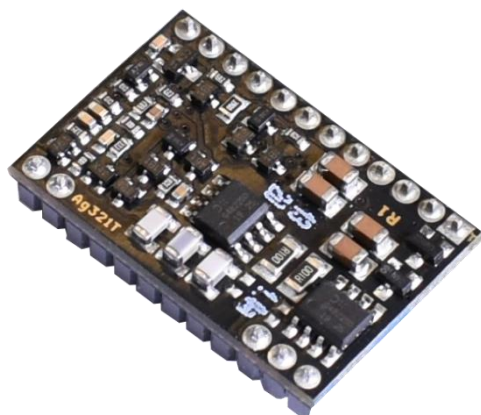




# Ag321T

15 Watt Qi compatible Wireless Power Module



## Features

- Qi compatible wireless power transmitter for 15W and 5W receiver
- Backward compatible Silvertel's proprietary 15W receivers the Ag320R
- Low bit rate customer communication(with Ag320R)
- Foreign object detection
- Low Standby Current
- Size 32 mm x 21 mm x 7.2 mm
- Simple Integration

## Description

The Ag321T is a wireless power transmitter module; designed to work with a 15W Qi receiver or the Ag320R to deliver 15W maximum power or backward compatible at 5W with any other Qi compliant wireless power receiver (E.g. the Ag301), typically used in wireless charging applications.

With the increased use of mobile & portable devices, the Ag321T wireless power module offer a wide range of benefits: -

There are no cables to get tangled and you don't have the problem of having different plugs or sockets for various devices. There is no risk of electrical shock, as there are no exposed metal parts. Can be used in explosive environments as there are no contacts to cause sparks. This means that there is no contact degradation due to friction, corrosion or abrasion. The units can be completely sealed for use in harsh environments, as its operation is not affected by dirt, dust, water or chemicals and can even be used underwater. Can be used in medical environment where disinfecting and sterilization is required. The Ag321T has 3 times the power of standard Qi wireless power making it suitable for higher power applications.

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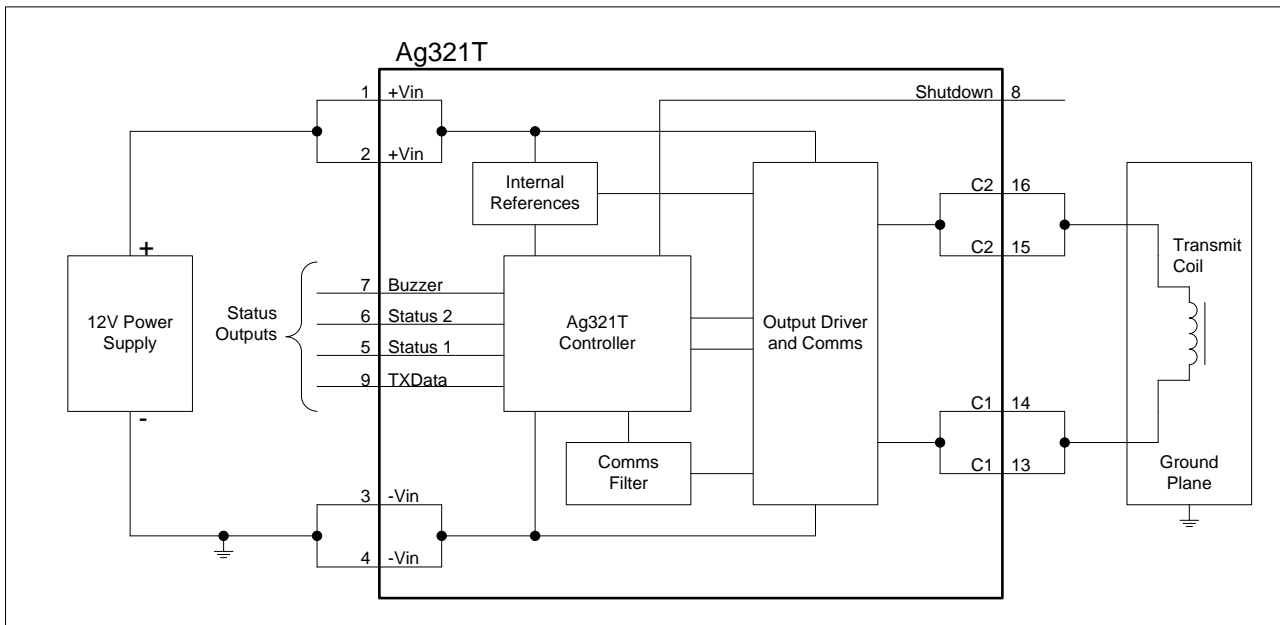
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### 1 Ag321T Product Selector<sup>†</sup>

Part Number	Input Voltage	Output Voltage	Maximum Output Current	Type
Ag321T	12V			Transmitter

<sup>†</sup> The Ag321T fully meets the requirements of the RoHS directive 2002/95/EC on the restriction of hazardous substances in electronic equipment.

