MORNSUN®

# SCM3406AFA Half-duplex Transceiver

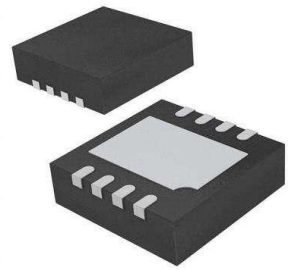
## Features

- 3.0-5.5V single supply operation
- Baud Rate Up to 10Mbps
- 1/8 Unit Load—Up to 256 Nodes on a Bus
- Bus-Pin ESD Protection Up to 15 kV
- Driver short circuit protection

## Applications

- Industrial Automation
- Building Automation
- Smart Electricity Meter
- Remote Signal Interaction, Transmission

## Package



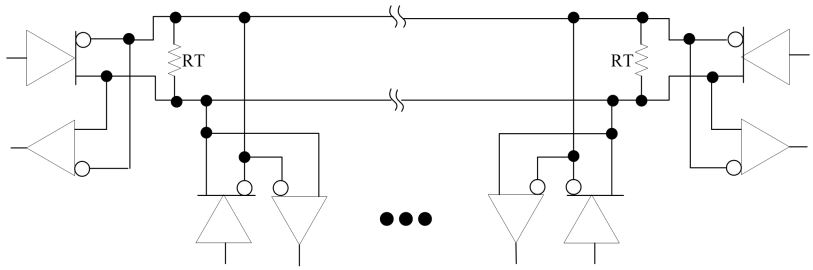
Mechanical package: DFN 3X3
(see “Ordering information” for details).

## Functional Description

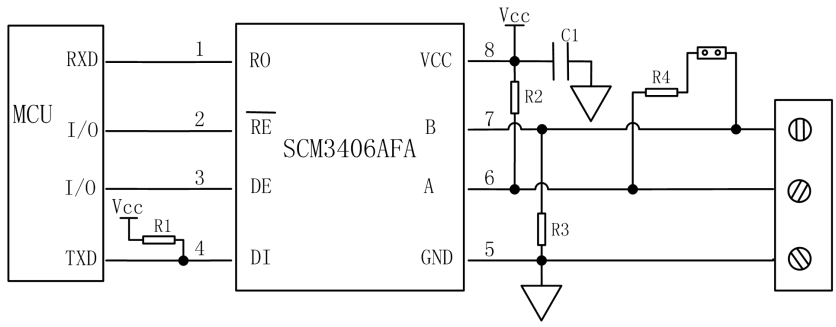
SCM3406AFA is a half-duplex enhanced transceiver designed for RS–485 data bus networks. Powered by 3.0-5.5V supply, the SCM3406AFA is fully compliant with TIA/EIA-485A standard and is suitable for data transmission of up to 10Mbps. Receivers have an exceptionally high input impedance, which places only 1/8 of the standard load on a shared bus and up to 256 transceivers .

The reliability design of A B pin is emphasized, including driver output over current protection and enhanced ESD design. The ESD protection level of A,B pin can be up to 15kV (Human Body Model).

## Typical Application Circuit




Typical Circuit 1: Half-Duplex Network

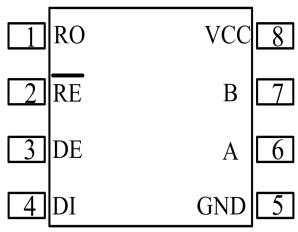



Typical Circuit 2: Application Diagram

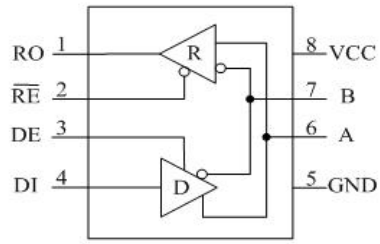
## Contents



## Pin Connection




## Internal Block Diagram




## Function table

| Driver | | | | |
|---|---|---|---|---|
| Input | | | Outputs | |
| $\overline{RE}$ | DE | DI | A | B |
| X | H | H | H | L |
| X | H | L | L | H |
| L | L | X | Z | Z |
| H | L | X | Z ( SHUTDOWN ) | |

| Receiver | | | |
|---|---|---|---|
| Input | | | Output |
| $\overline{RE}$ | DE | A-B | RO |
| L | X | ≥-40mV | H |
| L | X | ≤-220mV | L |
| L | X | Open/Short | H |
| H | H | X | Z |
| H | L | X | Z ( SHUTDOWN ) |

## Pin descriptions

| Pin Number | Pin Name | Pin Functions |
|---|---|---|
| 1 | RO | Receiver Output. When $\overline{RE}$ is low and if (A – B) ≥ -40mV, RO is high. If (A – B) ≤ - 220mV, RO is low. |
| 2 | $\overline{RE}$ | Receiver Output Enable. When $\overline{RE}$ is low, RO is enabled. When $\overline{RE}$ is high, RO is high impedance. Drive $\overline{RE}$ high and DE low to enter shutdown mode |
| 3 | DE | Driver Output Enable. When DE is high, outputs are enabled. When DE is low, outputs are high impedance. Drive DE low and $\overline{RE}$ high to enter shutdown mode |
| 4 | DI | Driver Input |
| 5 | GND | Ground |
| 6 | A | Non-Inverting Driver Output / Receiver input |
| 7 | B | Inverting Driver Output / Receiver input |
| 8 | VCC | Positive Supply VCC. Bypass to GND with a 0.1uF capacitor |

## Absolute Maximum Ratings

General test conditions: Free-air, normal operating temperature range (unless otherwise specified).

| Parameters | Unit |
|---|---|
| Supply voltage range, Vcc | -0.3V~+7V |
| Voltage range at A or B | -15V~+15V |
| Voltage range at DE、DI、$\overline{RE}$、RO | -0.3V ~ (VCC + 0.3V) |
| Storage Temperature | -55℃~150℃ |
| Lead Temperature (soldering, 10s) | 300℃ |

Support ±15V in receiver mode, and -8 ~+13V in driver mode

Important: Exposure to Absolute Maximum Rated conditions for an extended period may severely affect the device reliability, and stress levels exceeding the “Absolute Maximum Ratings” may result in permanent damage.

