

Meter-Bus Transceiver

FEATURES

- Meter-Bus Transceiver (for Slave) Meets Standard EN1434-3
- Receiver Logic With Dynamic Level Recognition
- Constant-Current Sink Adjustable By Resistor
- Polarity Independent
- Power-Fail Function
- Module Supply Voltage Switch
- 3.3-V Constant Voltage Source
- Up to 9600 Baud in Half Duplex for UART Protocol
- Slave Power Support
 - Supply From Meter-Bus by Output VDD
 - Supply From Meter-Bus by Output VDD or From Backup Battery
 - Supply From Battery – Meter-Bus Active for Data Transmission Only

APPLICATIONS

- E-metering
- Advanced Metering Infrastructure (AMI)
- Water Meters
- Gas Meters
- Heat Meters

DESCRIPTION

The TSS521 device is a single-chip transceiver developed for Meter-Bus standard (EN1434-3) applications.

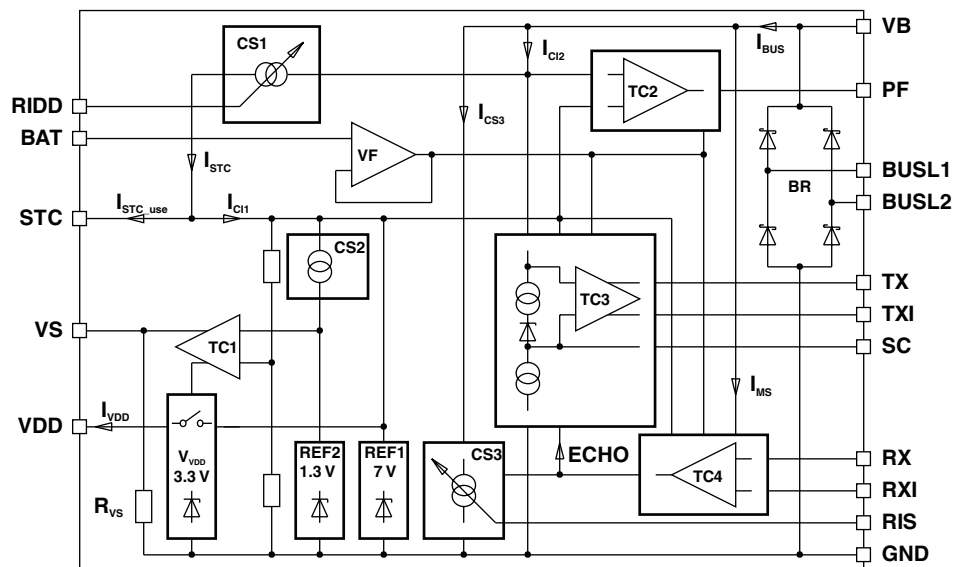
The TSS521 interface circuit adjusts the different potentials between a slave system and the Meter-Bus master. The connection to the bus is polarity independent and supports full galvanic slave isolation with optocouplers.

The circuit is supplied by the master through the bus. Therefore, this circuit offers no additional load for the slave battery. A power-fail function is integrated.

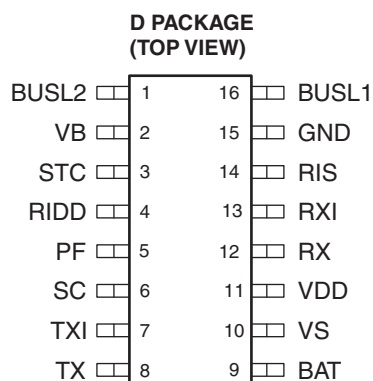
The receiver has dynamic level recognition, and the transmitter has a programmable current sink.

A 3.3-V voltage regulator with power reserve for a delayed switch off at bus fault is integrated.