**Table 1: Ordering Information**

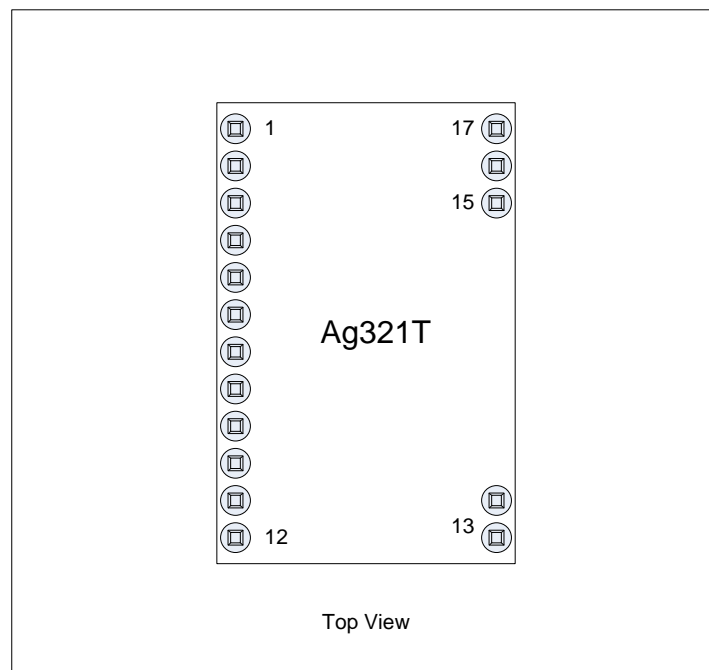


**Figure 1: Ag321T Block Diagram**

## 2 Pin Description

### 2.1 Ag321T

Pin	Name	Description
1	+Vin	<b>12V (Supply).</b> These pins connect to an external +12V power supply rail.
2		
3	-Vin	<b>0V (Supply).</b> These pins connect to the 0V return rail of the input power supply.
4		
5	Status 1	<b>Status (Outputs).</b> These pins indicate the status of the Ag321T.
6	Status 2	
7	Buzzer	<b>Buzzer (Output).</b> This pin can be connected to an external DC buzzer.
8	Shutdown	<b>Shutdown (Input).</b> Pulling this input low, will stop the Ag321T transmitting power. This pin has an internal pull up to a +3.3V rail.
9	TXData	<b>TXData (Output).</b> Serial output of received data from the powered Ag320R. details in section 5.6
10	NC	
11	NC	
12	NC	
13	C2	<b>Coil Return.</b> These pins connect to return of the transmitter coil.
14		
15	C1	<b>Output Coil.</b> These pins connect to the transmitter coil.
16		
17	NC	

**Figure 2: Ag321T Package Format**

## 3 Functional Description

### 3.1 Wireless Power Overview

When the Ag321T wireless transmitter is connected to a 12V supply, it will start up and will commence looking for a 15w Qi receiver, Ag320R, Ag301 or other Qi Compatible wireless receiver in range.

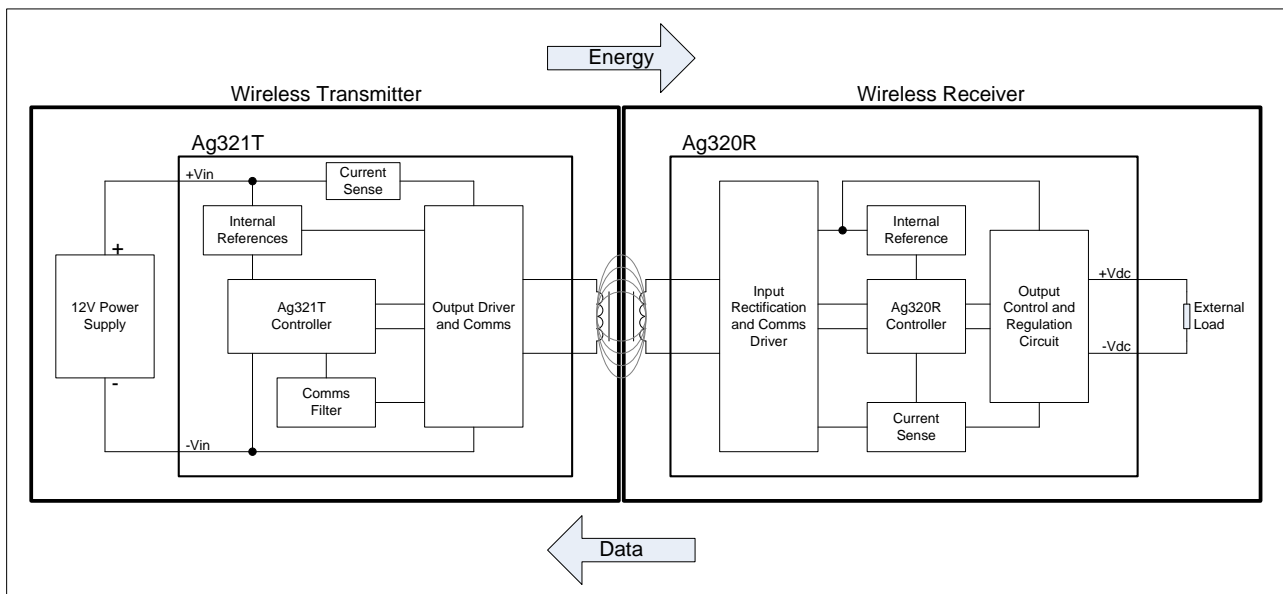
It does this by applying a short power signal to the transmit coil to detect an object. If an object is detected then this signal is extended, looking for a “Ping” data message back from the receiver.

