M-Bus Transceiver

PRODUCT DESCRIPTION

The MS721 is a single chip transceiver developed for M-Bus standard (EN1434-3) applications. The MS721 interface circuit can accommodate the voltage difference between slave and master systems. The bus connection has no polarity demand. The circuit is supplied by the master via the bus. Therefore, no additional load is increased for the slave battery. A power-fail function is integrated.

The receiver has dynamic level recognition, and the transmitter has a programmable current source. The MS721 also integrates a 3.3V voltage regulator. After bus fault occurs, the MS721 is in shutdown for delaying over a period of time.

SOP16

FEATURES

- Meet EN1434-3 Standard (for Slave)
- Receiver Logic with Dynamic Level Recognition
- Adjustable Receiving Current via Resistor
- No Polarity Connection
- Power-Fail Function
- Module Voltage Switch
- 3.3V Voltage Source
- Remote Supply
- Up to 9600 Baud in Half Duplex for UART Protocol
- Selection for Slave Power:
  – Supply From M-Bus via Output VDD
  – Supply From M-Bus via Output VDD or From Backup Battery
  – Supply From Battery - M-Bus Active for Only Data Transmission

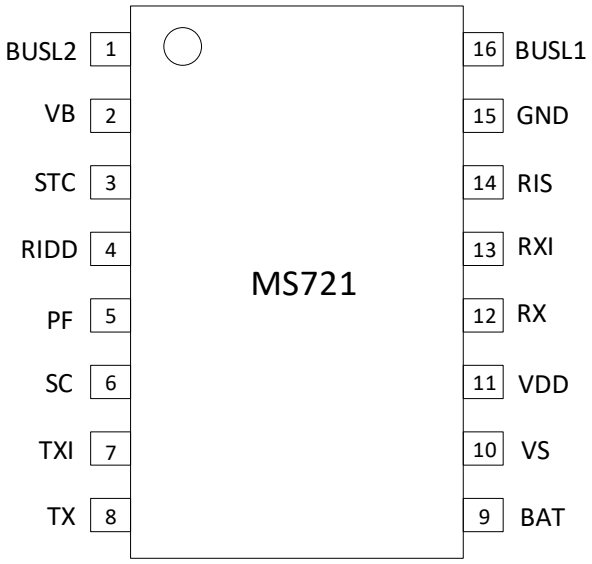
APPLICATIONS

- M-Bus

PRODUCT SPECIFICATION

Part Number	Package	Marking
MS721	SOP16	MS721

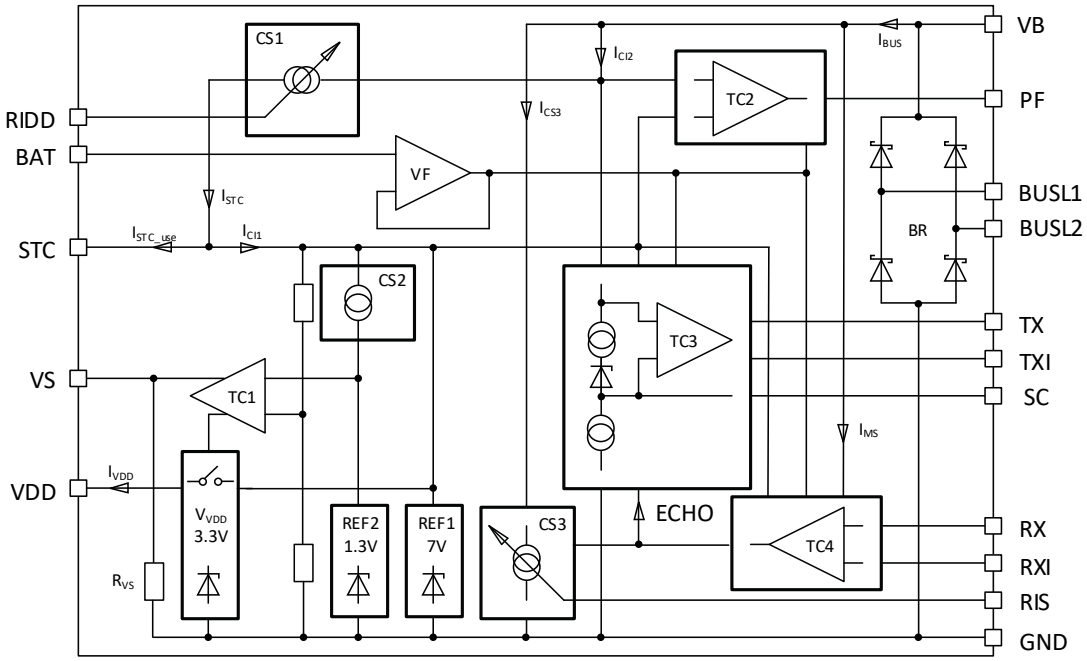
PIN CONFIGURATION



PIN DESCRIPTION

Pin	Name	Description
1	BUSL2	M-Bus Terminal 2
2	VB	Differential Bus Voltage after Rectification
3	STC	Power Supply Capacitor
4	RIDD	Charge Current Adjustment
5	PF	Power Fail Output
6	SC	Sample Capacitor
7	TXI	Data Inverted Output
8	TX	Data Output
9	BAT	Logic Level Adjustment
10	VS	Selection for Bus or Battery Supply Output
11	VDD	Voltage Regulator Output
12	RX	Data Input
13	RXI	Data Inverted Input
14	RIS	Transmitting Current Adjustment
15	GND	Ground
16	BUSL1	M-Bus Terminal 1

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Any exceeding absolute maximum rating application causes permanent damage to device. Because long-time absolute operation state affects device reliability. Absolute ratings just conclude from a series of extreme tests. It doesn't represent chip can operate normally in these extreme conditions.

Parameter		Symbol	Ratings	Unit
Voltage between BUSL1 to BUSL2		V_{MB}	±50	V
Input Voltage	RX, RXI	V_I	-0.3 ~ 5.5	V
	BAT		-0.3 ~ 5.5	