## Recommended Operating Conditions

| Recommended Operating Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Supply Voltage, $V_{VCC}$ | 3 | 5 | 5.5 | V |
| Voltage at any bus terminal (differential or common mode), $V_I$ | -7 | | 12 | |
| High-level input voltage ( DI, DE, $\overline{RE}$ ) , $V_{IH}$ | 2 | | VCC | |
| Low-level input voltage ( DI, DE, $\overline{RE}$ ) , $V_{IL}$ | 0 | | 0.8 | |
| Differential load resistance | 54 | 60 | | Ω |
| Signaling rate | | | 10000 | kbps |
| Operating ambient temperature, $T_A$ in free–air | -40 | | 125 | ℃ |
| Maximum operating junction temperature, $T_J$ | | | 150 | ℃ |

## Electrical Characteristics

General test conditions and $V_{VCC}$= 5V, Ta = 25℃ (unless otherwise specified).

| Parameters | | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Digital Input Signals: DI, DE, $\overline{RE}$ | | | | | | | |
| Logic input thresholds | | High, $V_{IH}$ | | 2 | | | V |
| | | Low, $V_{IL}$ | | | | 0.8 | |
| Driver | | | | | | | |
| Differential Driver Output ($V_{OD}$) | | No Load | | | | $V_{VCC}$ | V |
| Differential Driver Output (1) | | Vin=3V, $R_L$=54Ω, Figure16 | | 1.5 | 1.9 | | V |
| Differential Driver Output (2) | | Vin=5V, $R_L$=54Ω, Figure16 | | 2.1 | 2.8 | | |
| Differential Driver Output (3) | | $R_L$=60Ω, $V_{CM}$ = -7 ~ 12V, VCC = 3.0~3.6V, Figure17 | | 1.5 | | $V_{VCC}$ | |
| Driver Common Mode Output Voltage | | Figure18 | | 1 | | 3 | V |
| Change in Common Mode Output Voltage | | Figure19 | | | | ±0.05 | V |
| Driver Short Circuit Current Limit | | -7V≤$V_{OUT}$≤12V, Figure22 | | | | ±150 | mA |
| Receiver | | | | | | | |
| Receiver Input Resistance | | -7V≤$V_{OUT}$≤12V | | 96 | | | kΩ |
| Input Current (A, B pins) | | DE=0, $\overline{RE}$ =0 $V_{VCC}$=0 or 5.5V | $V_{OUT}$ =12V | | | 120 | uA |
| | | | $V_{OUT}$ = -7V | -110 | | | uA |
| Change in magnitude of differential output voltage | | $I_O$ = ±8 mA | | -220 | | -40 | mV |
| Receiver Input Hysteresis | | | | | 70 | | mV |
| Receiver Output Voltage | $V_{OH}$, Figure 23 | $I_{OUT}$ = -8mA,Vcc = 4.5V ~ 5.5V $V_{ID}$= 1 | | 3 | 4.5 | | V |
| | $V_{OH}$, Figure 23 | $I_{OUT}$ = -8mA,Vcc = 3.0V ~ 3.6V $V_{ID}$= 1V | | 2.45 | 2.65 | | |
| | $V_{OL}$, Figure 23 | $I_{OUT}$ = 8mA,Vcc = 4.5V ~ 5.5V VID= -1V | | | | 0.4 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | $V_{OL}$, Figure 23 | $I_{OUT}$ = 8mA,Vcc = 3.0V ~ 3.6V<br>VID= -1V | | | 0.5 | |
| Supply and Protection | | | | | | |
| $I_{VCC}$ | Driver and receiver enabled | DE = $V_{VCC}$, $\overline{RE}$ = 0, No load | | 1900 | 2200 | uA |
| | Driver enabled, receiver disabled | DE = $V_{VCC}$, $\overline{RE}$ = $V_{VCC}$, No load | | 1800 | 2200 | uA |
| | Receiver enabled, driver disabled | DE = $V_{VCC}$, $\overline{RE}$ = 0, No load | | 1700 | 2000 | uA |
| | Driver and receiver disabled | DE = 0, $\overline{RE}$ = $V_{VCC}$, No load | | 1650 | 2000 | uA |
| ESD | Human Body Model | A, B and GND | | ±15 | | kV |
| | | Other pins | | ±4 | | kV |
| | IEC61000-4-2 | A, B and GND | | ±15 | | kV |
| EFT | IEC61000-4-4 | A, B and GND | | ±1 | | kV |

## Transmission Characteristics

General test conditions and $V_{VCC}$ = 5V, Ta = 25℃ (unless otherwise specified).

| Parameters | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Driver | | | | | |
| Data Signaling Rate | Duty Cycle 40% ~ 60% | | | 10000 | kbps |
| Driver Propagation Delay ( $T_{PHL}$,$T_{PLH}$ ) | $R_L$ = 54Ω, $C_L$ = 50pF, Figure 19 | | 21 | 30 | nS |
| Driver Output Rise/Fall Time ( $T_R$,$T_F$ ) | | | 8 | | nS |
| Driver Differential Skew ( $\lvert T_{PHL} - T_{PLH} \rvert$ ) | | | 3 | 6 | nS |
| Driver Enable to Output High ( $T_{PZH}$ ) | $R_L$=110Ω, $\overline{RE}$ = 0,Figure 20, Figure 21 | | 20 | 45 | nS |
| Driver Enable to Output Low ( $T_{PZL}$ ) | | | 30 | 50 | nS |
| Driver Disable from Output High ( $T_{PHZ}$ ) | | | 30 | 50 | nS |
| Driver Disable from Output Low ( $T_{PLZ}$ ) | | | 30 | 50 | nS |
| Receiver | | | | | |
| Receiver Propagation Delay ( $T_{PLH}$,$T_{PHL}$ ) | $C_L$ = 15pF, Figure 22 | | 35 | 50 | nS |
| Receiver Differential Skew ( $\lvert T_{PLH} - T_{PHL} \rvert$ ) | | | 10 | 15 | nS |
| Receiver Output Rise/Fall Time ( $T_R$,$T_F$ ) | $C_L$ = 15pF, $V_{DI}$=-1.5V~1.5V, Figure 22 | | 14 | | nS |
| Receiver Enable to Output High ( $T_{PZH}$ ) | $C_L$ = 15pF, Figure 23, Figure 24 | | 20 | 30 | nS |
| Receiver Enable to Output Low ( $T_{PZL}$ ) | | | 25 | 40 | nS |
| Receiver Disable from Output High ( $T_{PHZ}$ ) | | | 30 | 60 | nS |
| Receiver Disable from Output Low ( $T_{PLZ}$ ) | | | 30 | 60 | nS |