If a valid “Ping” message is not received, the transmitter will remove the power signal and wait ~500ms before repeating the above process.

If a valid “Ping” message is received, the power signal is maintained and the transmitter looks for the “Identification & Configuration” message and the “Power Transfer” message.

If either the “Identification & Configuration” or the “Power Transfer” messages are invalid, the transmitter will remove the power signal and wait ~500ms before repeating the above steps.

If the transmitter receives valid data, it will maintain and adjust the power signal in accordance with the data sent back from the receiver. The Status 1 output will go to logic 1 and the Buzzer output pin will go to logic 1 for ~500ms, indicating that the power transfer has started.



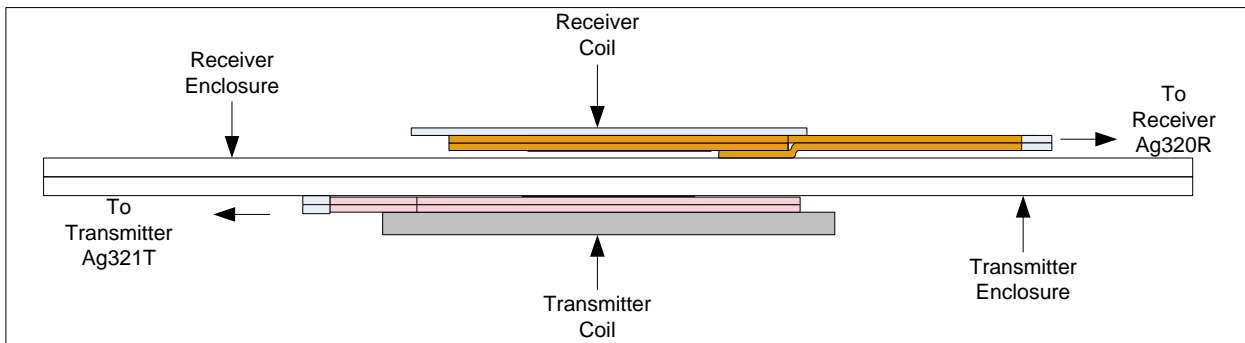
**Figure 3: Charger Overview**

### 3.2 Coils and Alignment

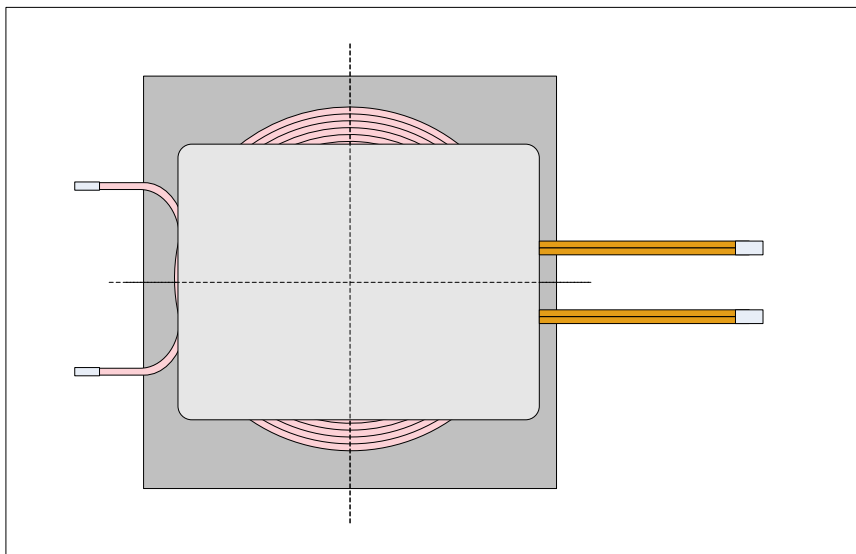
The wireless power connection is established through transmit and receive coils. For the Ag321T we recommend Würth Elektronik 760308100141, Würth Elektronik 760308103102 or equivalents.

The nominal alignment position of the coils is shown below in Figure 4 and 5.

In Figure 4 you can see that the coils are separated by the transmitter and receiver enclosures. The Qi specification allows the transmitter enclosure thickness to be between 1.5mm to 2.25mm, and the receiver enclosure thickness to be between 0mm to 2.5mm. The Ag321T has been designed to meet this specification and the Ag320R is capable of operating well beyond the 2.5mm specification.

