晶焱科技股份有限公司
Amazing Microelectronic Corp.

AZRS1396T
Auto-Powerdown
+3.0V to +5.5V RS-232 3Tx/5Rx Transceiver
with IEC61000-4-2 Contact ±8kV ESD Protection

Features

● Meets EIA/TIA-232-F standards from a +3.0V to +5.5V power supply
● Guaranteed data rate 2Mbps under loading
● Three Transmitters and Five Receivers design
● AUTO-Powerdown function for power saving
● Latch-up free
● External Capacitor : 4 x 0.1μF
● Accepts 5V Logic Input under 3.3V supply
● Integrated ESD Transient Voltage Suppressor (TVS) in the Transceiver IC
● TVS protection Immunities for Bus Terminals:
  ± 8 kV IEC 61000-4-2 Contact Discharge
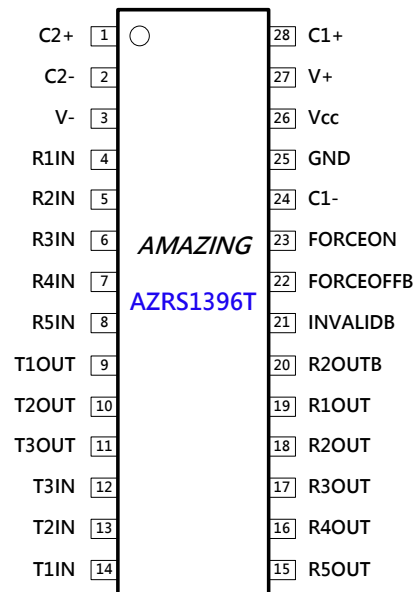 ±15kV IEC 61000-4-2 Air Discharge

Applications

● Portable Computers
● Battery-Powered Systems
● Production Data Acquisition (PDA) and Point of Sale (POS) terminal
● Routers and HUBs
● Peripherals and Printers
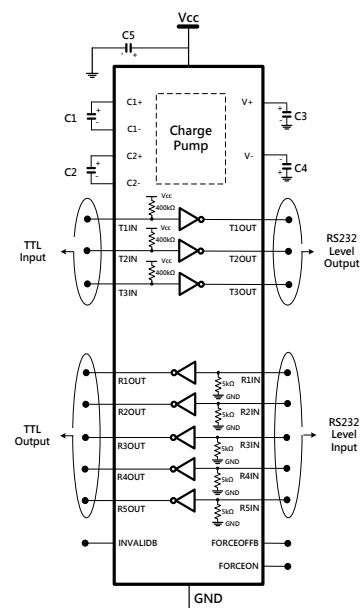● Industrial Controlled Machine

Description

AZRS1396T is an RS-232 transceiver that meets the EIA/TIA-232-F standards under supply power +3.0V to +5.5V. AZRS1396T is a 3-transmitter and 5-receiver device with a high-efficient charge pump circuit embedded. This high-efficient charge pump circuit with 0.1μF external capacitors provides the bipolar output to the transmitters. AZRS1396T includes the AUTO-Powerdown function, which is functioned to wake up when peripheral is connected and to shut itself down when peripheral is disconnected. The AZRS1396T also includes one complementary receiver for monitor of external device's Ring Indicate signal.
AZRS1396T operates with ultra low power consumption under guaranteed data rate of 2Mbps. AZRS1396T is ideal transceiver IC for portable application such as notebook or PDA.

AZRS1396T is also a high reliable device with both latch-up free and enhanced ESD protection. All the outputs of transmitters and the inputs of receivers can meet the specifications of IEC 61000-4-2 contact ±8kV, and air ±15kV.

Pin Configuration for AZRS1396T

Functional Block of AZRS1396T

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS			
PARAMETER	**PARAMETER**	**RATING**	**UNITS**
Power Supply Vcc	Vcc	-0.3 to +6.0	V
Charge Pump Positive Output V+	V+	-0.3 to +9.5	V
Charge Pump Negative Output V-	V-	+0.3 to -9.5	V
V+, V- Supply voltage difference	|V+ - V-|	19	V
Transmitter Input and Enable Pin	TxIN , FORCEON, FORCEOFFB	-0.3 to (Vcc +0.3)	V
Receiver Input	RxIN	±25	V
Transmitter Output	TxOUT	±13.2	V
Receiver Output	RxOUT, RxOUTB	-0.3 to (Vcc +0.3)	V
Operating Temperature	T_{OP}	-40 to +125	^{o}C
Storage Temperature	T_{STO}	-65 to +150	^{o}C

