status of logic coils used to control discrete outputs from the addressed slave only. Broadcast mode is not supported with this function code. In addition to the slave address and function fields, the message requires that the information field contain the initial coil address to be read (Starting Address) and the number of locations that will be interrogated to obtain status data.

The addressing allows up to 2000 coils to be obtained at each request; however, the specific slave device may have restrictions that lower the maximum quantity. The coils are numbered from zero; (coil number 1 = zero, coil number 2 = one, coil number 3 = two, etc.).

Figure C1 is a sample read output status request to read coils 0020 to 0056 from slave device number 11.

ADR	FUNC	DATA START PT HO	DATA START PT LO	DATA #OF PTS HO	DATA# OF PTS LO	ERROR CHECK FIELD
11	01	00	13	00	25	CRC

Figure C1 Read Output Status Query Message

Response

An example response to Read Output Status is as shown in Figure C2. The data is packed one bit for each coil. The response includes the slave address, function code, quantity of data characters, the data characters, and error checking. Data will be packed with one bit for each coil (1 = ON, 0 = OFF). The low order bit of the first character contains the addressed coil, and the remainder follow. For coil quantities that are not even multiples of eight, the last characters will be filled in with zeros at high order end. The quantity of data characters is always specified asquantity of RTU characters, i.e., the number is the same whether RTU or ASCII is used.

Since the slave interface device is serviced at the end of a controller's scan, data will reflect coil status at the end of the scan. Some slaves will limit the quantity of coils provided each scan; thus, for large coil quantities, multiple PC transactions must be made using coil status from sequential scans.

ADR	FUNC	BYTE COUNT	DATA COIL STATUS 20-27	DATA COIL STATUS 28-35	DATA COIL STATUS 36-43	DATA COIL STATUS 44-51	DATA COIL STATUS 52-56	ERROR CHECK FIELD
11	01	05	CD	6B	B2	OE	1B	CRC

Figure C2 Read Output Status Response Message

The status of coils 20-27 is shown as CD(HEX) = 1100 1101 (Binary). Reading left to right, this shows that coils 27, 26, 23, 22, and 20 are all on. The other coil data bytes are decoded similarly. Due to the quantity of coil statuses requested, the last data field, which is shown 1B (HEX) = 0001 1011 (Binary), contains the status of only 5 coils (52-56) instead of 8 coils. The 3 left most bits are provided as zeros to fill the 8-bit format.

10.7.2 Read Input Status (Function Code 02)

Query

This function allows the user to obtain the ON/OFF status of discrete inputs in the addressed slave PC Broadcast mode is not supported with this function code. In addition to the slave address and function fields, the message requires that the information field contain the initial input address to be read (Starting Address) and the number of locations that will be interrogated to obtain status data.

The addressing allows up to 2000 inputs to be obtained at each request; however, the specific slave device may have restrictions that lower the maximum quantity. The inputs are numbered form zero; (input 10001 = zero, input 10002 =one, input 10003 = two, etc., for a 584).

Figure C3 is a sample read input status request to read inputs 10197 - 10218 from slave number 11.

ADR	FUNC	DATA START PT HO	DATA START PT LO	DATA #OF PTS HO	DATA# OF PTS LO	ERROR CHECK FIELD
11	02	00	C4	00	16	CRC

Figure C3 Read Input Status Query Message

Response

An example response to Read input status is as shown in Figure C4. The data is packed one bit for each input. The response includes the slave address, function code, quantity of data characters, the data characters, and error checking. Data will be packed with one bit for each input (1=ON, 0=OFF). The lower order bit of the first character contains the addressed input, and the remainder follow. For input quantities that are not even multiples of eight, the last characters will be filled in with zeros at high order end. The quantity of data characters is always specified as a quantity of RTU characters, i.e., the number is the same whether RTU or ASCII is used.

Since the slave interface device is serviced at the end of a controller's scan, data will reflect input status at the end of the scan. Some slaves will limit the quantity of inputs provided each

scan; thus, for large coil quantities, multiple PC transactions must be made using coil status for sequential scans.

ADR	FUNC	BYTE COUNT	DATA DISCRETE INPUT 10197-10204	DATA DISCRETE INPUT 10205-10212	DATA DISCRETE INPUT 10213-10218	ERROR CHECK FIELD
11	02	03	AC	DB	35	CRC

Figure C4 Read Input Status Response Message

The status of inputs 10197-10204 is shown as AC (HEX) = 10101 1100 (binary). Reading left to right, this show that inputs 10204, 10202, and 10199 are all on. The other input data bytes are decoded similar.