## Typical Performance Curves

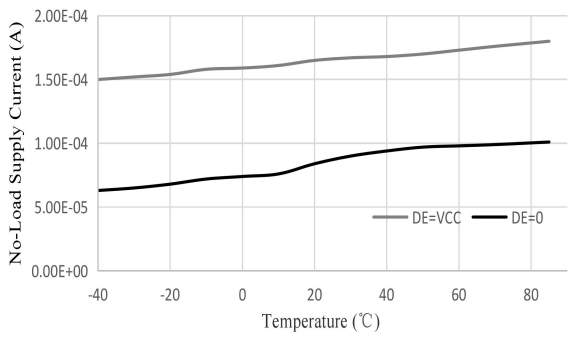



Figure 1 No-Load Supply Current vs. Temperature

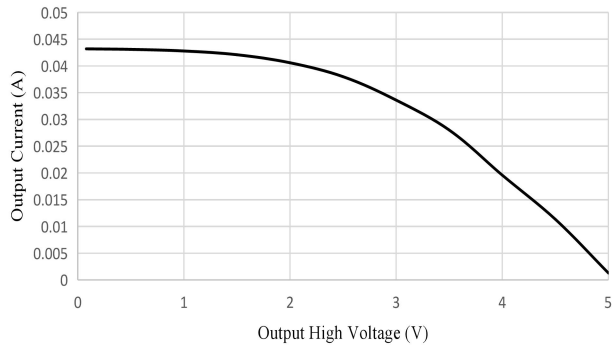



Figure 2 Output Current vs. Receiver Output High Voltage

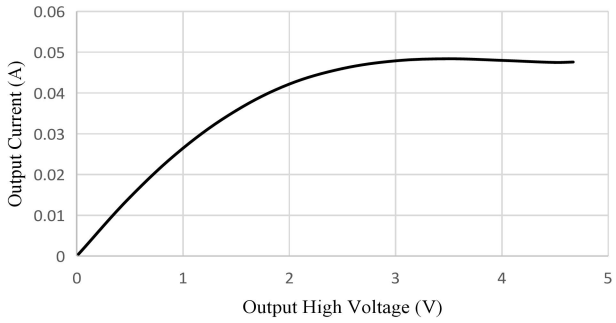



Figure 3 Output Current vs. Receiver Output Low Voltage

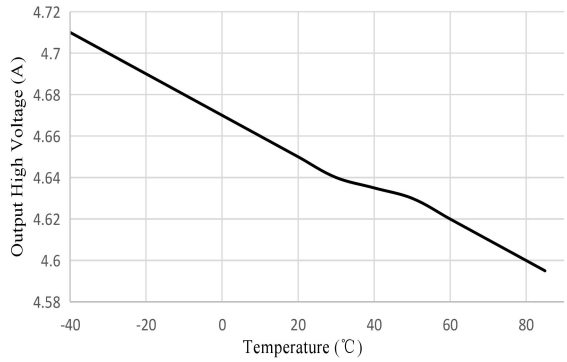



Figure 4 Receiver Output High Voltage vs. Temperature

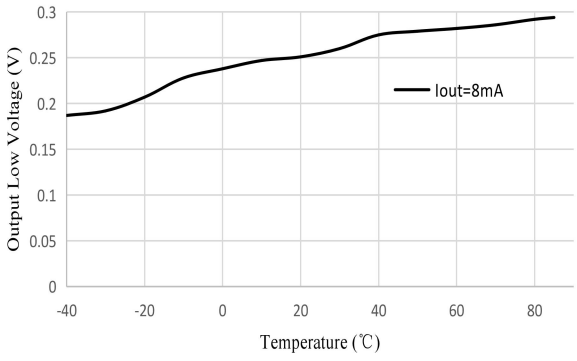



Figure 5 Receiver output low voltage vs. Temperature

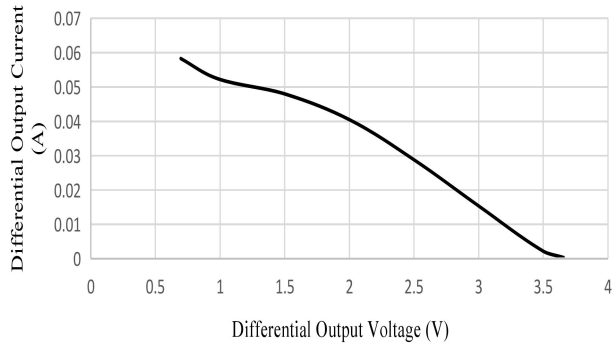



Figure 6 Driver differential output current vs. Differential output voltage

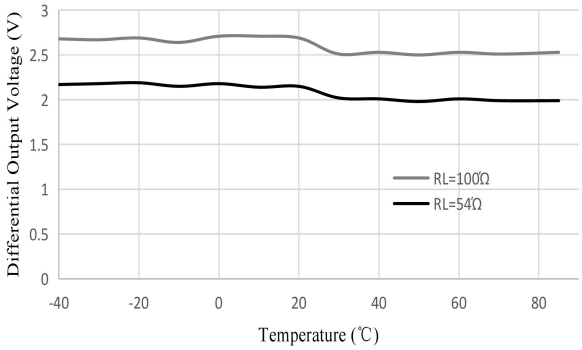



Figure 7 Driver Differential Output Voltage vs Temperature

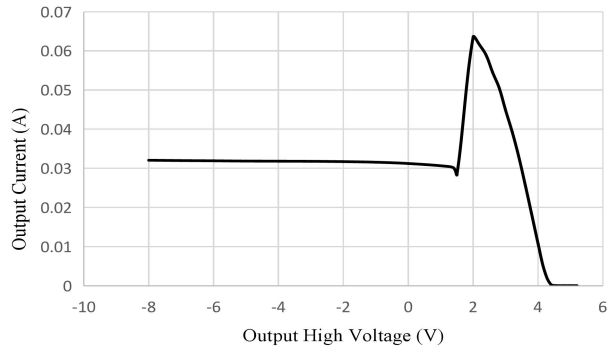



Figure 8 Output current vs. Transmitter output high voltage

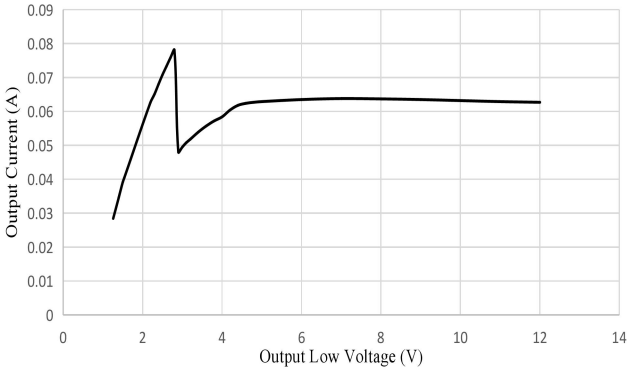