ELECTRICAL CHARACTERISTICS

Unless otherwise noted, the following specifications apply for Vcc= +3.0V to +5.5V with T_{AMB}= -40 ^{o}C to +125 ^{o}C. C1 to C4=0.1µF. Typical values apply at Vcc=+5V and T_{AMB}=25 ^{o}C.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
DC CHARACTERISTICS					
Supply Current (Auto-powerdown disabled)	FORCEON=Vcc, FORCEOFFB= Vcc, TxIN=Floating or Vcc or GND, No Load		0.3	3	mA
Powerdown Supply Current (Auto-powerdown enabled)	FORCEON=GND, FORCEOFFB= Vcc, TxIN=Floating or Vcc or GND, No Load		10	100	µA
Powerdown Supply Current (Shutdown)	FORCEON=Vcc or GND, FORCEOFFB=GND, TxIN=Floating or Vcc or GND, No Load		10	100	µA
LOGIC INPUTS					
Logic Input Voltage Low	TxIN, Vcc=3.3V			0.8	V
	TxIN, Vcc=5V			0.8	V
Logic Input Voltage High	TxIN, Vcc=3.3V	2.0			V
	TxIN, Vcc=5V	2.4			V

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Logic Input Pull-up Current	TxIN=GND		12	25	μA
TRANSMITTER OUTPUTS					
Output Voltage Swing	3kΩ load to ground, Vcc=3.3V	±3.9	±5		V
	3kΩ load to ground, Vcc=5V	±5	±8		V
Output Resistance	Vcc=V+=V-=0V, V_{OUT}=±2V	300			Ω
Output Short-Circuit Current	V_{OUT}=0V		±25	±60	mA
Output Leakage Current	FORCEOFFB=GND, V_{OUT}=±12V, Vcc=0V or 3.0V to 5.5V, Transmitters disabled.		±10		uA
RECEIVER INPUTS AND OUTPUTS					
Input Voltage Range		-25		25	V
Positive-going input threshold voltage	Vcc=3.3V		1.7	2.4	V
	Vcc=5.0V		2.0	2.4	
Negative-going input threshold voltage	Vcc=3.3V	0.8	1.4		V
	Vcc=5.0V	0.8	1.7		
Input Hysteresis			0.3		V
High-level output voltage	I_{OH}=-1mA	Vcc -0.6	Vcc – 0.1		V
Low-level output voltage	I_{OL}=+1.6mA			0.4	V
Output Leakage Current	Receivers disabled, FORCEOFFB=GND, V_{OUT}=0 to Vcc		±0.1	±25	μA
Input Resistance		3	5	7	kΩ
TIMING CHARACTERISTICS					
TRANSMITTER					
Maximum Data Rate	R_L=3kΩ, C_L=150pF, one transmitter switching		2		Mbps
Transmitter Propagation Delay	t_{DPHL}, TxIN to TxOUT, R_L=3kΩ, C_L=150pF		100		ns
	t_{DPLH}, TxIN to TxOUT, R_L=3kΩ, C_L=150pF		100		
Transmitter Skew	| t_{DPHL} – t_{DPLH} |, R_L=3kΩ, C_L=150pF		20		ns
Transition-Region Slew	R_L=3kΩ, C_{LT}=2200pF, One		12		V /μs