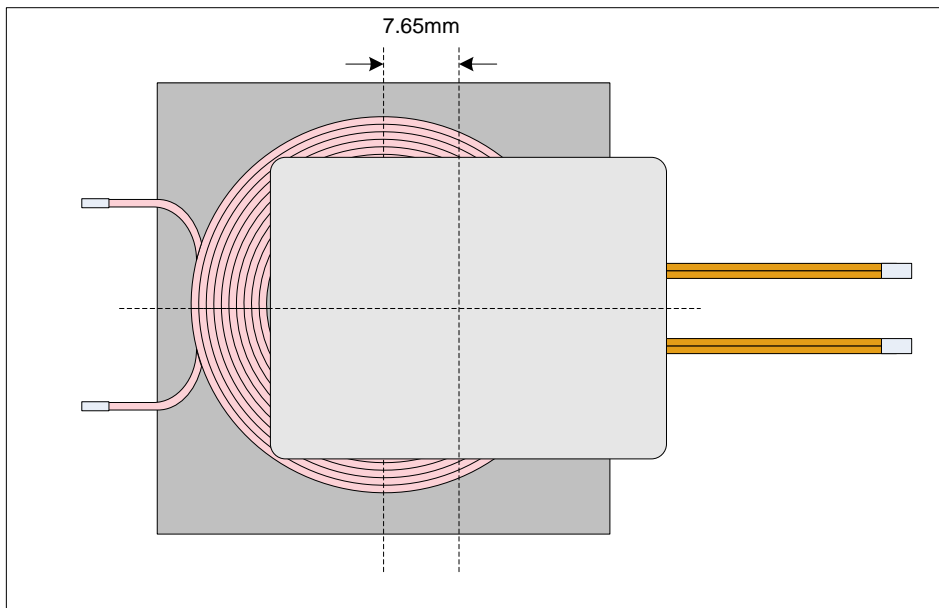


**Figure 4: Horizontal View**

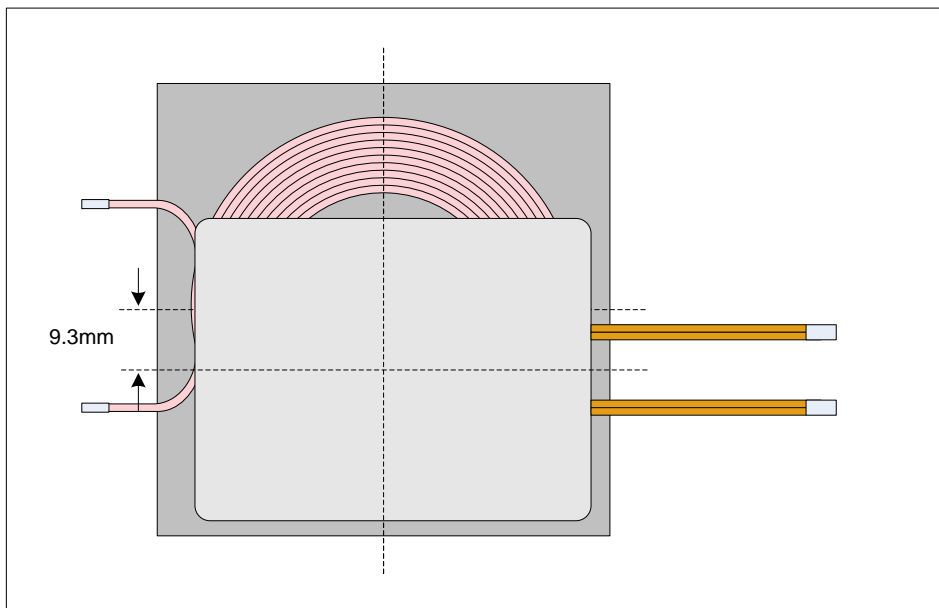


**Figure 5: Vertical View**

Figure 5 shows the Ag320R and Ag321T coils perfectly centred, which is the optimum position for power and data transfer. But the Ag320R and Ag321T will operate if the coils are not perfectly centred. Figures 6 and 7 shows the amount the coils can be offset, still allowing the Ag320R and Ag321T to start up even at full load.



**Figure 6: X Offset**



**Figure 7: Y Offset**

Once the Ag320R is fully up and running, the X Offset can be increased to ~7.65 mm or the Y Offset increased to ~9.3 mm.

### 3.3 Input Power Supply

It is important that the input power supply used, is a stable regulated 12V supply with low ripple. It is also very important that the voltage drop between the power supply output and the Ag321T input is kept as low as possible. Using a low quality power supply or high resistance connections can cause operational stability issues. This may result in additional ripple on the output of the receiver, or no operation at all.