Junction Temperature		T_J	-40 ~ 150	°C
Ambient Temperature		T_A	-40 ~ 100	°C
Storage Temperature		T_{STG}	-65 ~ 150	°C
Thermal Resistance, Junction to Ambient		$R_{\theta JA}$	88	°C/W

RECOMMENDED OPERATING CONDITIONS

All parameters are measured over room temperature range, unless otherwise noted.

Parameter		Symbol	Range		Unit
			Min	Max	
Bus Voltage, |BULS2-BUSL1|	Receiver	V_{MB}	10.8	42	V
	Transmitter		12	42	
Input Voltage	VB (Receiver Mode)	V_I	9.3		V
	BAT		2.5	3.8	
RIDD Resistor		R_{RIDD}	13	80	kΩ
RIS Resistor		R_{RIS}	100		Ω
Ambient Temperature		T_A	-40	100	°C

Note:

1. All voltage values are measured with respect to GND terminal, unless otherwise noted.
2. $V_{BAT(max)} \leq V_{STC}$-1V.

ELECTRICAL CHARACTERISTICS

All parameters are measured over room temperature range, unless otherwise noted.

Parameter	Symbol	Condition		Min	Typ	Max	Unit
Voltage Drop on Rectifier BR	ΔV_{BR}	I_{BUS} = 3mA				1.5	V
Voltage Drop on Current Source CS1	ΔV_{CS1}	R_{RIDD} = 13kΩ				1.8	V
Bus Current	I_{BUS}	V_{STC} = 6.5V, I_{MC} = 0mA	R_{RIDD} = 13kΩ			3	mA
			R_{RIDD} = 30kΩ			1.5	
Bus Current Accuracy	ΔI_{BUS}	ΔV_{BUS} = 10V, I_{MC} = 0mA, R_{RIDD} = 13kΩ to 30kΩ				2	%
Power Supply Current	I_{CC}	V_{STC} = 6.5V, I_{MC} = 0mA, V_{BAT} = 3.8V, R_{RIDD} =13kΩ				650	μA
CI1 Current	I_{CI1}	V_{STC} = 6.5 V, I_{MC} = 0mA, V_{BAT} = 3.8 V, R_{RIDD} = 13kΩ, V_{BUS} = 6.5 V, RX/RXI = off				350	μA
BAT Input Current	I_{BAT}	V_{BAT}=3.8V		-0.5		0.5	μA
BAT + VDD Current	$I_{BAT}+I_{VDD}$	V_{BUS} = 0 V, V_{STC}=0		-0.5		0.5	μA
VDD Output Voltage	V_{VDD}	I_{VDD} = 1mA, V_{STC} = 6.5 V		3.1		3.4	V
VDD Output Impedance	R_{VDD}	I_{VDD} = 2 ~ 8mA, V_{STC} = 4.5 V				5	Ω
STC Voltage	V_{STC}	VDD = on, VS = on		5.6		6.4	V
		VDD = off, VS = off		3.8		4.3	
		I_{VDD} < I_{STC_use}		6.5		7.5	
STC Current	I_{STC_use}	V_{STC} = 5V	R_{RIDD} = 30kΩ	0.65		1.1	mA
			R_{RIDD} = 13kΩ	1.85		2.4	
RIDD Voltage	V_{RIDD}	R_{RIDD} = 30kΩ		1.23		1.33	V
VS Output Voltage	V_{VS}	VDD= on, I_{VS} = -5μA		V_{STC}-0.4		V_{STC}	V
VS Output Impedance	R_{VS}	VDD = off		0.3		1	MΩ
PF Output Voltage	V_{PF}	V_{STC} = 6.5V	V_{VB} = V_{STC}+ 0.8V, I_{PF} = -100μA	V_{BAT}-0.6		V_{BAT}	V
			V_{VB} = V_{STC}+ 0.3V, I_{PF} = 1μA	0		0.6	
			V_{VB} = V_{STC}+ 0.3V, I_{PF} = 5μA	0		0.9	V
Turn-on Time	t_{on}	C_{STC} = 50μF, Bus voltage slew rate: 1V/μs				3	s