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Rate	Transmitter Switching, transition from -3.0V to +3.0V or +3.0V to -3.0V (See Note 1)				
RECEIVER					
Receiver Propagation Delay	t_{RPHL}, RxIN to RxOUT, C_L=150pF		800		ns
	t_{RPLH}, RxIN to RxOUT, C_L=150pF		800		
Receiver Skew	| t_{RPHL} − t_{RPLH} |, C_L=150pF		20		ns
Receiver Output Enable Time	t_{PZL}, FORCEOFFB to RxOUT, C_L=150pF, R_L=3kΩ to Vcc, RxIN=Vcc		35		ns
	t_{PZH}, FORCEOFFB to RxOUT, C_L=150pF, R_L=3kΩ to GND, RxIN=GND				
Receiver Output Disable Time	t_{PLZ}, FORCEOFFB to RxOUT, C_L=150pF, R_L=3kΩ to Vcc, RxIN=Vcc		350		ns
	t_{PHZ}, FORCEOFFB to RxOUT, C_L=150pF, R_L=3kΩ to GND, RxIN=GND				
AUTO-POWERDOWN ELECTRICAL CHARACTERISTICS					
Receiver input voltage for INVALIDB high-level output	FORCEON=GND, FORCEOFFB=Vcc	-2.7		2.7	V
Receiver input voltage for INVALIDB low-level output	FORCEON=GND, FORCEOFFB=Vcc	-0.3		0.3	V
V_{OH} INVALIDB high-level output voltage	I_{OH}=-1.0mA, FORCEON=GND, FORCEOFFB=Vcc	V_{CC}-0.6			V
V_{OL} INVALIDB low-level output voltage	I_{OL}=+1.6mA, FORCEON=GND, FORCEOFFB=Vcc			0.4	V
AUTO-POWERDOWN TIMING					
Receiver Input to INVALIDB output high				1	µs
Receiver Input to INVALIDB output Low			30		µs
Powerdown mode to Supply enabled			100		µs

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
ESD PROTECTION					
Pin Name (Pin Number)	**Test Condition**				
RxIN(4,5,6,7,8)	IEC61000-4-2 Contact	-8		+8	kV
TxOUT(9,10,11)	IEC61000-4-2 Air	-15		+15	kV
All Other Pins	HBM	-2		+2	kV

Note 1:

C_{LT} includes C_{SR} & C_L.

C_{SR} is application circuit for slew-rate (Low-speed).

C_L includes probe and jig capacitance.

Application circuit for note 1

PIN FUNCTION DESCRIPTION

Pin Number	Mnemonic	Description
1	C2+	Positive terminal of the second switch capacitor
2	C2-	Negative terminal of the second switch capacitor
3	V-	Negative voltage of charge pump output
4	R1IN	First receiver input
5	R2IN	Second receiver input
6	R3IN	Third receiver input
7	R4IN	Fourth receiver input
8	R5IN	Fifth receiver input
9	T1OUT	First transmitter output
10	T2OUT	Second transmitter output
11	T3OUT	Third transmitter output
12	T3IN	Third transmitter input
13	T2IN	Second transmitter input
14	T1IN	First transmitter input
15	R5OUT	Fifth receiver output
16	R4OUT	Fourth receiver output
17	R3OUT	Third receiver output
18	R2OUT	Second receiver output
19	R1OUT	First receiver output
20	R2OUTB	Second receiver non-inverting output. Always active
21	INVALIDB	Output of a valid signal detection. INVALIDB is enabled high if a valid RS232 level is present on any receiver input.
22	FORCEOFFB	Force off control. Force both the charge pump and the transmitters off.
23	FORCEON	A logic HIGH to override AUTO-Powerdown circuit keeping transmitters on. (FORCEOFFB must be HIGH)
24	C1-	Negative terminal of the first switch capacitor
25	GND	Ground of the device
26	Vcc	+3.0V to +5.5V Supply voltage
27	V+	Positive voltage of charge pump output
28	C1+	Positive terminal of the first switch capacitor

Detail Description

AZRS1396T is a RS-232 transceiver that meets the EIA/TIA-232 and V.28/V.24 communication protocols. AZRS1396T is a 3-transmitter /5-receiver device with a high-efficient charge pump circuit embedded. The design of high-efficient charge pump circuit is Amazing's property that can generate RS-232 voltage levels from +3.0V to +5.5V power supply. This high-efficient charge pump circuit with 0.1μF capacitors provides the bipolar output to the transmitters, and makes the transmitters deliver the RS-232 output voltage levels. The design of transmitter is also the property of Amazing. Under normal operation and with loaded, AZRS1396T can operate for guaranteed data rate of 2Mbps with ultra low power consumption. AZRS1396T is an ideal device for power saving issue due to the Auto-Powerdown circuit embedded. The Auto-Powerdown circuit will detect whether the RS232 cable is connected or not to decide to shut the device down or not. Therefore, AZRS1396T is ideal for portable application such as notebook or PDA.

AZRS1396T is also a high reliable device with both latch-up free and high ESD immunity. The high robust ESD devices embedded in AZRS1396T are also the properties of Amazing. All the outputs of transmitters and the inputs of receivers can meet the specifications of IEC 61000-4-2 contact ±8kV, and air ±15kV.