Functional Schematic



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

**Table 1. Terminal Functions**

| TERMINAL | | DESCRIPTION |
|----------|-----|--|
| NAME | NO. | |
| BUSL2 | 1 | Meter-Bus |
| VB | 2 | Differential bus voltage after rectifier |
| STC | 3 | Support capacitor |
| RIDD | 4 | Current adjustment input |
| PF | 5 | Power fail output |
| SC | 6 | Sampling capacitor |
| TXI | 7 | Data output inverted |
| TX | 8 | Data output |
| BAT | 9 | Logic level adjust |
| VS | 10 | Switch for bus or battery supply output |
| VDD | 11 | Voltage regulator output |
| RX | 12 | Data input |
| RXI | 13 | Data input inverted |
| RIS | 14 | Adjust input for modulation current |
| GND | 15 | Ground |
| BUSL1 | 16 | Meter-Bus |

Functional Description

Data Transmission, Master to Slave

The mark level on the bus lines $V_{BUS} = \text{MARK}$ is defined by the difference of BUSL1 and BUSL2 at the slave. It depends on the distance from Master to Slave, which affects the voltage drop on the wire. To make the receiver independent, a dynamic reference level on the SC pin is used for the voltage comparator TC3 (see Figure 1).

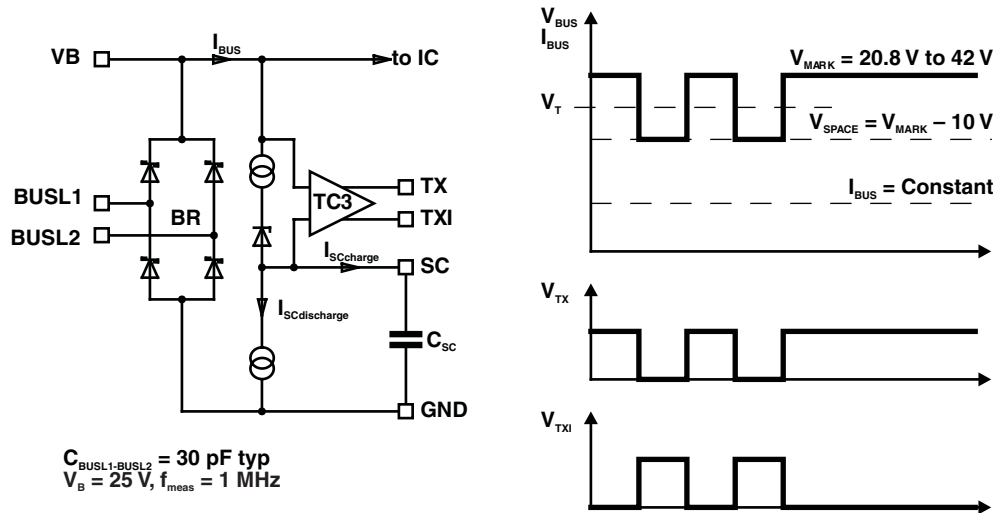


Figure 1. Data Transmission, Master to Slave

A capacitor (C_{SC}) at the SC pin is charged by a current ($I_{SC\text{charge}}$) and is discharged with a current ($I_{SC\text{discharge}}$) where:

$$I_{SC\text{discharge}} = \frac{I_{SC\text{charge}}}{40 \text{ (typ)}} \quad (1)$$

This ratio is necessary to run any kind of UART protocol independent of the data contents (for example, if an 11-bit UART protocol is transmitted with all data bits at 0 and only the stop bit at 1). There must be sufficient time to recharge the capacitor C_{SC} . The input level detector TC3 detects voltage modulations from the master ($V_{BUS} = \text{SPACE}$ or MARK conditions) and switches the inverted output TXI and the noninverted output TX.

Data Transmission, Slave to Master

The device uses current modulation to transmit information from the slave to the master while the bus voltage remains constant. The current source CS3 modulates the bus current and the master detects the modulation. The constant current source CS3 is controlled by the inverted input RXI or the noninverted input RX. The current source CS3 can be programmed by an external resistor R_{RIS} . The modulation supply current I_{MS} flows in addition to the current source CS3 during the modulation time.