Due to the quantity of input statuses requested, the last data field which is shown as 35 HEX = 0011 0101 (binary) contains the status of only 6 inputs (10213-102180) instead of 8 inputs. The two left-most bits are provided as zeros to fill the 8-bit format.

10.7.3 Read Holding Registers (Function Code 03)

Query

Read holding registers (03) allows the user to obtain the binary contents of holding registers 4xxxx in the addressed slave. The registers can store the numerical values of associated timers and counters which can be driven to external devices. The addressing allows up to 125 registers to obtained at each request; however, the specific slave device may have restriction that lower this maximum quantity. The registers are numbered form zero (40001 = zero, 40002 = one, etc.). The broadcast mode is not allowed.

The example below reads registers 40108 through 40110 from slave 584 number 11.

ADR	FUNC	DATA START REG HO	DATA START REG LO	DATA #OF REG HO	DATA# OF REG LO	ERROR CHECK FIELD
11	03	00	6B	00	03	CRC

Figure C5 Read Holding Register Query Message

Response

The addressed slave responds with its address and the function code, followed by the information field. The information field contains 1 byte describing the quantity of data bytes to be returned. The contents of the registers requested (DATA) are two bytes each, with the binary content right justified within each pair of characters. The first byte includes the high order bits and the second, the low order bits.

Since the slave interface device is normally serviced at the end of the controller's scan, the data will reflect the register content at the end of the scan. Some slaves will limit the quantity of

register content provided each scan; thus for large register quantities, multiple transmissions will be made using register content from sequential scans.

In the example below, the registers 40108-40110 have the decimal contents 555, 0, and 100 respectively.

ADR FUNC		BYTE CNT	H.O. DATA	L.O. DATA	H.O. DATA	L.O. DATA	H.O. DATA	L.O. DATA	ERROR CHECK FIELD
11	03	06	02	2B	00	00	00	64	CRC

Figure C6 Read Holding Register Response Message

10.7.4 Read Input Registers (Function Code 04)

Query

Function code 04 obtains the contents of the controller's input registers at addresses 3xxxx. These locations receive their values from devices connected to the I/O structure and can only be referenced, not altered from within the controller, The addressing allows up to 125 registers to be obtained at each request; however, the specific slave device may have restrictions that lower this maximum quantity. The registers are numbered for zero (30001 = zero, 30002 = one, etc.). Broadcast mode is not allowed.

The example below requests the contents of register 3009 in slave number 11.

ADR	FUNC	DATA START REG HO	DATA START REG LO	DATA #OF REG HO	DATA# OF REG LO	ERROR CHECK FIELD
11	04	00	08	00	01	CRC

Figure C7 Read Input Register Query Message

Response

The addressed slave responds with its address and the function code followed by the information field. The information field contains 1 byte describing the quantity of data bytes to be returned. The contents of the registers requested (DATA) are 2 bytes each, with the binary content right justified within each pair of characters. The first byte includes the high order bits and the second, the low order bits.

Since the slave interface is normally serviced at the end of the controller's scan, the data will reflect the register content at the end of the scan. Each PC will limit the quantity of register contents provided each scan; thus for large register quantities, multiple PC scans will be required, and the data provided will be form sequential scans.

In the example below the register 3009 contains the decimal value 0.

ADR	FUNC	BYTE COUNT	DATA INPUT	DATA INPUT	ERROR CHECK

			REG HO	REG LO	FIELD
11	04	02	00	00	E9

Figure C8 Read Input Register Response Message

10.7.5 Force Single Coil (Function Code 5)

Query

This message forces a single coil either ON or OFF. Any coil that exists within the controller can be forced to either state (ON or OFF). However, since the controller is actively scanning, unless the coil is disabled, the controller can also alter the state of the coil. Coils are numbered from zero (coil 0001 = zero, coil 0002 = one, etc.). The data value 65,280 (FF00 HEX) will set the coil ON and the value zero will turn it OFF; all other values are illegal and will not affect that coil.

The use of slave address 00 (Broadcast Mode) will force all attached slaves to modify the desired coil. The example below is a request to slave number 11 to turn ON coil 0173.