Figure 9 Output current vs. Transmitter output low voltage

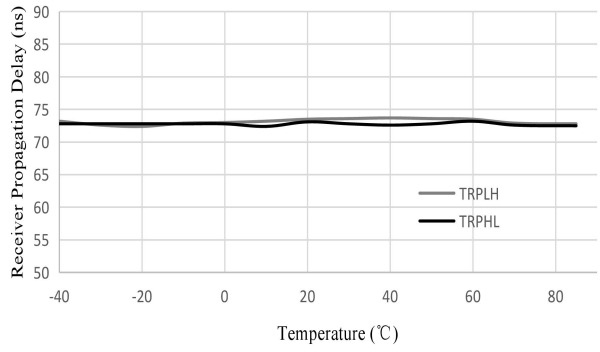



Figure 10 Receiver Propagation Delay vs. Temperature

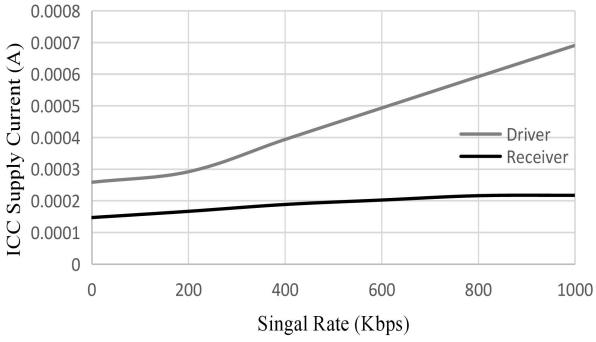



Figure 11 RMS Supply Current vs. Signaling Rate

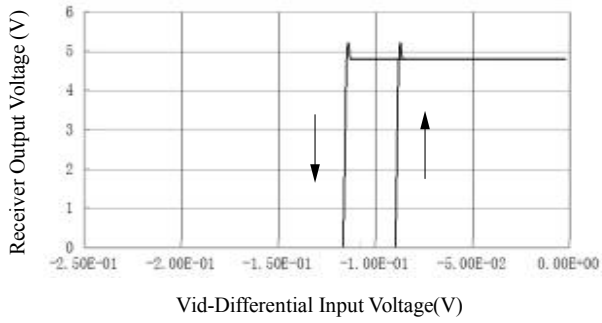



Figure 12 Receiver output voltage vs. Differential input voltage

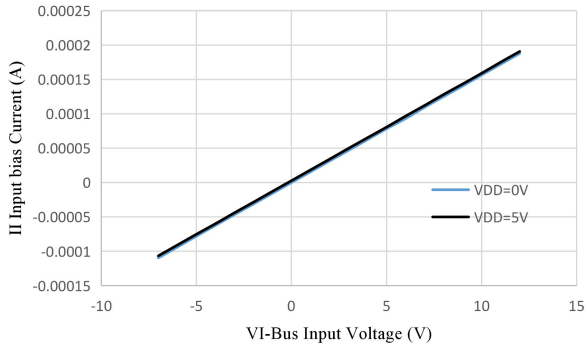



Figure 13 Bus input current vs. Bus input voltage

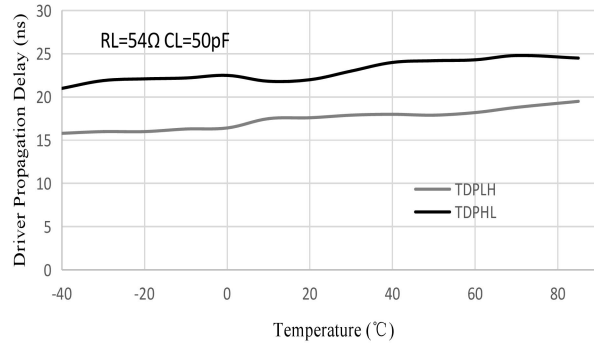



Figure 14 Driver propagation delay vs. Temperature

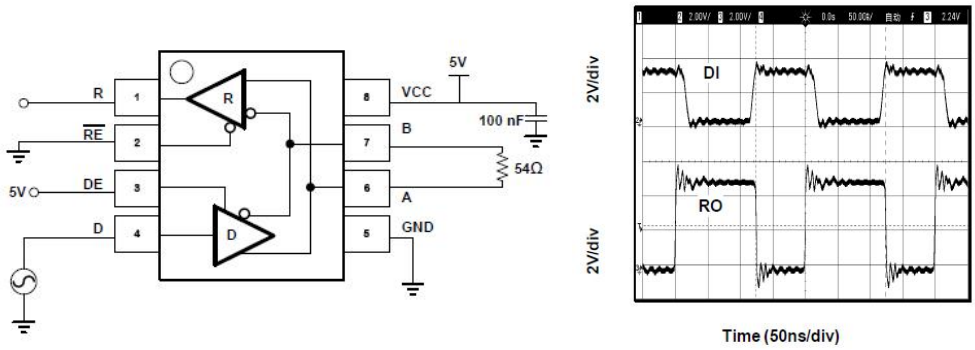



Figure 15 Loop back Test Circuit

## Test Circuits

Note: Load test capacitance includes probe and test fixture stray capacitance, unless otherwise specified. Signal generator with following characteristics: Rise and fall time < 6ns, pulse rate 100kHz, 50% duty cycle, ZO = 50Ω (unless otherwise specified).