Bipolar Charge Pump Circuit

High-efficient charge pump circuit in AZRS1396T is a four-capacitance structure with single power supply input. Bipolar voltage output of AZRS1396T can be pumped to above ±5.0V under the +3.0V to +5.5V supply power range. Because a negative feedback regulator is embedded, the output voltage is independent of supply power voltage. Moreover, the charge pump can select 2-phase or 4-phase operation for more flexible design. When AZRS1396T is powered on, the bipolar output will be pumped to the steady output with low ripple voltage in the 500μs. Under the powerdown mode, charge pump can be waken up to reach the steady voltage within 100μs.

Transmitter

The design of the transmitter is an inverted translator that converts TTL/CMOS-logic voltage level to EIA/TIA-232 voltage level. The transmitters of AZRS1396T guarantee a 2Mbps data rate under the loading of 3kΩ resistance in parallel with 150pF capacitance. When the transmitters are active (FORCEOFFB=HIGH), the input signals of transmitters will be transported to the outputs of transmitters in inverting level.

The inputs of transmitters have 400kΩ pull-up resistors design to ensure the output of transmitter to be a LOW state when the input of transmitter is unconnected.

Receiver

The receivers of AZRS1396T convert EIA/TIA-232 voltage levels to TTL/CMOS-logic voltage levels. The receivers have an inverted tri-state output controlled by FORCEOFFB. When the FORCEOFFB is LOW, all the outputs of receivers operate in tri-state except for R2OUTB. When the FORCEOFFB is HIGH, the receivers are active, as listed in the Table2.

The receiver guarantees a 2Mbps data rate under the loading of a 150pF.

The inputs of receivers have 5kΩ pull-down resistors design to ensure the output of receiver to be a HIGH state when the input of receiver is unconnected.

Application Information

To generate the high-efficient bipolar charge pump, the four capacitors (C1 ~ C4) must be placed as closer to RS232 transceiver as possible. The trace of the PCB layout is suggested to be shorter than 1cm from the pinout of the charge pump to the dedicated capacitor. The other node of dedicated capacitor should be connected to ground shortly, too. Moreover, the capacitor of power supply (C5) should be placed as close to the transceiver as possible, and connect to ground nearby.

If Slew-rate (Low speed) is required, it can be connected to the application circuit: C_{SR1}, C_{SR2} & C_{SR3} are connected to T1OUT, T2OUT & T3OUT (Recommended value of C_{SR1}, C_{SR2} & C_{SR3} = 2200pF)

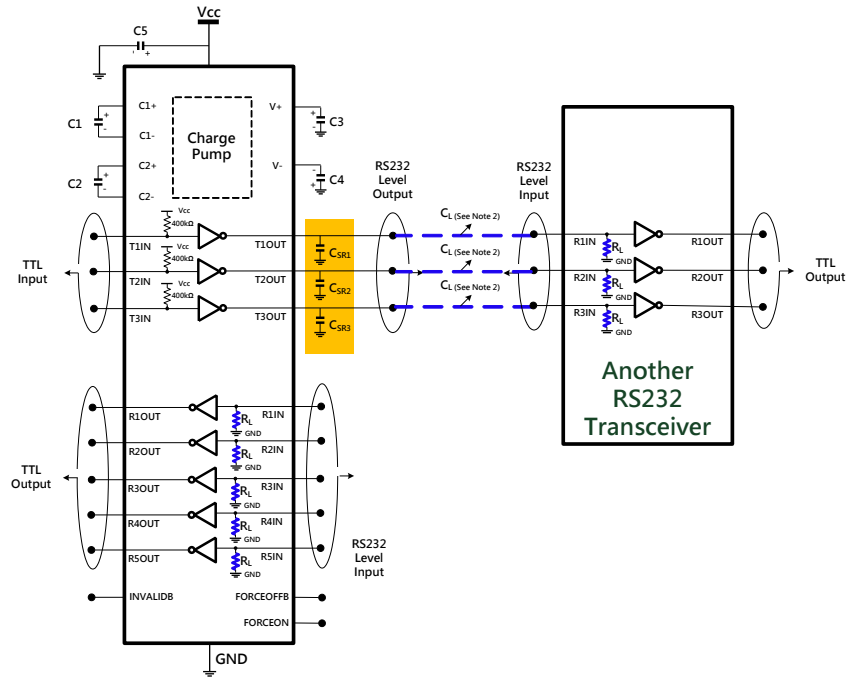In other applications, C3 could be changed to connect to Vcc.