ADR	FUNC	DATA COIL # HO	DATA COIL # LO	DATA ON/OFF IND	DATA	ERROR CHECK FIELD
11	05	00	AC	FF	00	CRC

Figure C9 Force Single Coil Query Message

Response

The normal response to the Command Request is to re-transmit the message as received after the coil state has be altered.

ADR	FUNC	DATA COIL # HO	DATA COIL # LO	DATA ON/OFF IND	DATA	ERROR CHECK FIELD
11	05	00	AC	FF	00	CRC

Figure C10 Force Single Coil Response Message

The forcing of a coil via MODBUS function 5 will be accomplished regardless of whether the addressed coil is disabled or not.
Coils that are reprogrammed in the controller logic program are not automatically cleared upon power up. Thus, if such a coil is set ON by function Code 5 and (even months later), an output is connected to that coil, the output will be "hot".

10.7.6 Preset Single Register (Function Code 06)

Query

Function (06) allows the user to modify the contents of a holding register. Any holding register that exists within the controller can have its contents changed by this message. However,

since the controller is actively scanning, it alsocan alter the content of any holding register at any time. The values are provided in binary up to the maximum capacity of the controller unused high order bits must be set to zero. When used with slave address zero (Broadcast mode) all slave controllers will load the specified register with the contents specified.

ADR	FUNC	DATA START REG HO	DATA START REG LO	DATA #OF REGS HO	DATA #OF REGS LO	ERROR CHECK FIELD
11	06	00	01	00	03	CRC

Figure C11 Preset Single Register Query Message

Response
The response to a preset single register request is to re-transmit the query message after the register has been altered.

ADR	FUNC	DATA REG HI	DATA REG LO	DATA INPUT REG HO	DATA INPUT REG LO	ERROR CHECK FIELD
11	06	00	01	00	03	CRC

Figure C12 Preset Single Register Response Message

10.7.7 Force Multiple Coils (Function Code 15)

Query
This message forces each coil in a consecutive block of coils to a desired ON or OFF state. Any coil that exists within the controller can be forced to either state (ON or OFF). However, since the controller is actively scanning, unless the coils are disabled, the controller can also alter the state of the coil. Coils are numbered from zero (coil 00001 = zero, coil 00002 = one, etc.). The desired status of each coil is packed in the data field, one bit for each coil (1= ON, 0= OFF). The use of slave address 0 (Broadcast Mode) will force all attached slaves to modify the desired coils.

The following example forces 10 coils starting at address 20 (13 HEX). The two data fields, CD =1100 and 00 = 0000 000, indicate that coils 27, 26, 23, 22, and 20 are to be forced on.

ADR	FUNC	H.O. ADD	L.O. ADD	QUANTITY		BYTE CNT	DATA COIL STATUS 20-27	DATA COIL STATUS 28-29	ERROR CHECK FIELD
11	0F	00	13	00	0A	02	CD	00	CRC

Figure C15 Force Multiple Coils Query Message

Response

The normal response will be an echo of the slave address, function code, starting address, and quantity of coils forced.

ADR	FUNC	H.O. ADD	L.O. ADD	QUANTITY		ERROR CHECK FIELD
11	0F	00	13	00	0A	CRC

Figure C16 Force Multiple Coils Response Message

The writing of coils via Modbus function 15 will be accomplished regardless of whether the addressed coils are disabled or not.

Coils that are unprogrammed in the controller logic program are not automatically cleared upon power up. Thus, if such a coil is set ON by function code 15 and (even months later) an output is connected to that coil, the output will be hot.

10.7.8 Preset Multiple Registers (Function Code 16)

Query

Holding registers existing within the controller can have their contents changed by this message (a maximum of 60 registers). However, since the controller is actively scanning, it also can alter the content of any holding register at any time. the values are provided in binary up to the maximum capacity of the controller (16-bit for the 184/384 and 584); unused high order bits must be set to zero. When specified registers with contents specified.

ADR	FUNC	H.O. ADD	L.O. ADD	QUANTITY		BYTE CNT	H.O. DATA	L.O. DATA	H.O. DATA	L.O. DATA	ERROR CHECK FIELD
11	10	00	87	00	02	04	00 0A	01		02	CRC

Figure C13 Preset Multiple Coils Query Message

Response

The normal response to a function 16 query is to echo the address, function code, starting address and number of registers to be loaded.

ADR	FUNC	H.O. ADD	L.O. ADD	QUANTITY		ERROR CHECK FIELD
11	10	00	87	00	02	56

Figure C14 Preset Multiple Registers Response Message