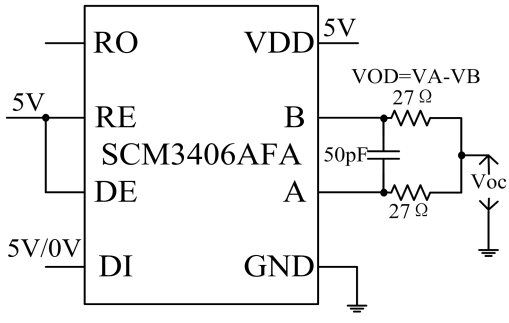



Figure 16 Driver Test Circuit, $V_{OD}$ and $V_{OC}$ Without Common-Mode Loading

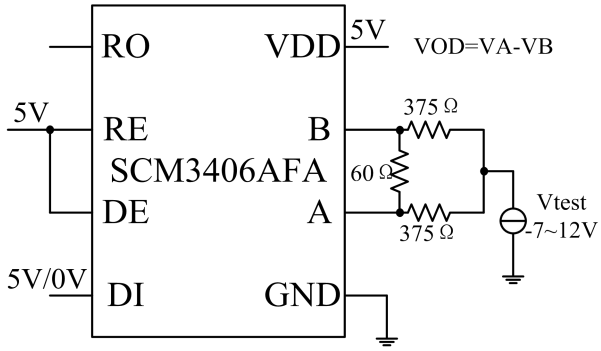



Figure 17 Driver Test Circuit, $V_{OD}$ With Common-Mode Loading

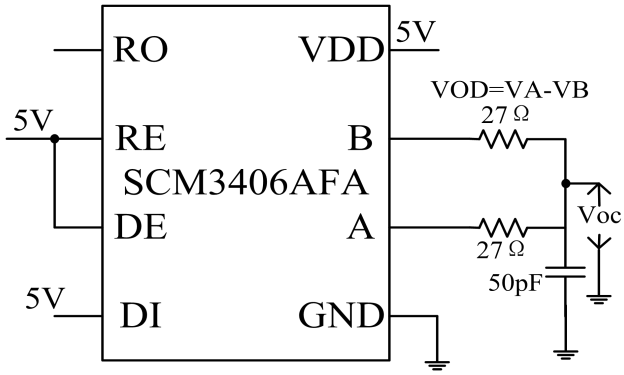



Figure 18 Driver $V_{OC}$ Test Circuit

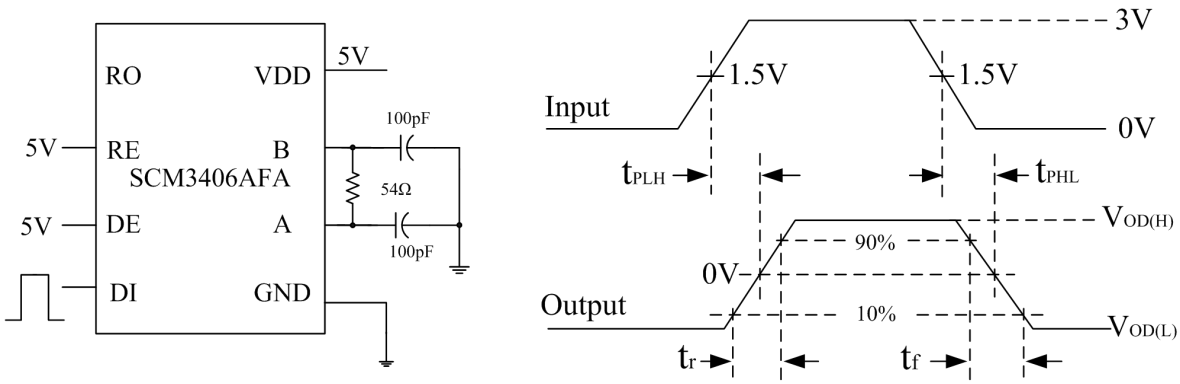



Figure 19 Driver Switching Test Circuit and Waveforms

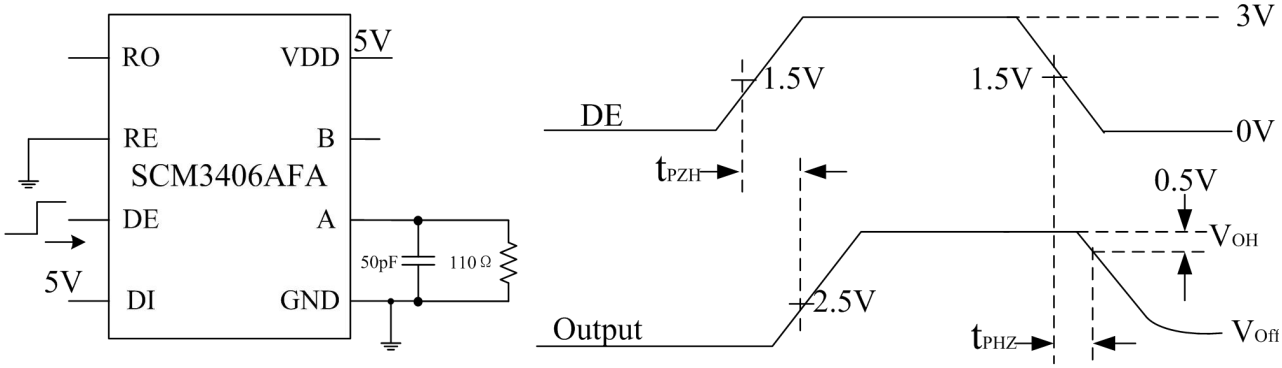



Figure 20 Driver Enable/Disable Test Circuit and Waveforms, High Output

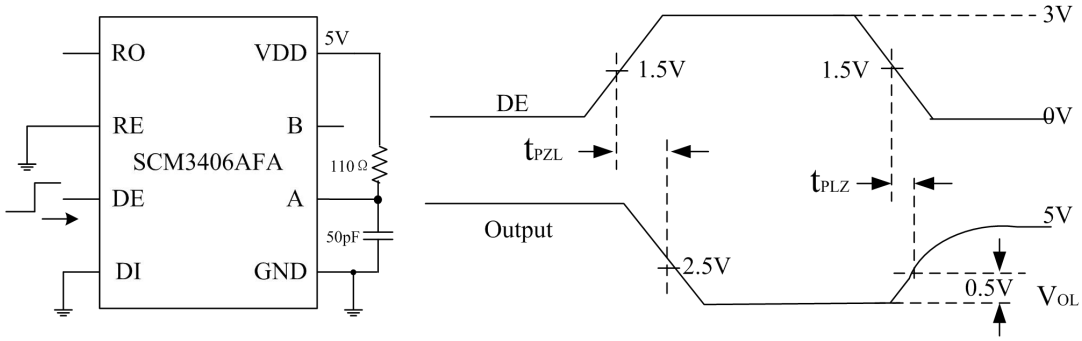



Figure 21 Driver Enable/Disable Test Circuit and Waveforms, Low Output

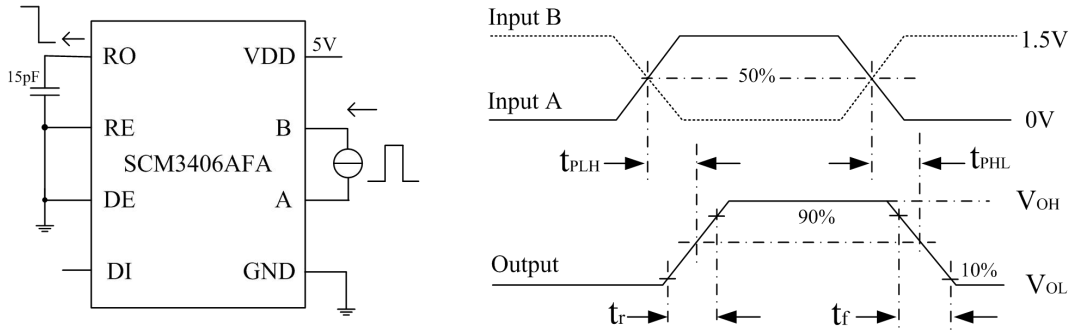



Figure 22 Receiver Switching Test Circuit and Waveforms

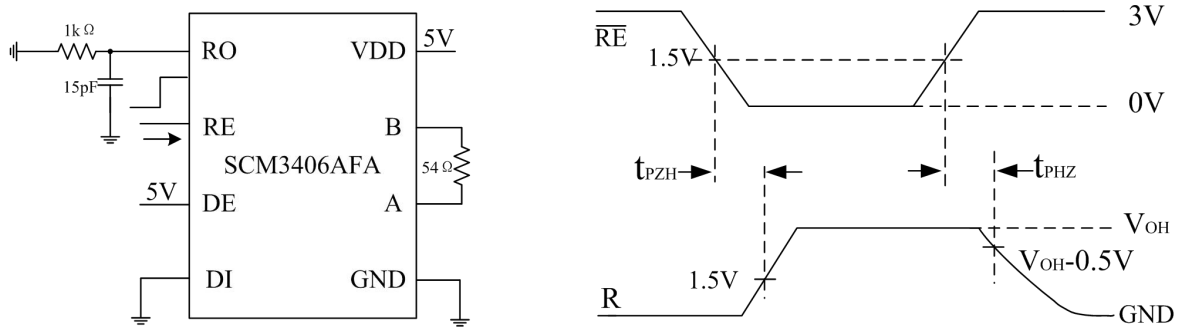



Figure 23 Receiver Enable/Disable Test Circuit and Waveforms, Data Output High

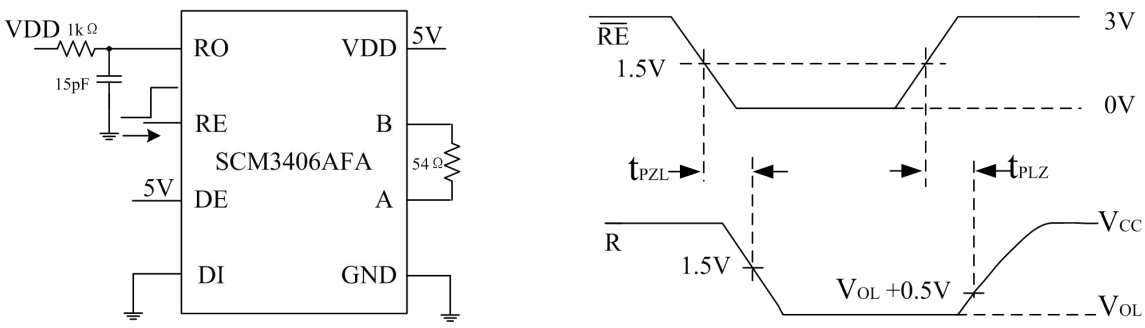