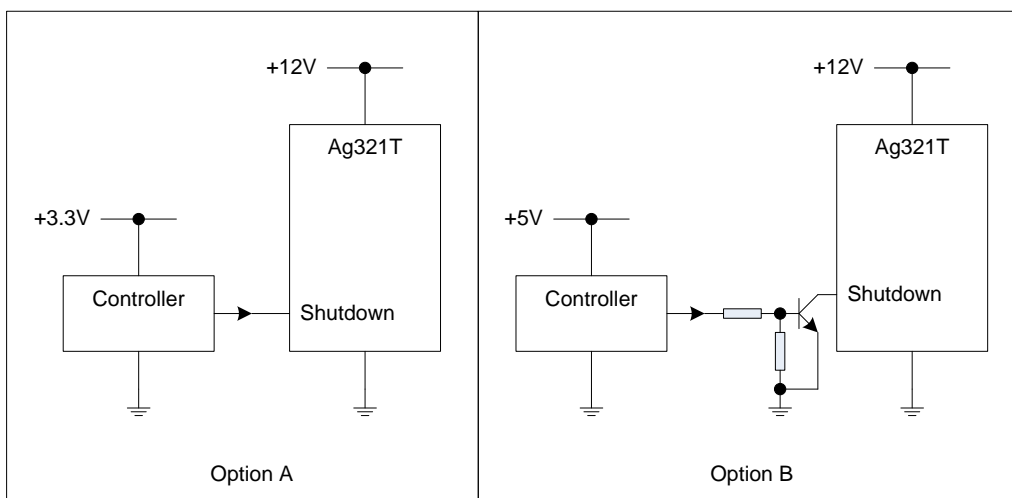
To ensure that you can get the maximum available power from the receiver, it is important that the input supply has sufficient power (see Section 10.3). The Ag321T will work with a limited power supply, but if the load tries to draw too much power the Ag321T will shut down.

### 3.4 Shutdown Input

The Ag321T has an optional control input: – Shutdown.

This input has an internal pull-up to a +3.3V reference. It can be driven directly from a controller (or logic gate) that has a +3.3V rail, or via an external transistor if the external rail is not +3.3V (see Figure 8).

It is important that if Figure 8 “Option A” is used, that the controller output is tri-state or high at start-up. If this is an issue, then “Option B” may be a better solution. The transistor does not need to be anything special and the resistors can be high values (100K $\Omega$ ).



**Figure 8: Control Inputs**

When this input is pulled low, the Ag321T will stop sending power and enter into error mode.

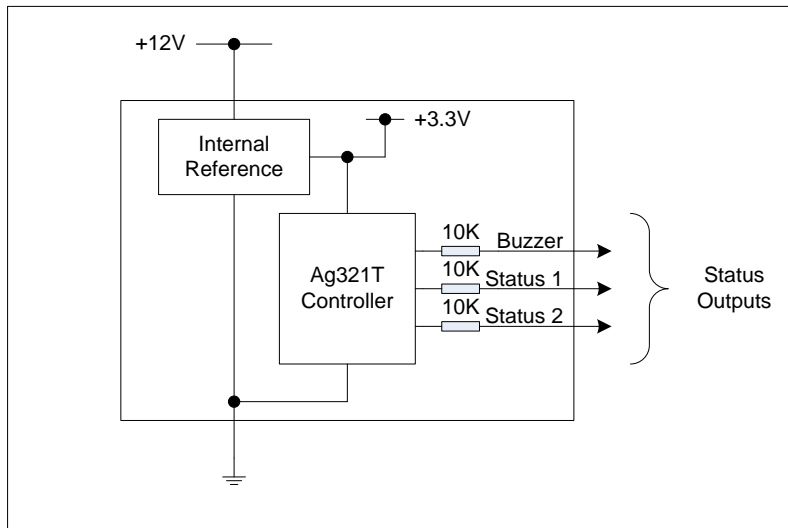
One of the applications where the Shutdown input can be used is for thermal protection. With one or more thermistors (thermally) connected to the coil, a controller could monitor the temperature and disable the Ag321T if the temperature gets too high.



### 3.5 Status Outputs

The Ag321T module has three status output pins – Buzzer, Status 1 and Status 2.

These outputs are all driven from an internal +3.3V reference and are limited with an internal 10K series resistor (see Figure 9).



**Figure 9: Status Outputs**

#### 3.5.1 Buzzer

On successful completion for the start-up communication protocol (as detailed in Section 5.1), this output will go to logic 1 (with reference to the internal +3.3V rail, shown in Figure 9) for a duration of ~500ms. This output can be connected to a Piezoelectric buzzer (as shown in Figure 10) to give an audible indication that the Ag321T has started to supply power to a receiver.

#### 3.5.2 Status 1 & 2

The two Status output pins indicate the operational condition of the Ag321T. Table 2 shows the output logic state of these outputs. Logic 1 is referenced to the internal +3.3V rail and current limited by the internal 10K series resistors (as shown in Figure 9).

Ag321T Status	Status 1 Output	Status 2 Output
Idle	0	0
Charging	1	0
Error	0	1
Charge Complete	1	1

**Table 2: Status 1 & 2**

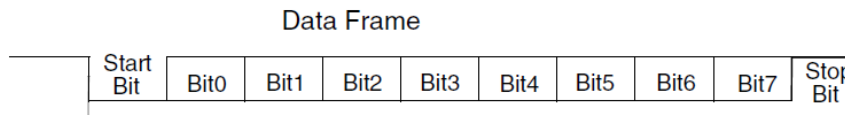
### 3.6 TXData - Customer communications output

The Ag321T module has an output for a low bit rate communications channel for the application use. The communications channel is 1 way from the Ag320R to Ag321T.