Note:

1. All voltage values are measured with respect to GND terminal, unless otherwise noted.
2. Inputs RX/RXI and outputs TX/TXI are open, $I_{CC}=I_{CI1}+I_{CI2}$.

Receiver Electrical Characteristics

All parameters are measured over room temperature range, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
V_T		See Figure 1	MARK-8.2		MARK-5.7	V
SC Voltage	V_{SC}				VVB	V
SC Charge Current	$I_{SCcharge}$	V_{SC} = 24V, V_{VB} = 36 V	-15		-40	μA
SC Discharge Current	$I_{SCdischarge}$	V_{SC} = V_{VB} = 24V	0.3		-0.033× $I_{SCcharge}$	μA
High-level Output Voltage (TX, TXI)	V_{OH}	I_{TX}/I_{TXI} = –100 μA (See Figure 1)	V_{BAT}-0.6		V_{BAT}	V
Low-level Output Voltage(TX, TXI)	V_{OL}	I_{TX}/I_{TXI} = 100μA	0		0.5	V
		I_{TX} = 1.1mA	0		1.5	
TX, TXI Current	I_{TX}/I_{TXI}	V_{TX} = 7.5V, V_{VB} = 12V, V_{STC} = 6V, V_{BAT} = 3.8V			10	μA

Note: All voltage values are measured with respect to GND terminal, unless otherwise noted.

Transmitter Electrical Characteristics

All parameters are measured over room temperature range, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
MC Voltage	I_{MC}	R_{RIS}= 100Ω	11.5		19.5	mA
RIS Voltage	V_{RIS}	R_{RIS}= 100Ω	1.4		1.7	V
		R_{RIS}= 1000Ω	1.5		1.8	
High-level Input Voltage (RX,RXI)	V_{IH}	See Figure 2	V_{BAT}-0.8		5.5	V
Low-level Input Voltage (RX,RXI)	V_{IL}	See Figure 2	0		0.8	V
RX Current	I_{RX}	V_{RX} = V_{BAT} = 3V, V_{VB} = V_{STC} = 0V	-0.5		0.5	μA
		V_{RX} = 0V, V_{BAT} = 3V, V_{STC} = 6.5V	-10		-40	
RXI Current	I_{RXI}	V_{RXI} = V_{BAT} = 3V, V_{VB} = V_{STC} = 0V	10		40	μA
		V_{RXI} = V_{BAT} = 3V, V_{STC} = 6.5V	10		40	

Note:

1. All voltage values are measured with respect to GND terminal, unless otherwise noted.
2. When V_{STC} > 6.5V, $V_{IH(max)}$=5.5V is valid.

FUNCTION DESCRIPTION

Data Transmission, Master to Slave

The mark level on the bus, V_{BUS} = MARK is defined by the difference between BUSL1 and BUSL2 at the slave. It is determined by the distance of master to slave, because distance affects the voltage drop on the wire. To make the receiver without being affected, dynamic reference level on the SC terminal is used for the voltage comparator TC3 (see Figure 1).