Figure 24 Receiver Enable/Disable Test Circuit and Waveforms, Data Output Low

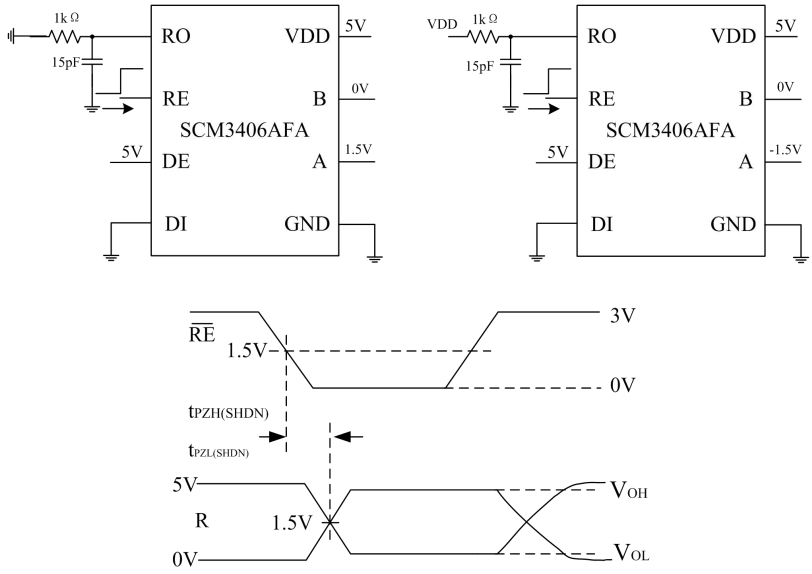



Figure 25 Receiver Enable from Shutdown Test Circuit and Waveforms

## Detailed Description

The SCM3406AFA series are advanced RS-485 transceivers. They each contain one driver and one receiver. These devices feature a fail-safe circuitry that guarantees a high receiver output voltage when the receiver inputs are either open, shorted or when they are connected to a terminated transmission line with all drivers disabled. These devices operate with a single 5.0V supply. Drivers limit the output current by over current protection, to avoid the damage to the transceivers.

Receiver input filter: The SCM3406AFA receivers have an integrated input filter which enhances noise immunity of the high-speed differential signals. The receiver propagation delay increases due to this filtering.