The communication is transmitted over the power interface, using the same method as the power control data. This means the data rate is limited and varies depending on load variation. It has an approximate maximum of 4 bytes per second when the load is stable.

The Ag320R interfaces with the user application using an SPI interface. When a byte of data is received it is transmitted in the next available slot between the power control data to the transmitter. Full details of Ag320R interface in the Ag320R datasheet section 5.4.

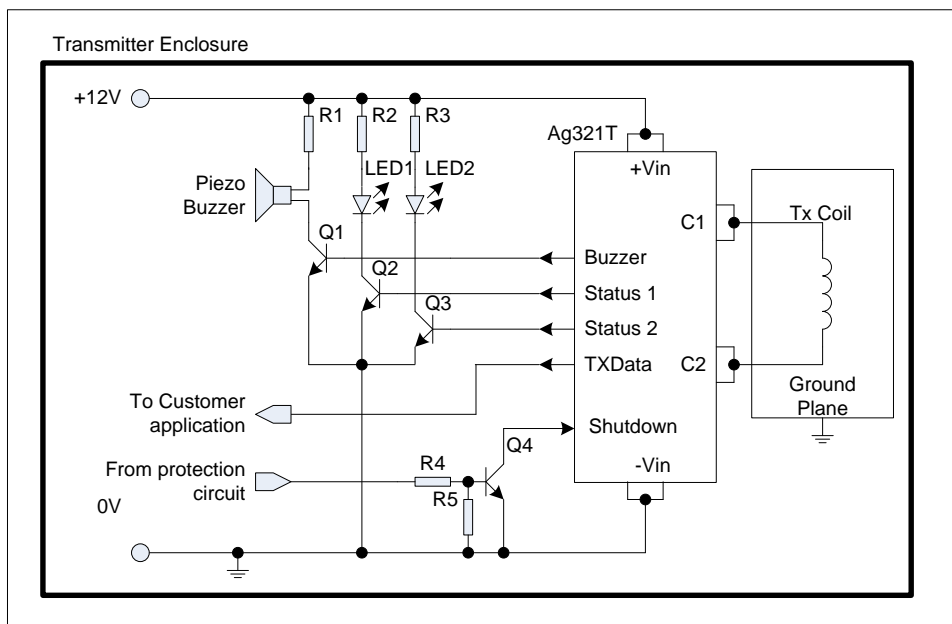
When the Ag321T receives a byte of data, it is immediately transmitted on the TXData pin, as an asynchronous serial byte at 9600 bps baud rate. The data format is idle line high, 1 start, 1 stop bit and no parity. As shown in figure 10.



**Figure 10: Output data frame format**

## 4 Typical Connections

The Ag321T is very easy to implement, Figure 11 shows typical application drawing, giving a basic overview.



**Figure 11: Typical Application Drawing**

## 5 Typical Applications

The Ag321T can be used in a wide range of wireless power and charging applications and with the increased use of mobile & portable devices this list is expanding every day.

At present one of the biggest market sectors for wireless charging are in mobile phones.

But there are many more applications that can benefit from the advantages of wireless power transfer.

Because there are no contacts to cause sparks, wireless charging can be used in environments where combustible materials or gases are present.

Also as the transmitter and receiver can be built into completely sealed enclosures; they can be used in harsh environments, where dust, dirt, water or chemicals are present.

On the other end of the spectrum, wireless power also lends itself for use in clean environments, where disinfecting and sterilization is required.

