

## Migrating Free Topology Smart Transceiver Designs to the FT-X3 Transformer

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## 1. Introduction

The TP/FT-10 LonWorks Communication Channel has been very popular for use in control networks. The latest generation of Free Topology FT 5000/6000 Smart Transceiver ICs are 3.3V chips that interface with the TP/FT-10 Channel via the FT-X1, FT-X2 or FT-X3 communication transformers. Unfortunately, the older FT-X1 and FT-X2 transformers use a specialized transformer core material which is no longer available and an end of life notice has been issued for these devices. FT-X1 and FT-X2 customers have the following three options available to them:

1. Buy lifetime quantities of the FT-X1 and FT-X2 transformer product during the last time buy period.
2. Renesas is planning on stocking additional inventory of FT-X1 and FT-X2 product after the last time buy period and we will continue to sell these products as long as we have inventory available, however, due to the additional expense and risk associated with stocking this inventory, we will be charging a considerable premium over current pricing.
3. Transition designs to the FT-X3 transformer (the topic of the remainder of this document)

Renesas recommends either option 1 or 3. Supplies available under option 2 cannot be guaranteed.

This rest of this Application Note will provide some tips for migrating to the FT-X3 communication transformer in FT device designs.

#### Supporting Documentation/References:

- 1) "FT-5000-smart-transceiver-datasheet"
- 2) "Series\_5000 Databook" (005-0199-01)
- 3) "FT-6050-Datasheet"
- 4) "Series-6000-databook" (005-0230-01)
- 5) Legacy "FT31x0\_Databook" (005-0139-01)
- 6) "Communication Transformer" (US Patent 7,969,270) for the FT-X3 transformer

## 2. Legacy TP/FT-10 Channel Interfaces

A typical FT channel interface using the legacy FT 31x0 Smart Transceiver and the FT-X1 or FT-X2 transformer is shown in Figure 1 below (from [5]).

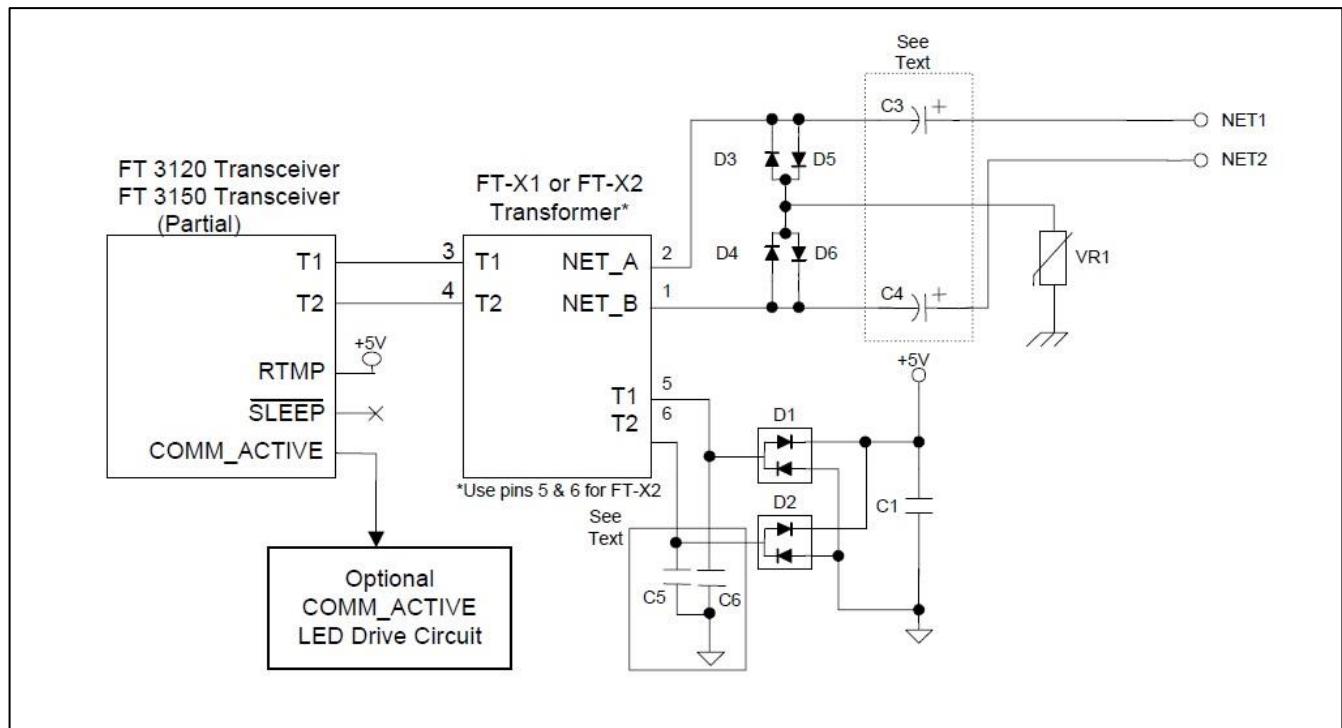


Figure 1. FT 31x0 Smart Transceiver Network Interface Connections

The FT-X1 communication transformer is a through-hole device, and the FT-X2 transformer is an SMT version of that transformer:



Figure 2. FT-X1 Through-Hole Communication Transformer



**Figure 3. FT-X2 SMT Communication Transformer**

See Reference [5] for more information on the legacy FT 31x0 Smart Transceivers and the electrical interface shown in Figure 1 above.