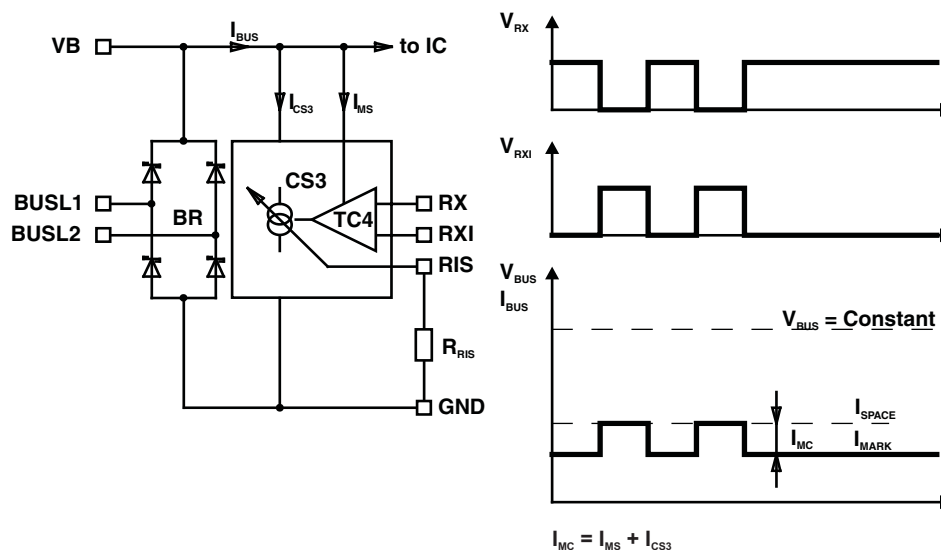


Figure 2. Data Transmission, Slave to Master

Because the TSS521 is configured for half-duplex only, the current modulation from RX or RXI is repeated concurrently as ECHO on the outputs TX and TXI. If the slave, as well as the master, is trying to send information on the lines, the added signals appear on the outputs TX and TXI, which indicates the data collision to the slave (see).

The bus topology requires a constant current consumption by each connected slave.

To calculate the value of the programming resistor R_{RIS} , use the formula shown in Figure 3.

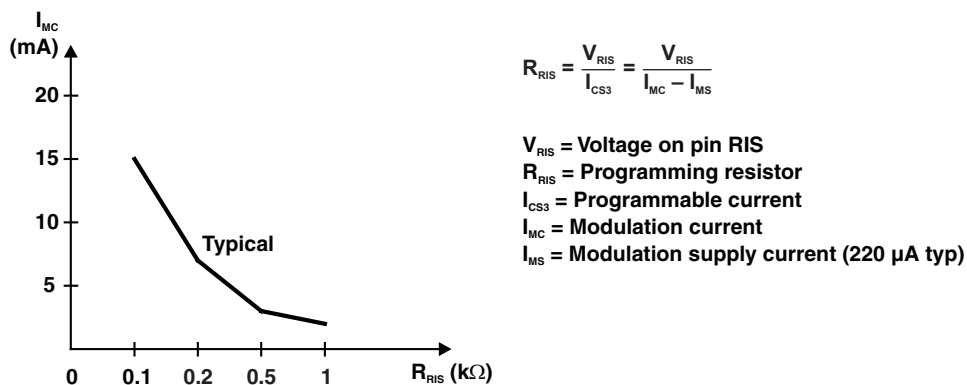


Figure 3. Calculate Programming Resistor R_{RIS}

Slave Supply, 3.3 V

The TSS521 has an internal 3.3-V voltage regulator. The output power of this voltage regulator is supplied by the storage capacitor C_{STC} at the STC pin. The storage capacitor C_{STC} at the STC pin is charged with constant current I_{STC_use} from the current source CS1. The maximum capacitor voltage is limited to REF1. The charge current I_{STC} has to be defined by an external resistor at pin RIDD.

The adjustment resistor R_{RIDD} can be calculated using [Equation 2](#).

$$R_{RIDD} = 25 \frac{V_{RIDD}}{I_{STC}} = 25 \frac{V_{RIDD}}{I_{STC_use} + I_{IC1}} \quad (2)$$

Where,

- I_{STC} = current from current source CS1
- I_{STC_use} = charge current for support capacitor
- I_{IC1} = internal current
- V_{RIDD} = voltage on pin RIDD
- R_{RIDD} = value of adjustment resistor

The voltage level of the storage capacitor C_{STC} is monitored with comparator TC1. Once the voltage V_{STC} reaches V_{VDD_on} , the switch S_{VDD} connects the stabilized voltage V_{VDD} to pin VDD. VDD is turned off if the voltage V_{STC} drops below the V_{VDD_off} level.