Bus fail-safe: Ordinary RS485 bus receivers will be in an indeterminate state when -220mV< A - B <-40mV. This situation can occur whenever the data bus is not being actively driven. The advanced Fail-safe feature of the SCM3406AFA guarantees a high receiver output voltage if the receiver's differential inputs are either shorted, open circuit, or if they are connected to a termination resistor.

The SCM3406AFA receiver thresholds are very precise, and the offset between threshold voltage and ground has a margin of at least 40mV.

Load abilities on the bus (256 nodes): The standard receiver input impedance of RS-485 is 12kΩ (1 unit load). A standard RS485 driver can drive at least 32 unit loads. The SCM3406AFA transceiver is design to 1/8th of the standard unit load and the input impedance is higher than 96kΩ, hence allowing up to 256 unit loads, in other words eight times as many. The SCM3406AFA can work combined with other standard RS485 that use the smaller amount of unit loads.

Driver output protection: The device prevents excessive output current caused by fault conditions or driver short circuit. A driver current limit on the output stage provides and ensures immediate protection against short circuits over the entire common mode voltage range.

## Expansion Output Design

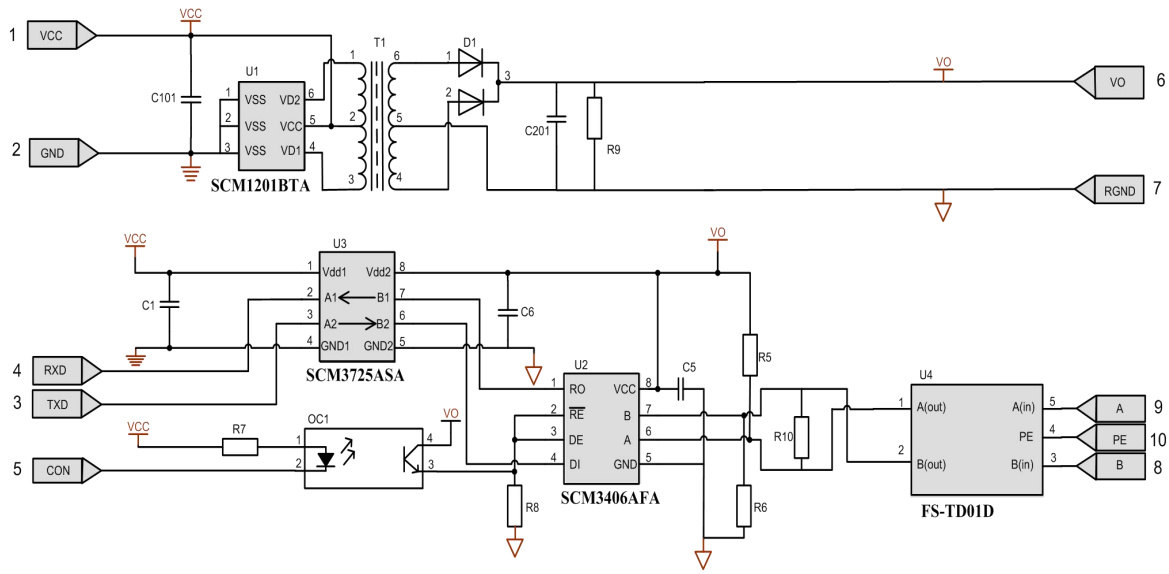



Fig. 26 Schematic diagram of isolation application circuit for UART to RS485 signal

## Suggestions for Power Supply

If the input power is a few inches from the SCM3406AFA, as much as possible, connect a 0.1μF bypass capacitor to the $V_{CC}$ pin and a 10μF capacitor near the center tap pin of the transformer.

## Ordering Information

| Part number | Package | Number of pins | Product Marking |
|---|---|---|---|
| SCM3406AFA | DFN | 8 | 3406AFA<br>YM |