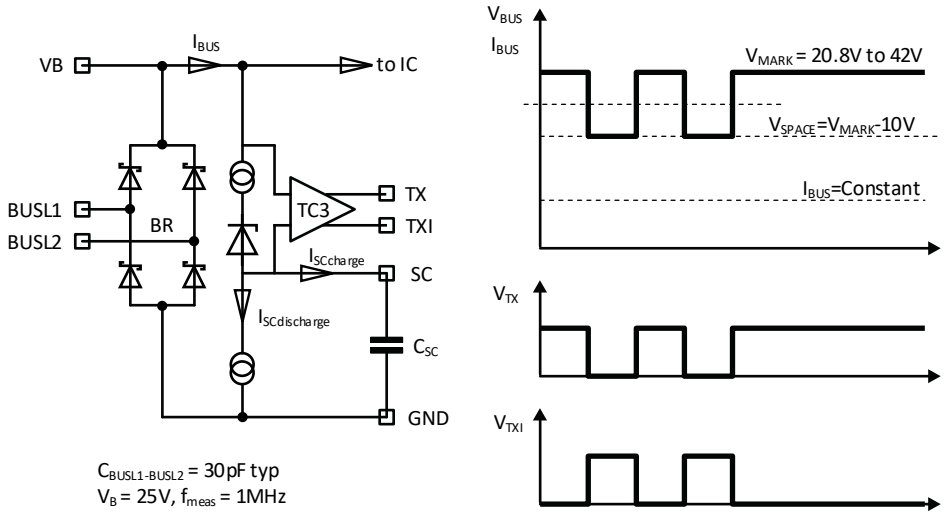


Figure 1. Data Transmission, Master to Slave

A capacitor C_{SC} on SC pin is charged with $I_{SCcharge}$ and is discharged with $I_{SCdischarge}$.

$$I_{SCdischarge} = \frac{I_{SCcharge}}{40}$$

This ratio is necessary to any UART protocol independent of the data contents (for example, the worst case, an 11-bit UART protocol is transmitted with all data bits at 0 and only the stop bit is 1). Thus, there has enough time to charge the capacitor C_{SC}. According to V_{BUS} = SPACE/MARK conditions, the input level detector TC3 detects the bus modulation voltage, and switches the inverted output TXI and the non-inverted output TX。

Data Transmission, Slave to Master

The MS721 adopts current modulation to transmit data from the slave to the master. Bus voltage remains constant during the modulation. Current source modulates the bus current and the master detects the modulation current. Current source CS3 is controlled by the inverted input RXI or the non-inverted input RX. Current source CS3 can be adjusted by external resistor R_{RIS}. The current consumed by modulation circuit is I_{MS} plus current source CS3 during the modulation.

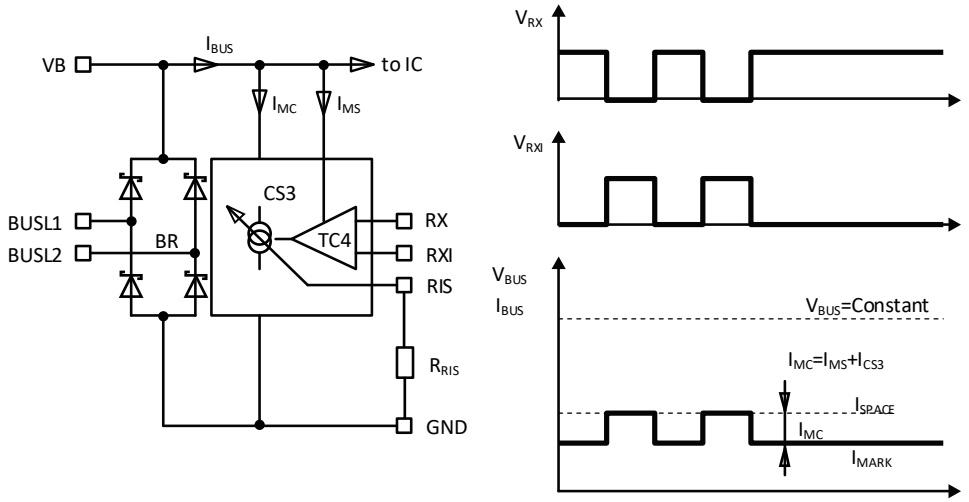
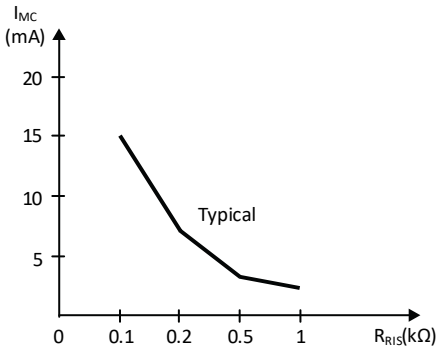