### 3. Migrating to the FT-X3 Comm Transformer in your Design

Because of the discontinuation of the FT-X1 and FT-X2 transformers, it is important for FT Smart Transceiver customers to migrate to using the more standard construction FT-X3 transformer shown in Figure 4 below:

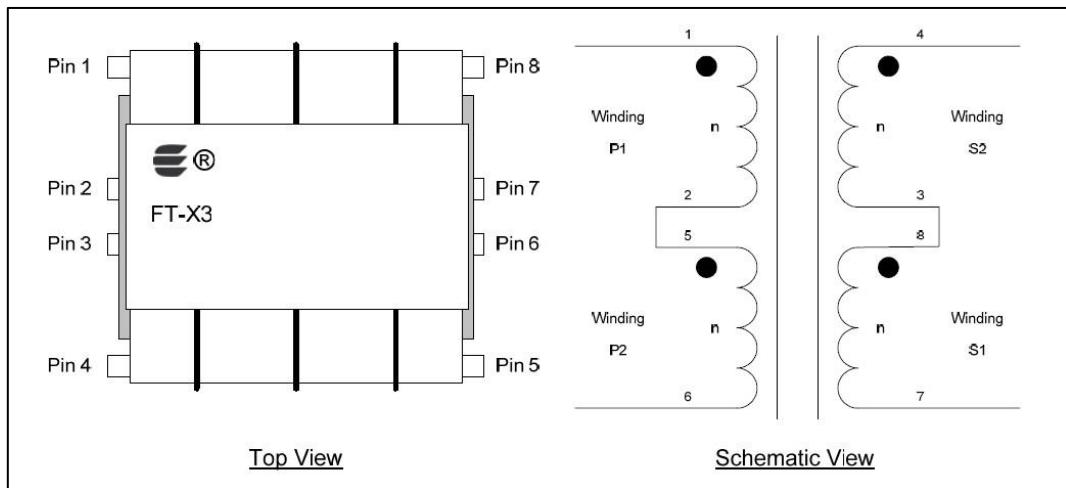


**Figure 4. FT-X3 Communication Transformer**

The FT-X3 transformer fits in the same PCB footprint area as the -X1 and -X2 transformers, but is 4.3mm taller than the FT-X2 transformer.

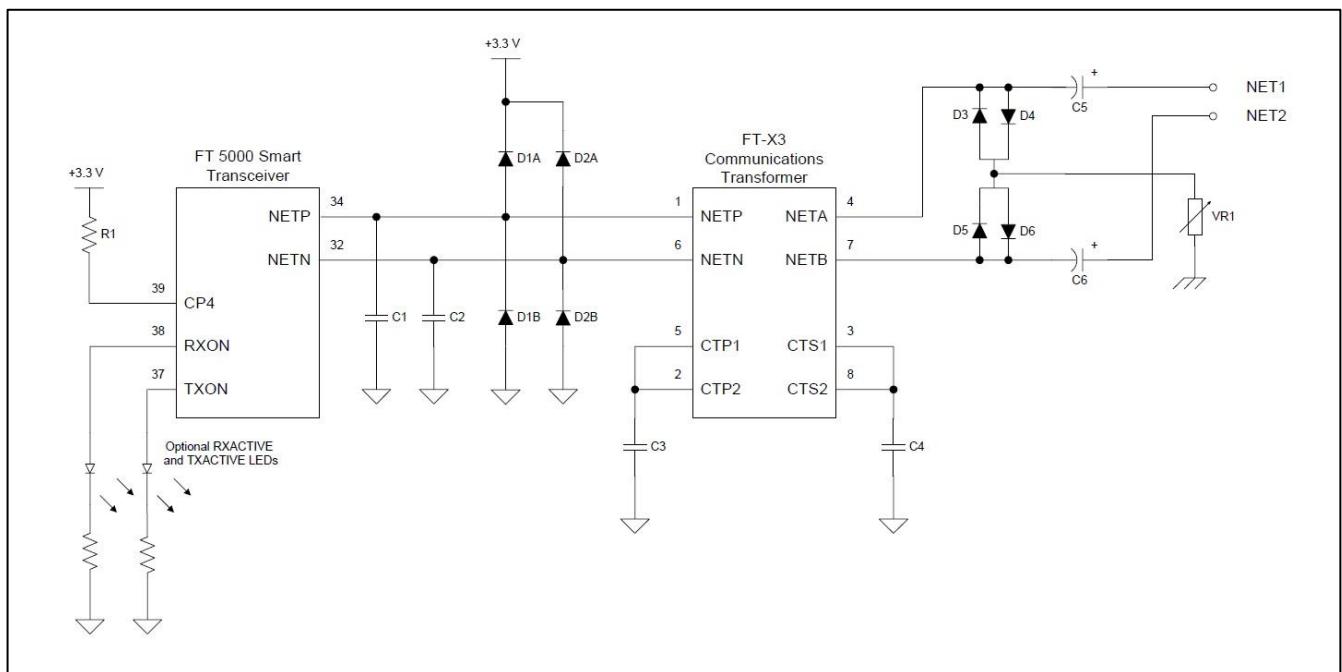
# Migrating Free Topology Smart Transceiver Designs to the FT-X3 Transformer