Voltage variations on the capacitor C_{STC} create bus current changes (see [Figure 4](#)).

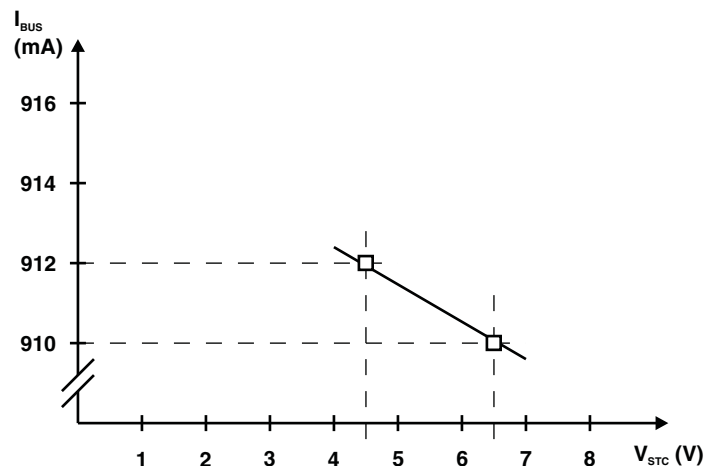


Figure 4. Single Mode Bus Load

At a bus fault the shut down time of VDD (t_{off}) in which data storage can be performed depends on the system current I_{VDD} and the value of capacitor C_{STC} . See [Figure 5](#), which shows a correlation between the shutdown of the bus voltage V_{BUS} and V_{DD_off} and t_{off} for dimensioning the capacitor.

The output VS is meant for slave systems that are driven by the bus energy, as well as from a battery should the bus line voltage fail. The switching of VS is synchronized with VDD and is controlled by the comparator TC1. An external transistor at the output VS allows switching from the Meter-Bus remote supply to battery.