Figure 2. Data Transmission, Slave to Master

Because the MS721 is half-duplex, the input data from RX or RXI is repeated concurrently by ECHO to outputs TX and TXI. If the slave or master sends data via the bus at the same time, outputs TX and TXI are the added input signals, which indicates the data collision occurs on the slave. Bus requires a constant current consumed by each slave. The value of the programmable resistor R_{RIS} can be calculated, according to the formula in Figure 3.



$$R_{RIS}=\frac{V_{RIS}}{I_{CS3}}=\frac{V_{RIS}}{I_{MC}-I_{MS}}$$

V_{RIS}: Voltage on RIS Pin
R_{RIS}: Programmable Resister
I_{CS3}: Programmable Current
I_{MC}: Modulation Current
I_{MS}: Modulation Supply Current (220μA Typ)

Figure 3. Programmable R_{RIS}

Slave Power Supply

The MS721 integrates an internal 3.3V voltage regulator. The power supply of the voltage regulator is provided by the storage capacitor C_{STC} on STC pin. The storage capacitor C_{STC} on STC pin is charged with constant current I_{STC_use} from the current source CS1. The maximum STC voltage is limited to REF1. The charge current I_{STC_use} is determined by external resistor on RIDD pin. R_{RIDD} can be calculated as follows.

$$R_{RIDD}=25\times\frac{V_{RIDD}}{I_{STC}}=25\times\frac{V_{RIDD}}{I_{STC\_use}+I_{IC1}}$$

$I_{STC:}$ CS1 Current

I_{STC_use}: STC Current

I_{CI}: Internal Current

V_{RIDD}: RIDD Voltage

Comparator TC1 monitors the voltage on storage capacitor C_{STC}. Once VSTC voltage reaches V_{VDD_on}, the switch S_{VDD} connects V_{VDD} to VDD pin. If V_{STC} voltage drops to V_{VDD_off}, VDD is turned off. The relationship between voltage variation on the capacitor C_{STC} and bus current is as shown in Figure 4 .

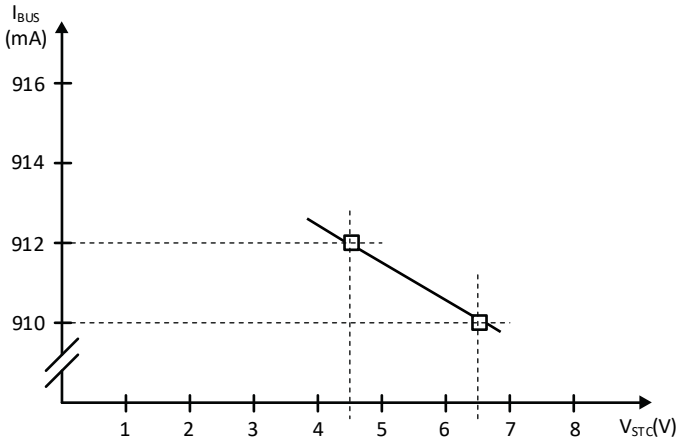


Figure 4. Bus Load in Single Mode

When bus fault occurs,shutdown time of VDD (t_{off}) is determined by system current I_{VDD} and the value of capacitor C_{STC}. And data storage needs to be completed within the time period. Figure 5 shows the relationship between V_{VDD_off}, t_{off} and C_{STC} after bus voltage V_{BUS} is in shutdown.

VS output terminal shows the slave system is powered by bus or battery. VS output is synchronized with VDD and are all controlled by the comparator TC1. An external transistor is connected on VS output terminal, which can switch between the bus and battery.