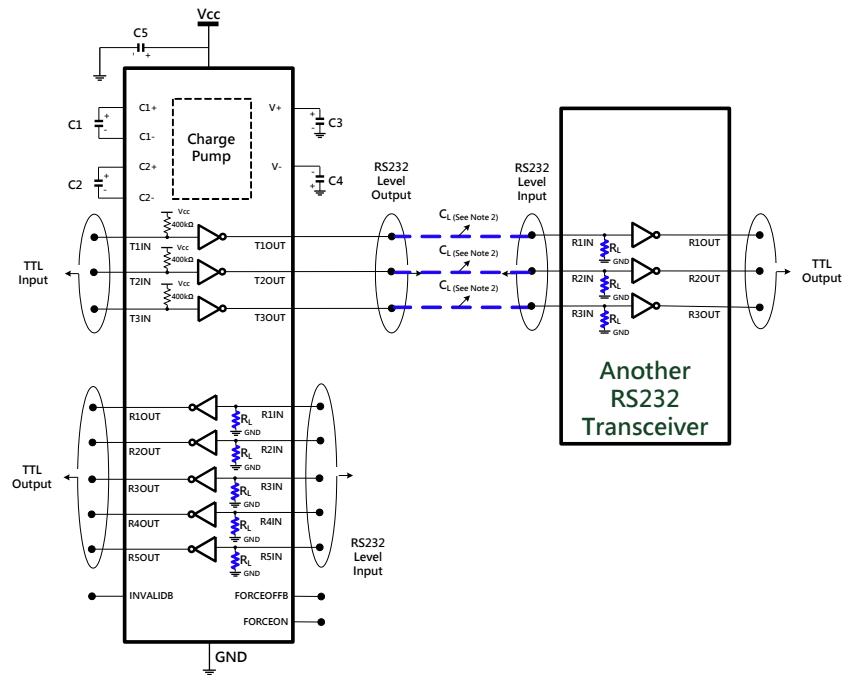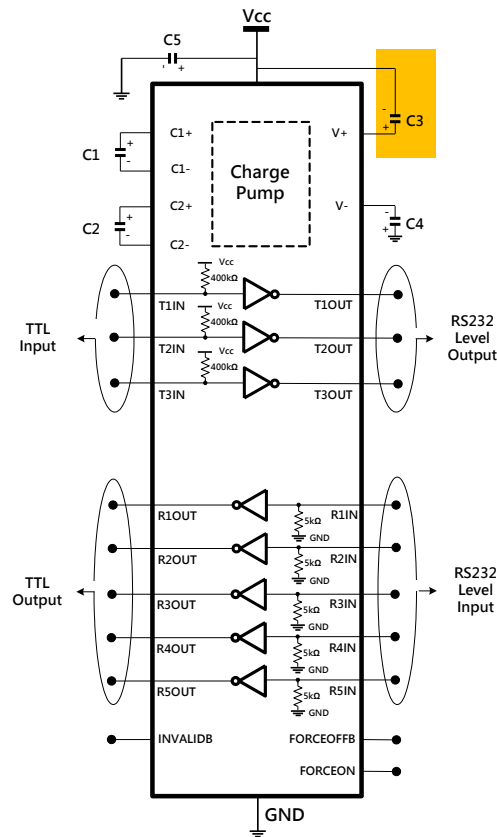**Operation of AZRS1396T for Slew-rate (Low-speed)**

Operation of AZRS1396T (High-speed)

Note 2:
C_L includes probe and jig capacitance

Application circuit for note 3

Note 3:
C3 could be changed to connect to Vcc

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Table 1 Function Table of Transmitter

INPUTS				OUTPUT	Transmitter Status
TxIN	FORCEOFFB	FORCEON	VALID RxIN RS-232 Level	TxOUT	
X	L	X	X	Z	Shutdown
L	H	H	X	H	Active
H	H	H	X	L	(Auto-powerdown disabled)
L	H	L	Yes	H	Active
H	H	L	Yes	L	(Auto-powerdown enabled)
X	H	L	No	Z	Shutdown by Auto-powerdown feature

H = High level, L = Low level, X = Irrelevant, Z = High impedance.