Power On and Off

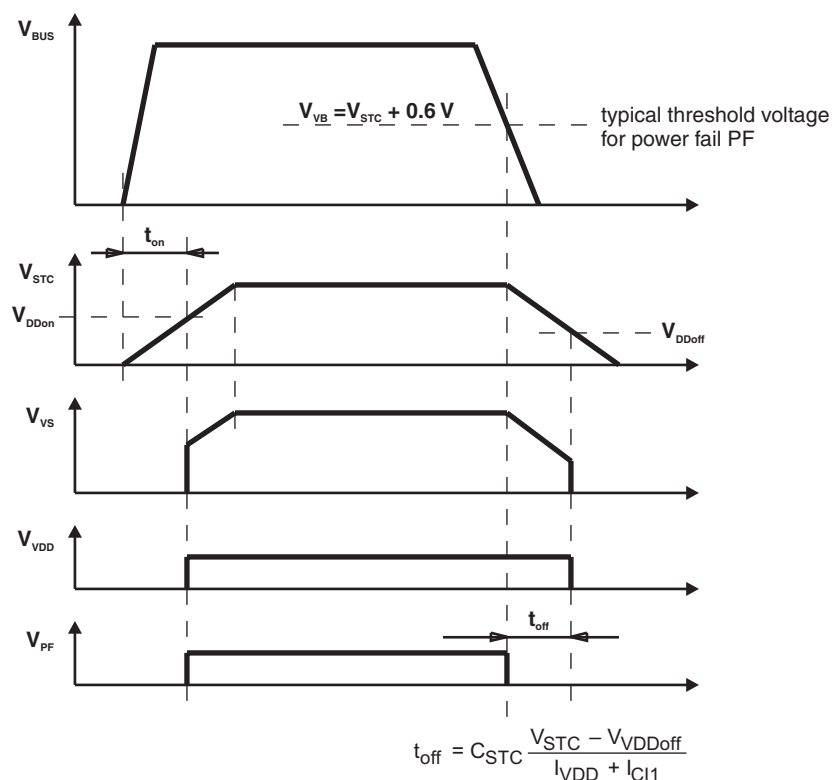


Figure 5. Power On/Off Timing

Power Fail Function

Because of the rectifier bridge BR at the input, BUSL1, and BUSL2, the TSS521 is polarity independent. The pin VB to ground (GND) delivers the bus voltage V_{VB} less the voltage drop over the rectifier BR. The voltage comparator TC2 monitors the bus voltage. If the voltage $V_{VB} > V_{STC} + 0.6\text{ V}$, then the output $PF = 1$. The output level $PF = 0$ (power fail) provides a warning of a critical voltage drop to the microcontroller to save the data immediately.

Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)

| | | | |
|-----------|--|------------|-----------------|
| V_{MB} | Voltage, BUSL1 to BUSL2 | | ± 50 V |
| V_I | Input voltage range | RX and RXI | –0.3 V to 5.5 V |
| | | BAT | –0.3 V to 5.5 V |
| T_J | Operating junction temperature range | | –25°C to 150°C |
| T_A | Operating free-air temperature range | | –25°C to 85°C |
| T_{STG} | Storage temperature range | | –65°C to 150°C |
| | Power derating factor, junction to ambient | | 8 mW/°C |

Recommended Operating Conditions

See note ⁽¹⁾. Typical values are specified at $V_{CC} = 3.3$ V and $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| | | MIN | MAX | UNIT |
|------------|--------------------------------|--------------------|------|------------|
| V_{MB} | Bus voltage, BUSL2 – BUSL1 | Receiver | 10.8 | 42 |
| | | Transmitter | 12 | 42 |
| V_I | Input voltage | VB (receive mode) | 9.3 | |
| | | BAT ⁽²⁾ | 2.5 | 3.8 |
| R_{RIDD} | RIDD resistor | 13 | 80 | k Ω |
| R_{RIS} | RIS resistor | 100 | | Ω |
| T_A | Operating free-air temperature | –25 | 85 | °C |

(1) All voltage values are measured with respect to the GND terminal unless otherwise noted.

(2) $V_{BAT(max)} \leq V_{STC} - 1$ V

Electrical Characteristics

See note ⁽¹⁾. Over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------|--|---|-----------------|-----------|------------|
| ΔV_{BR} | Voltage drop at rectifier BR $I_{BUS} = 3$ mA | | | 1.5 | V |
| ΔV_{CS1} | Voltage drop at current source CS1 $R_{RIDD} = 13$ k Ω | | | 1.8 | V |
| I_{BUS} | BUS current $V_{STC} = 6.5$ V, $I_{MC} = 0$ mA | $R_{RIDD} = 13$ k Ω | | 3 | mA |
| | | $R_{RIDD} = 30$ k Ω | | 1.5 | |
| ΔI_{BUS} | BUS current accuracy $\Delta V_{BUS} = 10$ V, $I_{MC} = 0$ mA, $R_{RIDD} = 13$ k Ω to 30 k Ω | | | 2 | % |
| I_{CC} | Supply current $V_{STC} = 6.5$ V, $I_{MC} = 0$ mA, $V_{BAT} = 3.8$ V, $R_{RIDD} = 13$ k Ω ⁽²⁾ | | | 650 | μ A |
| I_{CI1} | CI1 current $V_{STC} = 6.5$ V, $I_{MC} = 0$ mA, $V_{BAT} = 3.8$ V, $R_{RIDD} = 13$ k Ω , $V_{BUS} = 6.5$ V, RX/RXI = off ⁽²⁾ | | | 350 | μ A |
| V_{VDD} | VDD voltage $-I_{VDD} = 1$ mA, $V_{STC} = 6.5$ V | 3.1 | | 3.4 | V |
| R_{VDD} | VDD resistance $-I_{VDD} = 2$ to 8 mA, $V_{STC} = 4.5$ V | | | 5 | Ω |
| V_{STC} | STC voltage $V_{DD} = \text{on}$, $V_S = \text{on}$ $V_{DD} = \text{off}$, $V_S = \text{off}$ $I_{VDD} < I_{STC_use}$ | | 5.6 | 6.4 | V |
| | | | 3.8 | 4.3 | |
| | | | 6.5 | 7.5 | |
| I_{STC_use} | STC current $V_{STC} = 5$ V | $R_{RIDD} = 30$ k Ω | 0.65 | 1.1 | mA |
| | | $R_{RIDD} = 13$ k Ω | 1.85 | 2.4 | |
| V_{RIDD} | RIDD voltage $R_{RIDD} = 30$ k Ω | 1.23 | | 1.33 | V |
| V_{VS} | VS voltage $V_{DD} = \text{on}$, $I_{VS} = -5$ μ A | $V_{STC} - 0.4$ | | V_{STC} | V |
| R_{VS} | VS resistance $V_{DD} = \text{off}$ | 0.3 | | 1 | M Ω |
| V_{PF} | PF voltage $V_{STC} = 6.5$ V | $V_{VB} = V_{STC} + 0.8$ V, $I_{PF} = -100$ μ A | $V_{BAT} - 0.6$ | V_{BAT} | V |
| | | $V_{VB} = V_{STC} + 0.3$ V, $I_{PF} = 1$ μ A | 0 | 0.6 | |
| | | $V_{VB} = V_{STC} + 0.3$ V, $I_{PF} = 5$ μ A | 0 | 0.9 | |