Power Up/Power Down

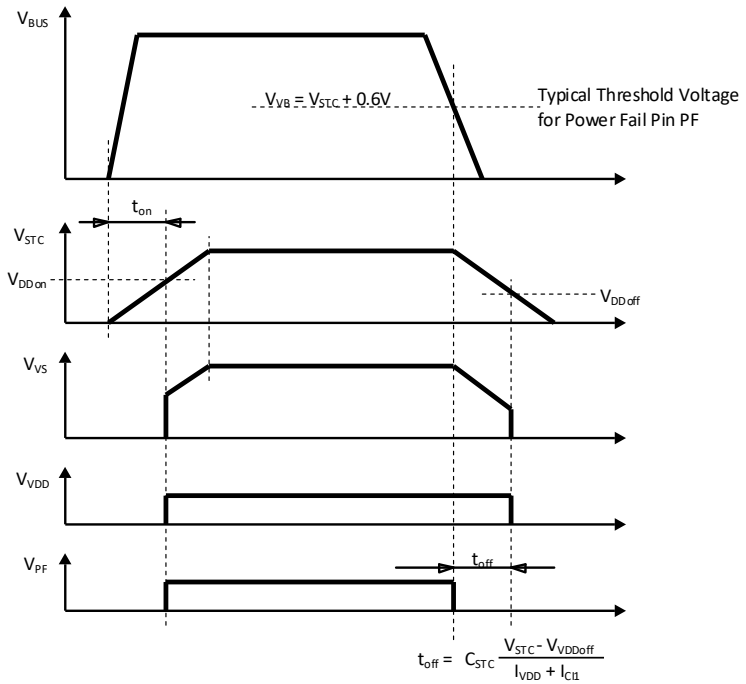
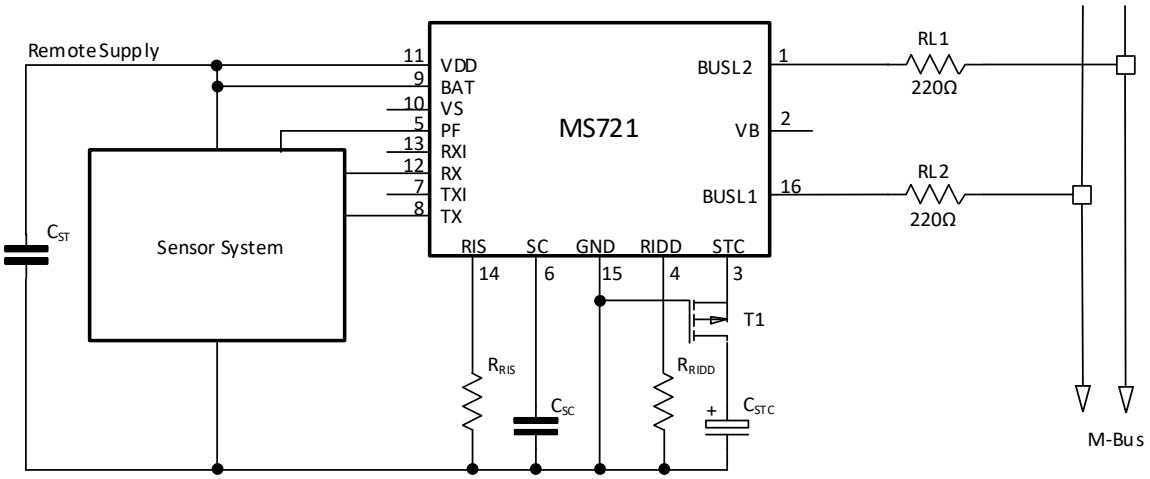


Figure 5. Power Up/Down Timing

Power Fail Function

Because input goes through the rectifier BR, BUSL1 and BUSL2 are all polarity independent. The bus voltage V_{VB} from VB pin to GND is bus voltage minus the voltage drop on rectifier BR. Voltage comparator TC2 monitors the bus voltage. If $V_{VB}>V_{STC}+0.6V$, PF=1. When powers fail, PF=0. And a warning is given to MCU: bus voltage drops and it is necessary to save data immediately.

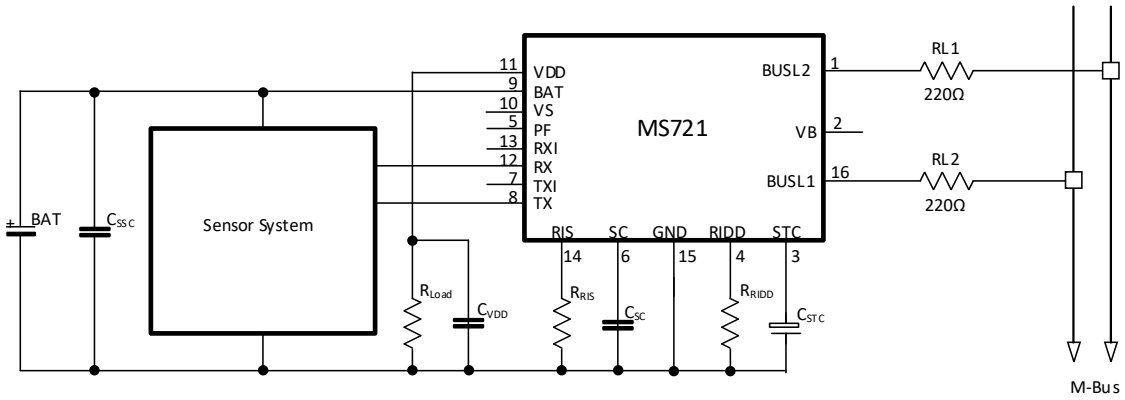
TYPICAL APPLICATION DIAGRAM



R_{RIDD} = 30kΩ	C_{STC} <= 220μF	Single Load 1UL
R_{RIDD} = 13kΩ	C_{STC} <= 470μF	Double Load 1UL