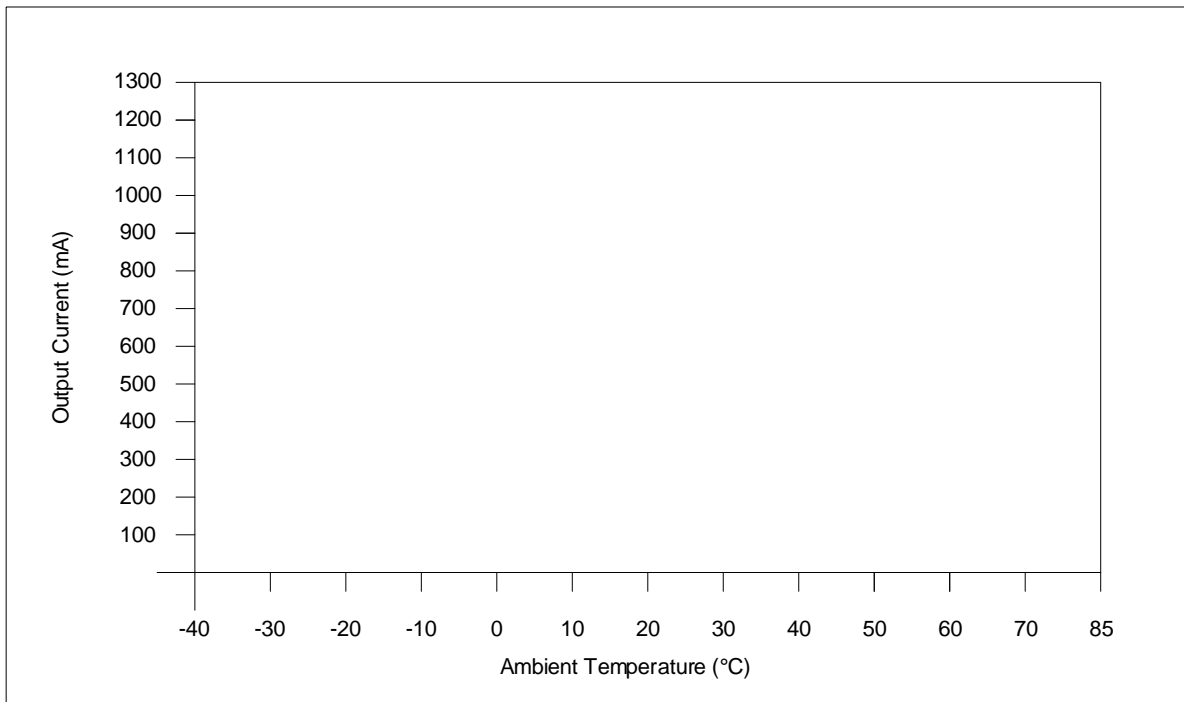
## 6 Operating Temperature

The Ag321T has to drive the output transmission coil, this process does cause the module to generate heat and as a result this will need to be taken into consideration.

The amount of heat generated by the module is primarily related to the current being drawn by the receiver and distance of power transfer. So care needs to be taken to control the ambient temperature around the module.

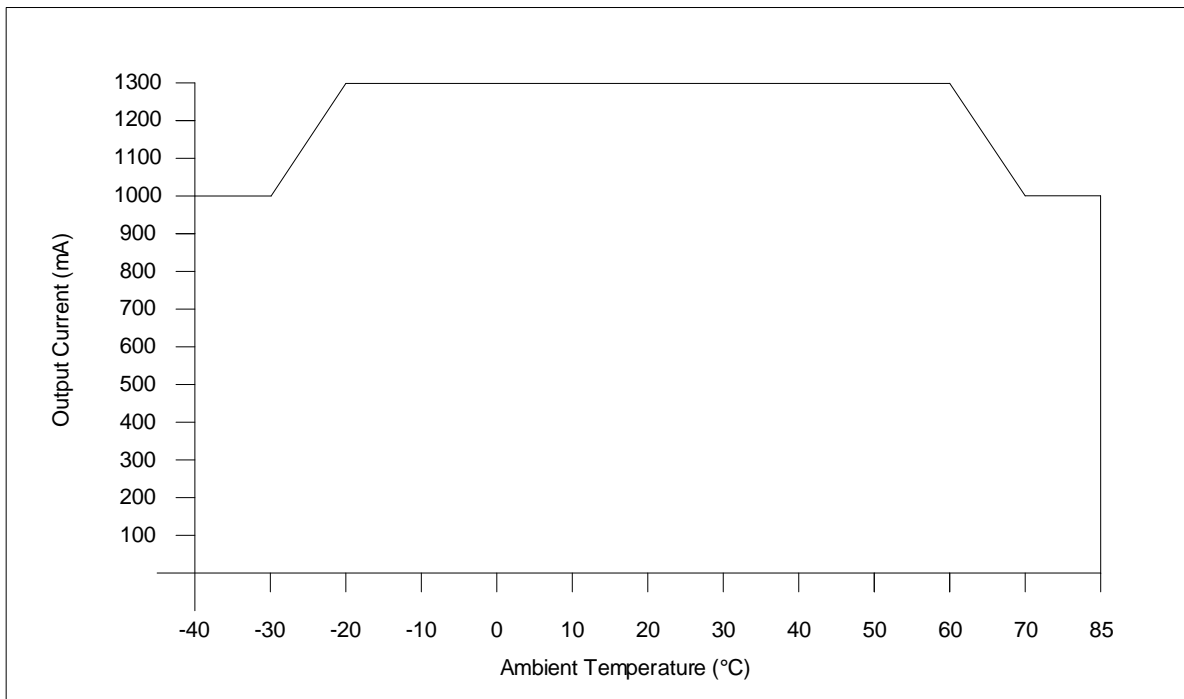
The Ag321T has a maximum ambient operating temperature of 85°C. These results were performed in an environmental chamber (Associated Environmental Systems – SD-302), without any heat-sinking.

The results shown in Figure 12 are relative to the output power drawn from an Ag320R receiver (used to load the Ag321T) with a nominal 4mm coil to coil spacing.



**Figure 12: Ag321T Operating Temperature Profile nominal distance**

Further derating of power transfer occurs with increased power transfer distance. The results shown in Figure 13 are relative to the output power drawn from an Ag320R receiver (used to load the Ag321T) with a maximum 8mm coil to coil spacing.



**Figure 13: Ag321T Operating Temperature Profile maximum distance**

## 7 Protection

### 7.1 Input Protection

To protect the Ag321T input from any over-voltage transients; we recommend fitting a SMAJ12A directly across the power supply input pins (+Vin and –Vin).