(1) All voltage values are measured with respect to the GND terminal unless otherwise noted.

(2) Inputs RX/RXI and outputs TX/TXI are open, $I_{CC} = I_{CI1} + I_{CI2}$

Electrical Characteristics (continued)

See note ⁽¹⁾. Over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------------------|--|-----|-----|-----|------|
| t_{on} Turn-on time | $C_{STC} = 50 \mu F$, Bus voltage slew rate: 1 V/ μs | | | 3 | s |

Receiver Section Electrical Characteristics

See note ⁽¹⁾. Over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|-----------------|-----|------------------------------|---------|
| V_T | See Figure 1 | MARK – 8.2 | | MARK – 5.7 | V |
| V_{SC} SC voltage | | | | V_{VB} | V |
| $I_{SCcharge}$ SC charge current | $V_{SC} = 24 V$, $V_{VB} = 36 V$ | –15 | | –40 | μA |
| $I_{SCdischarge}$ SC discharge current | $V_{SC} = V_{VB} = 24 V$ | 0.3 | | $-0.033 \times I_{SCcharge}$ | μA |
| V_{OH} High-level output voltage (TX, TXI) | I_{TX} , $I_{TXI} = -100 \mu A$ (see Figure 1) | $V_{BAT} - 0.6$ | | V_{BAT} | V |
| V_{OL} Low-level output voltage (TX, TXI) | I_{TX} , $I_{TXI} = 100 \mu A$ | 0 | | 0.5 | V |
| | $I_{TX} = 1.1 mA$ | 0 | | 1.5 | |
| I_{TX} I_{TXI} TX, TXI current | $V_{TX} = 7.5$, $V_{VB} = 12 V$, $V_{STC} = 6 V$, $V_{BAT} = 3.8 V$ | | | 16 | μA |

(1) All voltage values are measured with respect to the GND terminal unless otherwise noted.