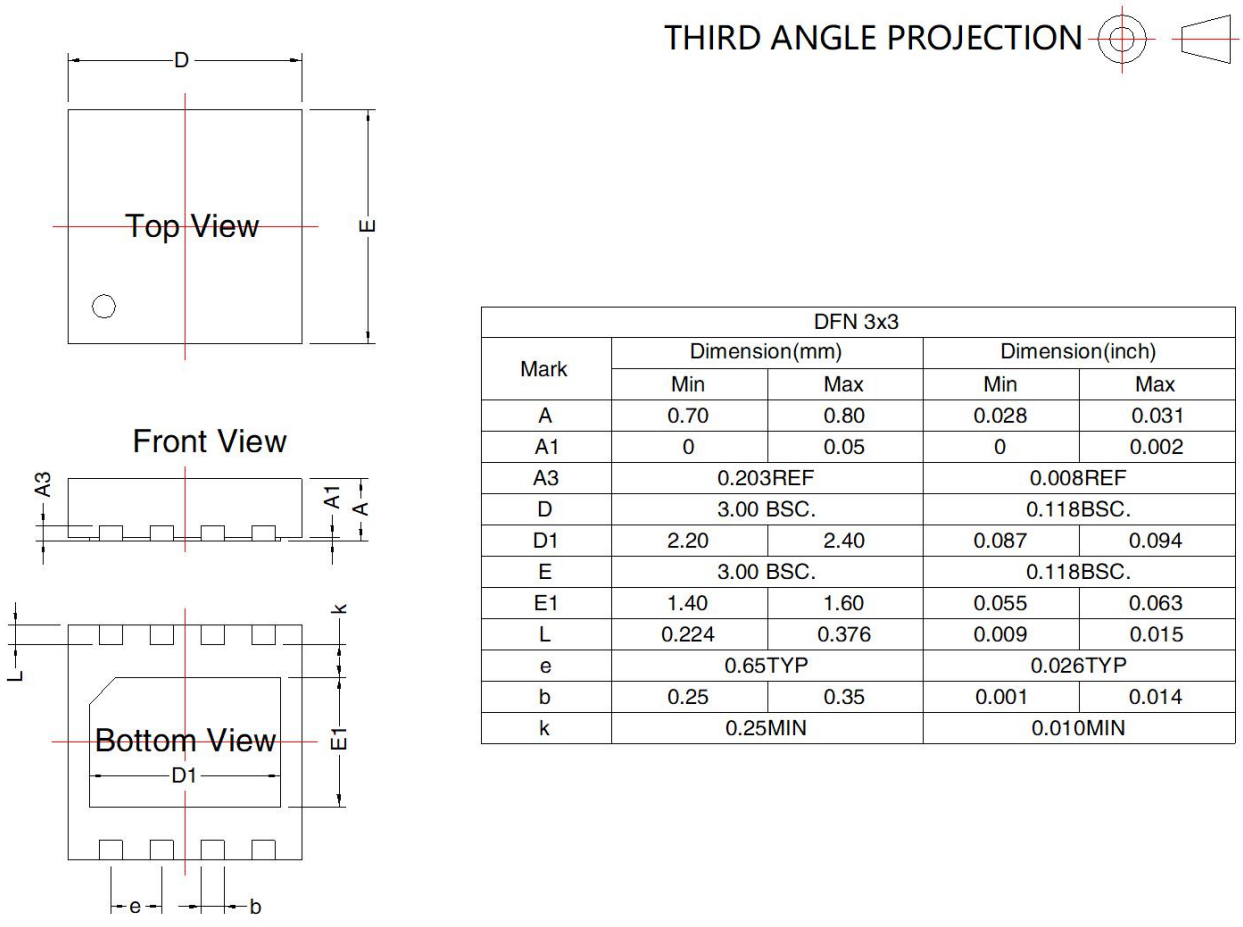
Description of product code

SCM3406AFAXYZ：

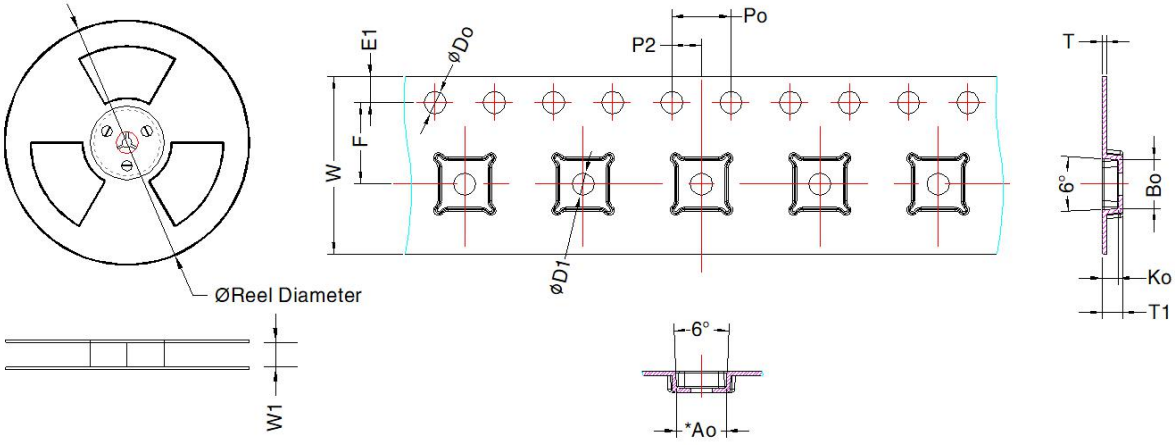
(1) SCM3406AFA, product code.
(2) X = A-Z, version code.
(3) Y = F encapsulation code; F: DFN encapsulation.
(4) Z = C, I, A, M, temperature grade code; C: 0℃-70℃, I:-40℃-85℃, A:-40℃-125℃, M:-55℃-125℃.

Product marking:
3406X
YM
(1) X = A-Z, version code
(2) YM: Product traceability code; Y: Code of product production year, M: Code of product production month

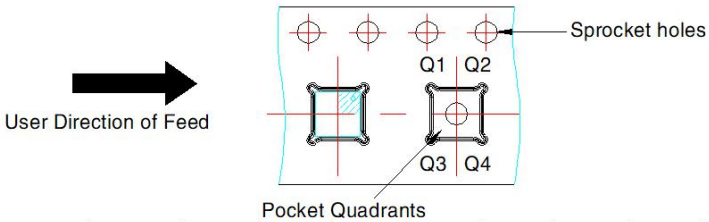
## Package Information




| DFN 3x3 | | | | |
|---|---|---|---|---|
| Mark | Dimension(mm) | | Dimension(inch) | |
| | Min | Max | Min | Max |
| A | 0.70 | 0.80 | 0.028 | 0.031 |
| A1 | 0 | 0.05 | 0 | 0.002 |
| A3 | 0.203REF | | 0.008REF | |
| D | 3.00 BSC. | | 0.118BSC. | |
| D1 | 2.20 | 2.40 | 0.087 | 0.094 |
| E | 3.00 BSC. | | 0.118BSC. | |
| E1 | 1.40 | 1.60 | 0.055 | 0.063 |
| L | 0.224 | 0.376 | 0.009 | 0.015 |
| e | 0.65TYP | | 0.026TYP | |
| b | 0.25 | 0.35 | 0.001 | 0.014 |
| k | 0.25MIN | | 0.010MIN | |




The orientation of IC in tape




| Device | Package Type | MPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | T (mm) | W (mm) | E (mm) | F (mm) | P1 (mm) | P0 (mm) | D0 (mm) | D1 (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCM3406AFA | DFN 3x3 | 6100 | 330.0 | 12.4 | 3.34 ± 0.1 | 3.34 ± 0.1 | 1.10 ± 0.1 | 0.30 ± 0.05 | 12.0 ± 0.3 | 1.75 ± 0.1 | 5.5 ± 0.1 | 8.0 ± 0.1 | 4.0 ± 0.1 | 1.5 ± 0.1 | 1.5 ± 0.1 | Q2 |

Note: Minimum order quantity is the minimum packing quantity the order quantity is the integer times of MPQ

Technical requirement:

1. Color：Blue ( Reference color number:
   PANTONE DS 196-1 C: C100 M70 Y0 K0
   PANTONE DS 197-1 C: C100 M70 Y0 K10
   PANTONE DS 205-1 C: C100 M60 Y0 K20
   PANTONE DS 205-2 C: C85 M50 Y0 K20
   PANTONE DS 206-2 C: C85 M50 Y0 K35
   PANTONE DS 219-1 C: C90 M50 Y5 K15 )
2. Dimensions and tolerances according to ANSI/EIA-481-C-2003;
3. Disk surface good finish, no warping deformation;
4. External packing in good condition, no damage or pollution.

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