## 8 Electrical Characteristics

### 8.1 Absolute Maximum Ratings\*

	Parameter	Symbol	Min	Max	Units
1	Storage Temperature	$T_S$	-40	+100	°C
2	DC Supply Voltage Surge for 1ms	$V_{SURGE}$		20	V
3	Shutdown Input Maximum DC Rating	$V_{SMAX}$	-0.3	3.5	V

\*Exceeding the above ratings may cause permanent damage to the product. Functional operation under these conditions is not implied. Maximum ratings assume free airflow.

### 8.2 Recommended Operating Conditions

	Parameter	Symbol	Min	Typ	Max	Units
1	Operating Temperature	$T_{OP}$	- 40	25	85	Ta / °C
2	Input Voltage Range	$V_{IN}$	11.5		12.5	V

†See Section 8

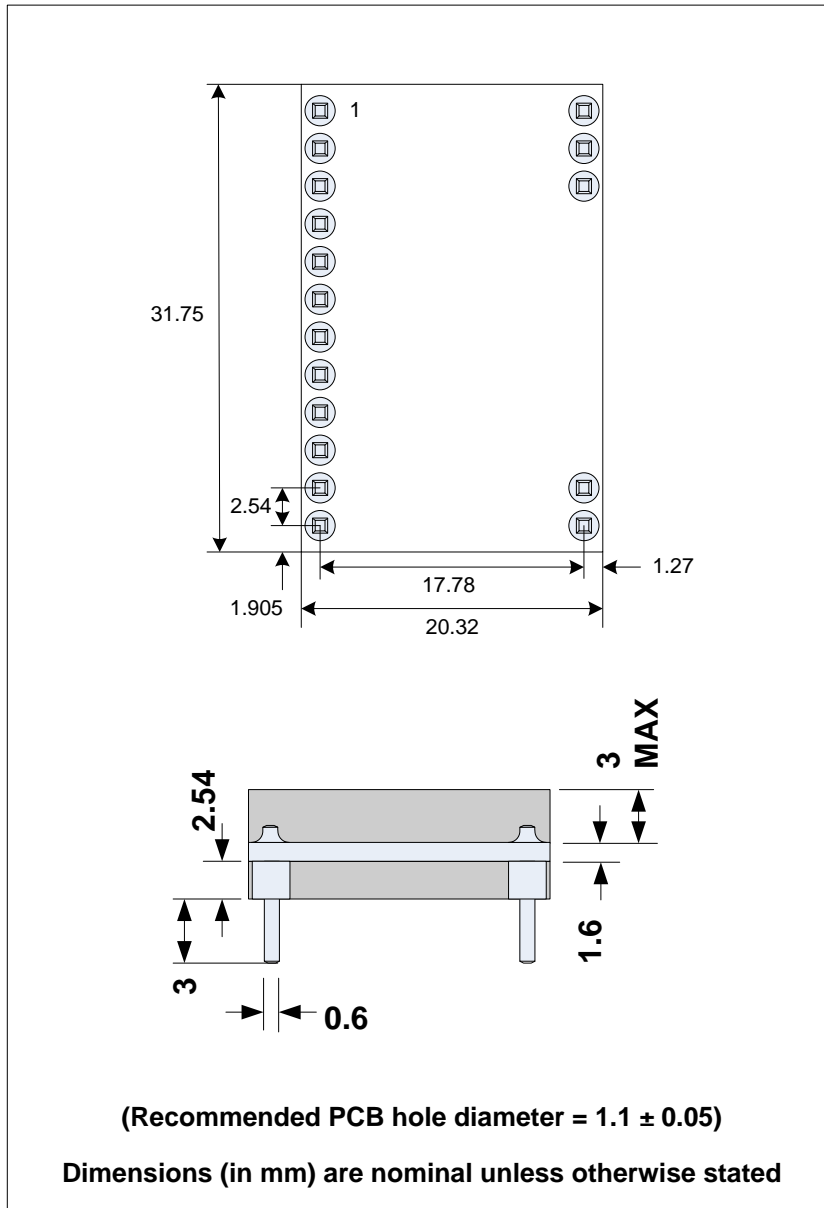
### 8.3 DC Electrical Characteristics\*

	DC Characteristic	Sym	Min	Typ*	Max	Units	Test Comments
1	Input Voltage	$V_{IN}$		12		V	
2	Input Current - Idle	$I_{IDLE}$		26.2		mA	
3	Input Current - Max Load**	$I_{ML}$		1800		mA	With Ag320R Load = 1.3A
4	Peak Efficiency**	EFF		82.2		%	With Ag320R
5	Maximum Start Up Distance Between Coils	$D_{ST}$		6		mm	@ Full Load with Ag320R
6	Maximum Operating Distance Between Coils	$D_{OP}$		6		mm	@ Full Load with Ag320R
7	Shutdown Input Logic Low Voltage	$V_{IL}$			0.75	V	
8	Shutdown Input Logic High Voltage	$V_{IH}$	2.25			V	

\*Typical figures are at 25°C and are for design aid only. Not Guaranteed

\*\*measured with nominal 4mm coil to coil spacing. With matched TX/RX coils.

### 9 Package



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