The FT-X3 transformer uses a patented design to provide high magnetic field noise immunity while using a standard bobbin-on-core construction. In order to achieve this high magnetic field immunity, the primary and secondary windings are split into two windings apiece, and those are wound on opposite sides of the core in a particular order [6]. This means that the FT-X3 transformer has more pins than the -X1 and -X2 transformers. The FT-X3 communication transformer is shown in Top View and Schematic View in Figure 5 below:



**Figure 5. FT-X3 Communication Transformer Views**

Since there are four separate wire coils in the FT-X3 transformer, and since the order that they are connected is important, the connection diagram shown in the databooks [2][4] should be followed as shown in Figure 6 below:



**Figure 6. Connections for the FT-X3 transformer and Smart Transceiver**

As discussed in the databooks [2][4], the centertap capacitors C3 and C4 shown in Figure 6 are generally not needed for most FT device designs, but can be incorporated if the FT network is exposed to very high levels of common-mode electrical noise.

# Migrating Free Topology Smart Transceiver Designs to the FT-X3 Transformer

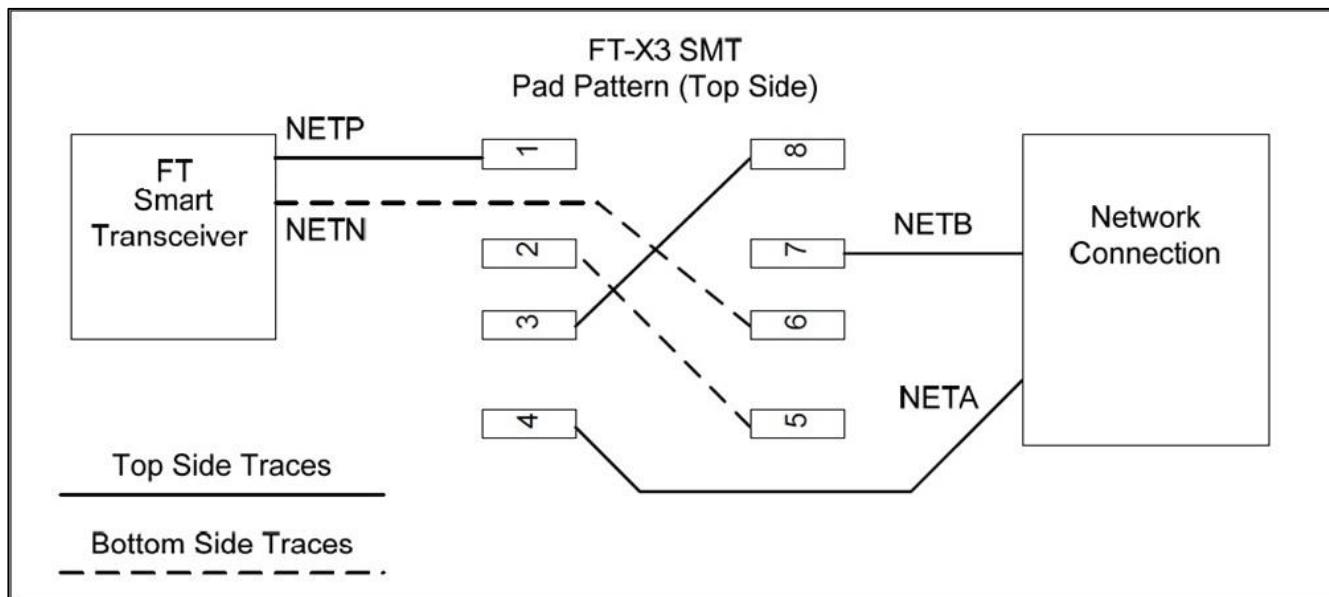
Note that the IC pin names and transformer/network connection names have changed over the years from the first Smart Transceivers to the latest 5000/6000 series ICs. Table 1 below lists those changes for convenience:

Smart Transceiver	IC Transceiver Pins	Transformer Pins In/Out	Network Connection Pins
FT 31x0	T1, T2	T1, T2 / NET_A, NET_B	NET1, NET2
FT 5000/6000	NETP, NETN	NETP, NETN / NETA, NETB	NET1, NET2

**Table 1. FT Connection Names for Smart Transceiver Versions**

Also note that if a customer is still migrating from the old Neuron 31x0 IC + FTT-10A network interface products, they should first read the section "**Quick Start for Users Familiar with the FTT-10A Transceiver**" in [5].

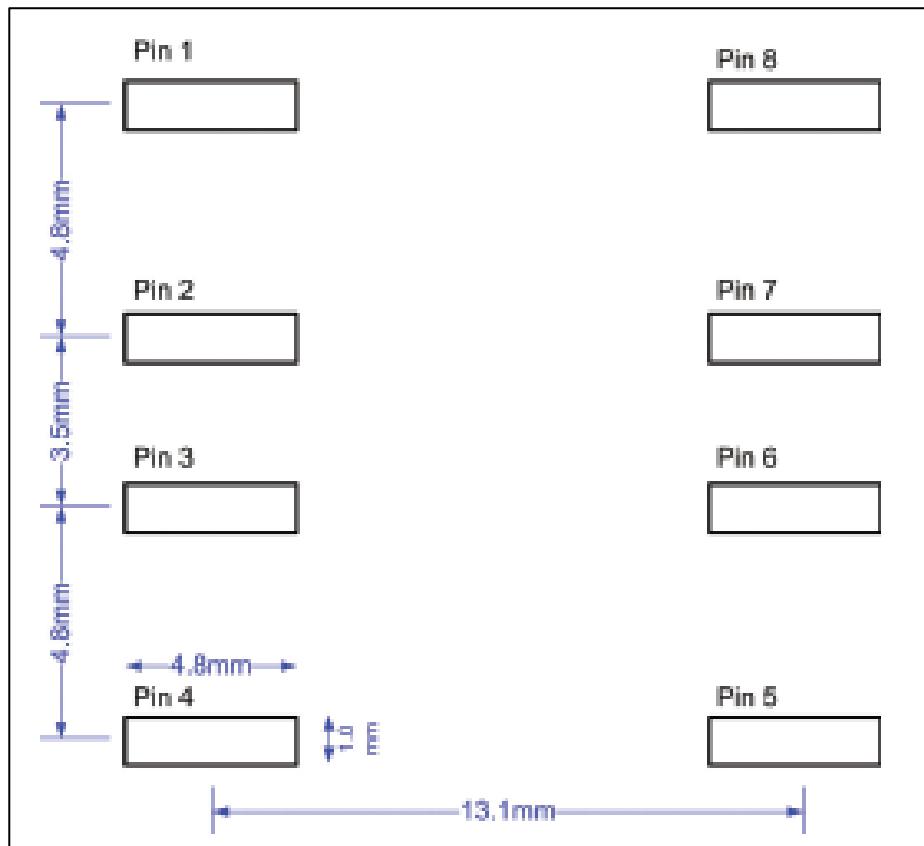
As already mentioned, The FT-X3 transformer fits inside the same PCB footprint as the older -X1 and -X2 transformers, so no extra PCB area is needed with this design migration. The PCBA does need to be changed to accommodate the different SMT pad layout and interconnections of the FT-X3 transformer. In order to help FT customers migrate to the FT-X3 communication transformer, the following figure is shown in Appendix C of [2][4] to provide a suggested PCB trace routing for making those connections to the FT-X3 transformer:



**Figure 7. Suggested PCB Trace Routings for the FT-X3 transformer**

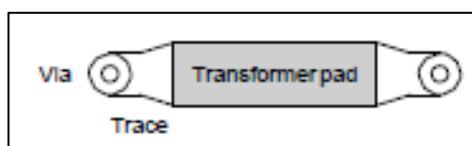
# Migrating Free Topology Smart Transceiver Designs to the FT-X3 Transformer

The datasheets [1][3] provide the suggested FT-X3 pad pattern dimensions, as shown in Figure 8 below:



**Figure 8. Suggested SMT PCB Pad Pattern for the FT-X3 transformer**

In order to provide extra SMT pad strength to resist pad delamination from the PCB during high vibration and shock, we recommend stitching the FT-X3 transformer pads with through-hole vias at the ends of the pads as shown in Figure 9 below (from [2][4]):



**Figure 9. Adding Vias to the Transformer Pad Layout**

## 4. Revision History

Revision	Date	Description
1.00	Oct. 14, 2022	Initial release.

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