Transmitter Section Electrical Characteristics

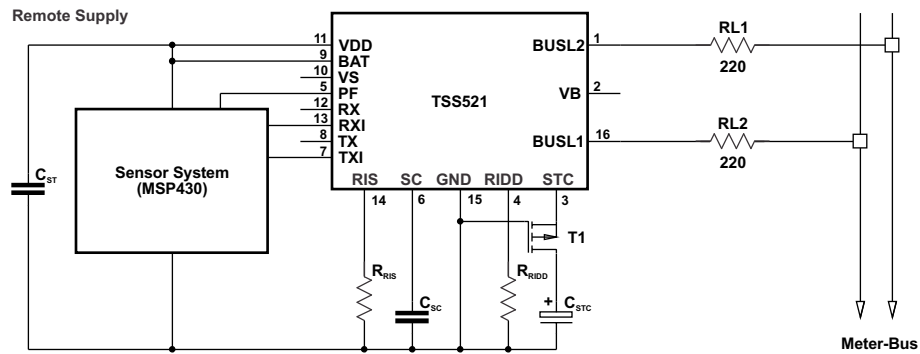
See note ⁽¹⁾. Over operating free-air temperature range (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|--|-----------------|-----|------|---------|
| I_{MC} MC voltage | $R_{RIS} = 100 \Omega$ | 11.5 | | 19.5 | mA |
| V_{RIS} RIS voltage | $R_{RIS} = 100 \Omega$ | 1.4 | | 1.7 | V |
| | $R_{RIS} = 1000 \Omega$ | 1.5 | | 1.8 | |
| V_{IH} High-level input voltage (RX, RXI) | See Figure 2 , see ⁽²⁾ | $V_{BAT} - 0.8$ | | 5.5 | V |
| V_{IL} Low-level input voltage (RX, RXI) | See Figure 2 | 0 | | 0.8 | V |
| I_{RX} RX current | $V_{RX} = 0 V$, $V_{BAT} = 3 V$, $V_{STC} = 6.5 V$ | –10 | | –40 | μA |
| I_{RXI} RXI current | $V_{RXI} = V_{BAT} = 3 V$, $V_{STC} = 6.5 V$ | 10 | | 40 | μA |

(1) All voltage values are measured with respect to the GND terminal unless otherwise noted.

(2) $V_{IH(max)} = 5.5 V$ is valid only when $V_{STC} \geq 6.5 V$.

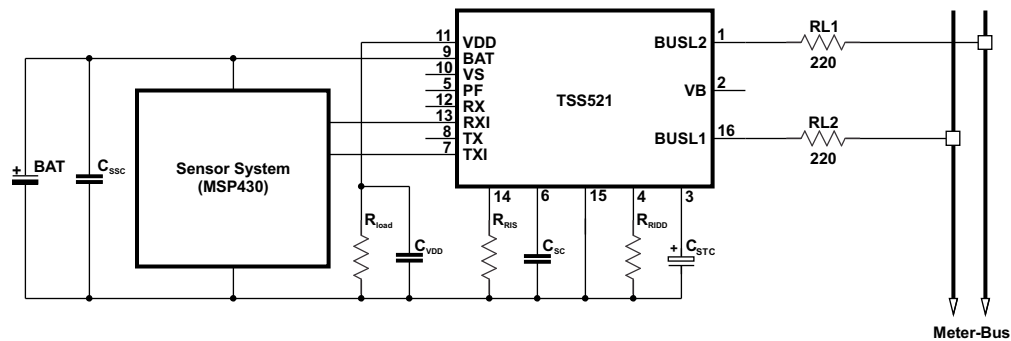
APPLICATION INFORMATION



| | | |
|---------------------------------|--|-----------------|
| $R_{RIDD} = 30 \text{ k}\Omega$ | $C_{STC} \leq 220 \text{ }\mu\text{F}$ | single load 1UL |
| $R_{RIDD} = 13 \text{ k}\Omega$ | $C_{STC} \leq 470 \text{ }\mu\text{F}$ | double load 2UL |

NOTE: Transistor T1 should be a BSS84.