Note: Transistor T1 can select BSS84

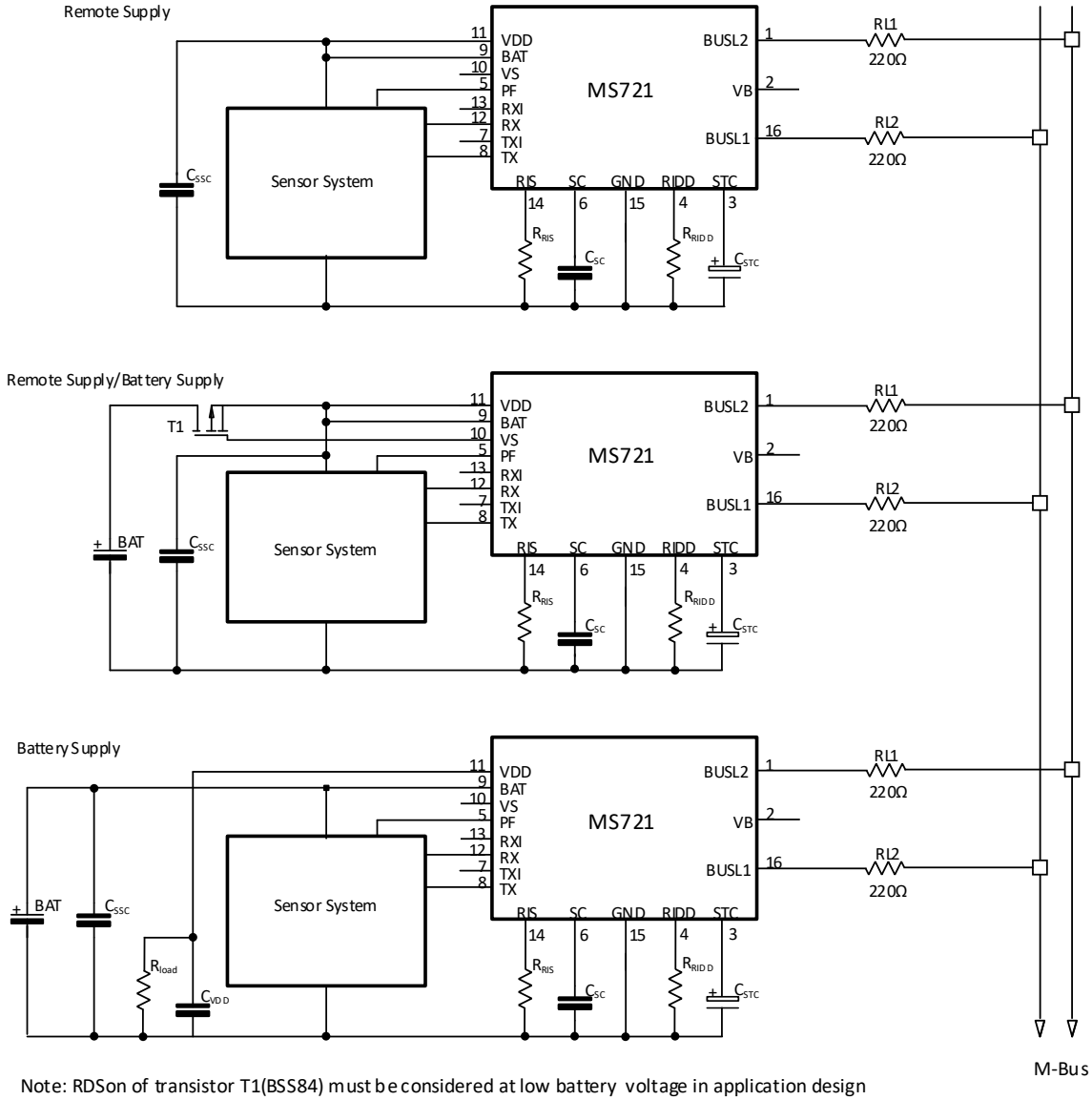
Figure 6. Basic Application Circuit-Powered by Bus, C_{STC} > 50μF