Table 2 Function Table of Receiver

INPUTS			OUTPUT	Receiver Status
RxIN	FORCEOFFB	FORCEON	RxOUT	
L	H	X	H	Active
H	H	X	L	Active
X	L	X	Z	Shutdown
OPEN	H	X	H	Active

H = High level, L = Low level, X = Irrelevant, Z = High impedance,

OPEN = Input disconnected or connected driver off.
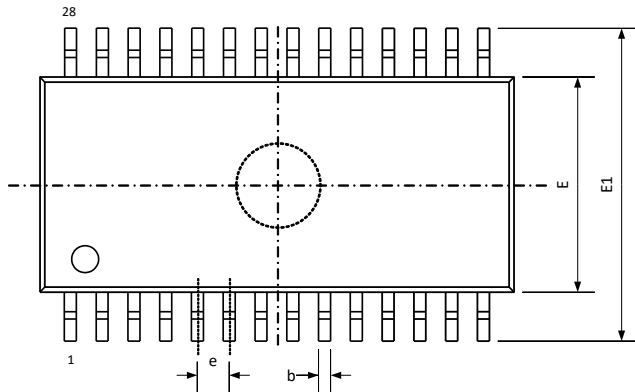
Table 3 R2OUTB and Outputs INVALIDB

INPUTS				OUTPUTS		Output Status
VALID RxIN RS-232 Level	R2IN	FORCEOFFB	FORCEON	INVALIDB	R2OUTB	
Yes	L	X	X	H	L	
Yes	H	X	X	H	H	
Yes	OPEN	X	X	H	L	Always active
No	OPEN	X	X	L	L	

H = High level, L = Low level, X = Irrelevant, Z = High impedance,
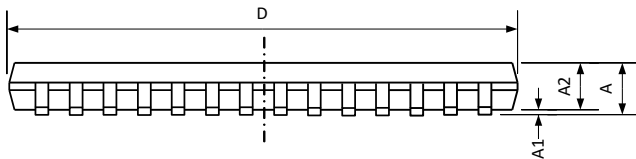
OPEN = Input disconnected or connected driver off.
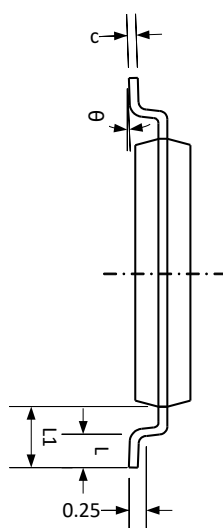
Mechanical Details
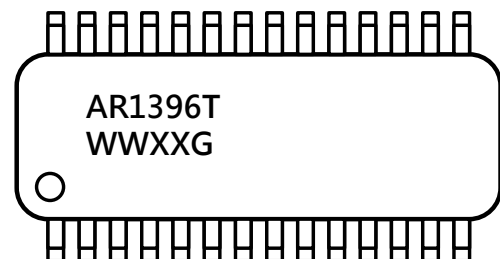
TSSOP-28L(173)
PACKAGE DIAGRAMS
TOP VIEW

SIDE VIEW

END VIEW

PACKAGE DIMENSIONS

SYMBOL	MILLIMETERS		
	MIN	NOM	MAX
A	-	-	1.20
A1	0.05	-	0.15
A2	0.80	-	1.00
b	0.19	-	0.30
c	0.09	-	0.20
D	9.60	9.70	9.80
E1	6.20	6.40	6.60
E	4.30	4.40	4.50
e	0.65BSC		
L	0.45	0.60	0.75
L1	1REF		
θ	0	-	8°

Marking Code

AR1396T = Device Code

WW = Date Code ; XX = Control Code

G = Green Part Indication

Part Number	Marking Code
AZRS1396T.RDG (Green part)	AR1396T WWXXG

Ordering Information

PN#	Material	Type	Reel size	MOQ	MOQ/internal box	MOQ/carton
AZRS1396T.RDG	Green	T/R	13 inch	3,000/reel	1 reel =3,000/box	5 boxes = 15,000/carton

Revision History

Revision	Modification Description
Revision 2024/03/29	Formal Release.
Revision 2024/09/23	Upgrade min. of Output Voltage Swing & Add Application information