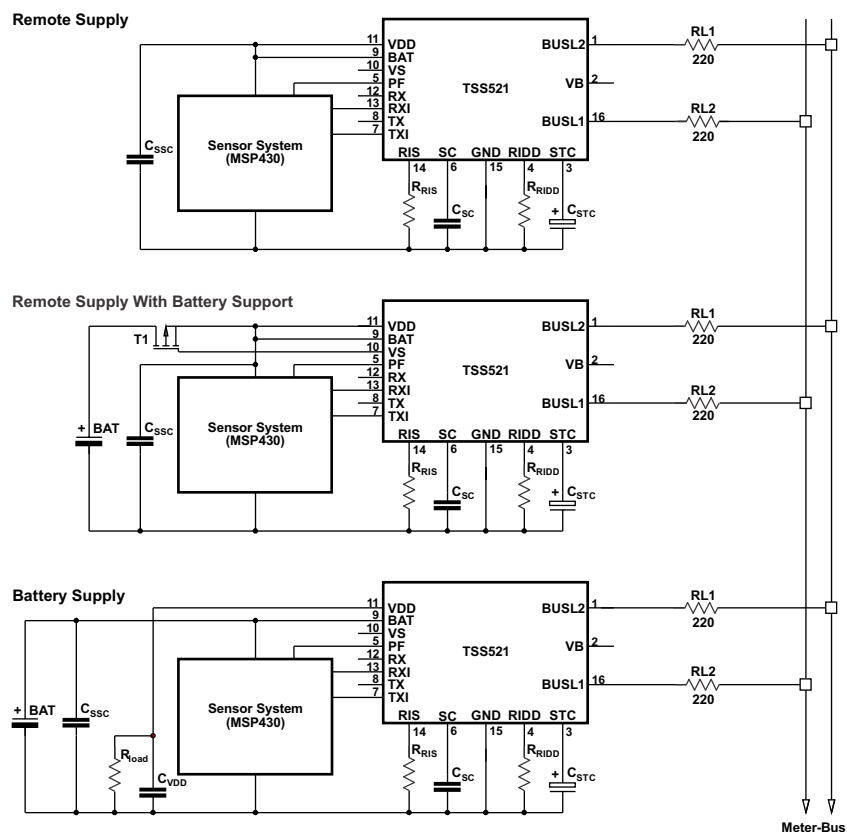
Figure 6. Basic Application Circuit With Support Capacitor $C_{STC} > 50 \text{ }\mu\text{F}$



C_{SSC} = system stabilizing capacitor
 C_{STC} = support capacitor
 C_{SC} = sampling capacitor
 C_{VDD} = stabilizing capacitor (100 nF)
 $C_{STC} : C_{VDD} \geq 4:1$

R_{RIDD} = slave=current adjustment resistor
 R_{RIS} = modulation-current resistor
 $RL1, RL2$ = protection resistors
 R_{LOAD} = discharge resistor (100 k Ω recommended)

Figure 7. Basic Application Circuit for Supply From Battery



NOTE: R_{DSon} of the transistor T1 (BSS84) at low battery voltage must be considered during application design.

Figure 8. Basic Applications for Different Supply Modes

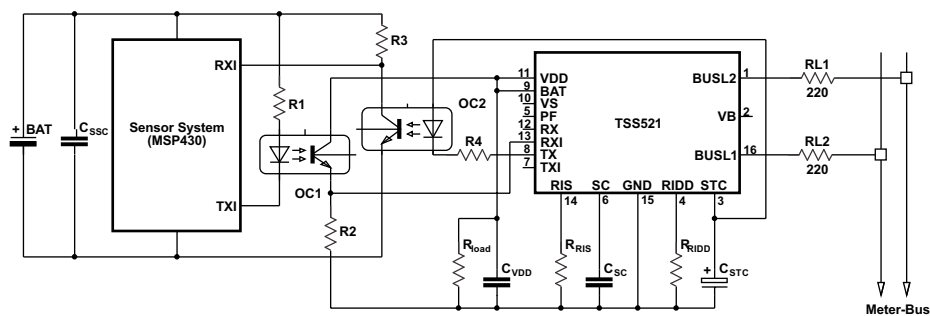


Figure 9. Basic Optocoupler Application

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TSS521DR | ACTIVE | SOIC | D | 16 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -25 to 85 | TSS521 | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TSS521DR | SOIC | D | 16 | 2500 | 330.0 | 16.4 | 6.5 | 10.3 | 2.1 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|----------|--------------|-----------------|------|------|-------------|------------|-------------|
| TSS521DR | SOIC | D | 16 | 2500 | 350.0 | 350.0 | 43.0 |

TUBE



*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|---------|--------------|--------------|------|-----|--------|--------|--------|--------|
| TSS521D | D | SOIC | 16 | 40 | 505.46 | 6.76 | 3810 | 4 |

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AC.

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