C_{SSC}: System Stable Capacitor
C_{STC}: Power Supply Capacitor
C_{SC}: Sampling Capacitor
C_{VDD}: Stable Capacitor (100nF)
C_{STC}: C_{VDD} >= 4:1

R_{RIDD}: Slave Current Adjustment Resistor
R_{RIS}: Modulation Current Resistor
RL1, RL2: Protection Resistor
R_{load}: Discharge Resistor (Recommendation Value: 100kΩ)

Figure 7. Basic Application Circuit-Powered by Battery



Note: RDSon of transistor T1(BSS84) must be considered at low battery voltage in application design

Figure 8. Basic Application Circuit-Different Power Modes

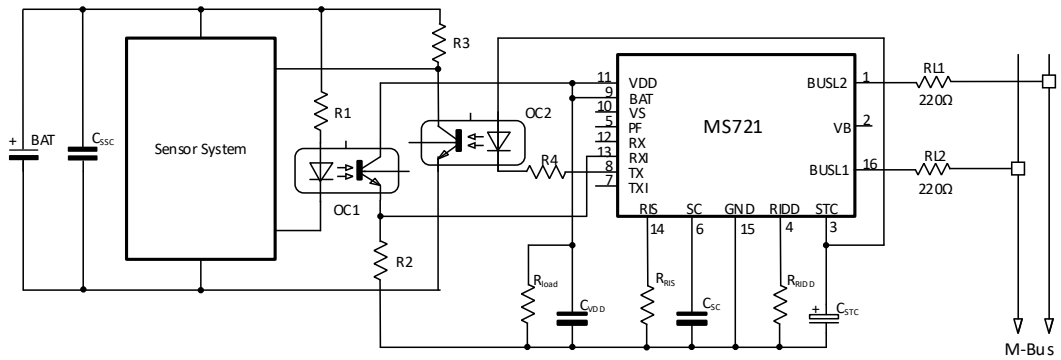
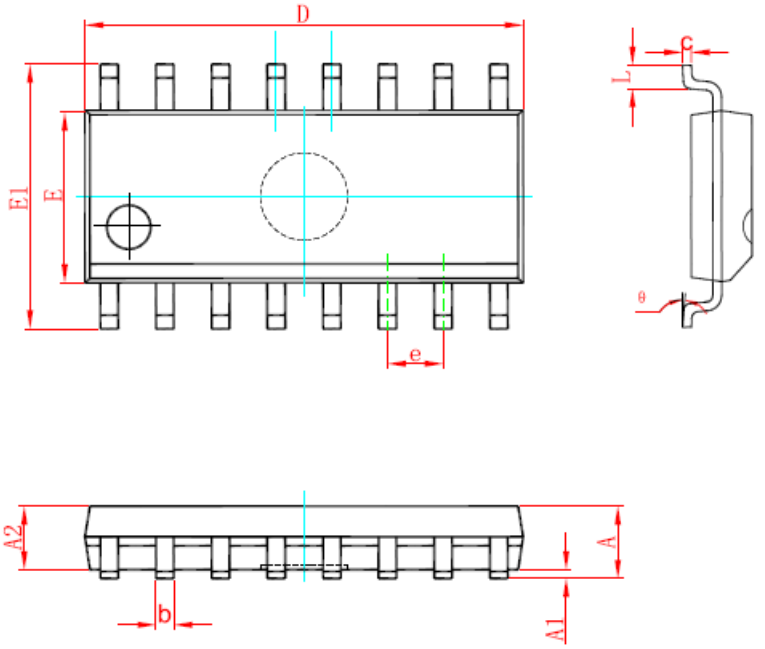


Figure 9. Optocoupler Application

PACKAGE OUTLINE DIMENSIONS

SOP16



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	9.800	10.200	0.386	0.402
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description

Product Name: MS721

Product Code : XXXXXXX

2. Marking Drawing Demand

Laser printing, contents in the middle, font type Arial.

3. Packaging Specification

Device	Package	Piece/Reel	Reel/Box	Piece/Box	Box/Carton	Piece/Carton
MS721	SOP16	4000	1	4000	8	32000

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MOS CIRCUIT OPERATION PRECAUTIONS

Static electricity can be generated in many places. The following precautions can be taken to effectively prevent the damage of MOS circuit caused by electrostatic discharge:

1. The operator shall ground through the anti-static wristband.
2. The equipment shell must be grounded.
3. The tools used in the assembly process must be grounded.
4. Must use conductor packaging or anti-static materials packaging or transportation.

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