E
LINE INTERFACE CIRCUIT COMPONENT VALUE CALCULATIONS

E.1 INTRODUCTION

The intent of this appendix is to provide information about the MC145572 2B1Q Interface Circuit (excluding protection, DC Termination, etc.) to compute optimal component values for line interface and transformer solutions. It also provides some basic explanation regarding the function of each of the components in the 2B1Q Interface Circuit.

E.2 CALCULATION OF TRANSMIT SERIES RESISTORS

The transmit series resistor values, R_X, depend on the amount of dc winding resistance of the transformer. The values of these resistors also depend on the impedance of the 1 µF dc blocking capacitor, C_b. Any resistors added to the line side of the transformer for primary circuit protection may be added to the dc winding resistance of the line side windings of the transformer. Portions of the line interface circuit are internal to the MC145572. The entire line interface circuit model is shown in Figure E–1.

The total transmit circuit model is shown in Figure E–2. Due to the duplexer nature of the line interface circuit RxP and RxN are at virtual signal ground for transmitted signals. Thus each R_f appears in parallel with each R_g (see Figure E–2) but since R_g is so low R_f can be ignored. The output impedance of the transmit drivers has been included in this model but will be subsequently ignored due to its insignificant nature.

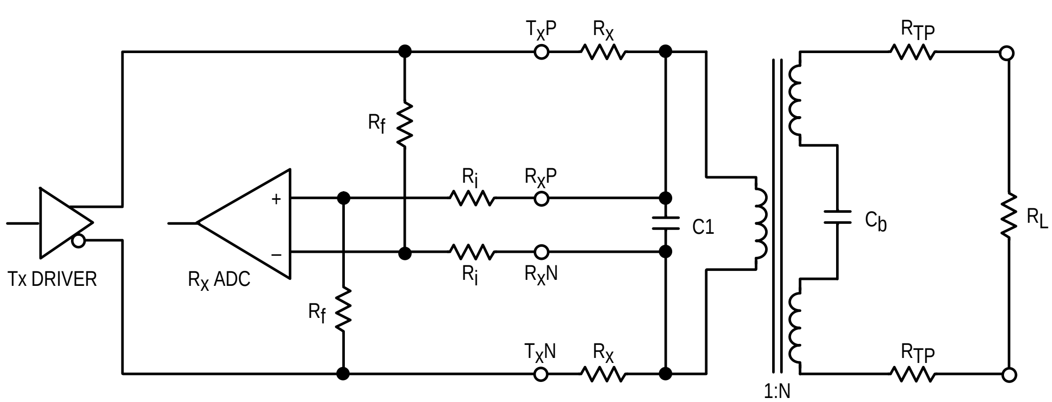

Figure E–1. Line Interface Circuit Model

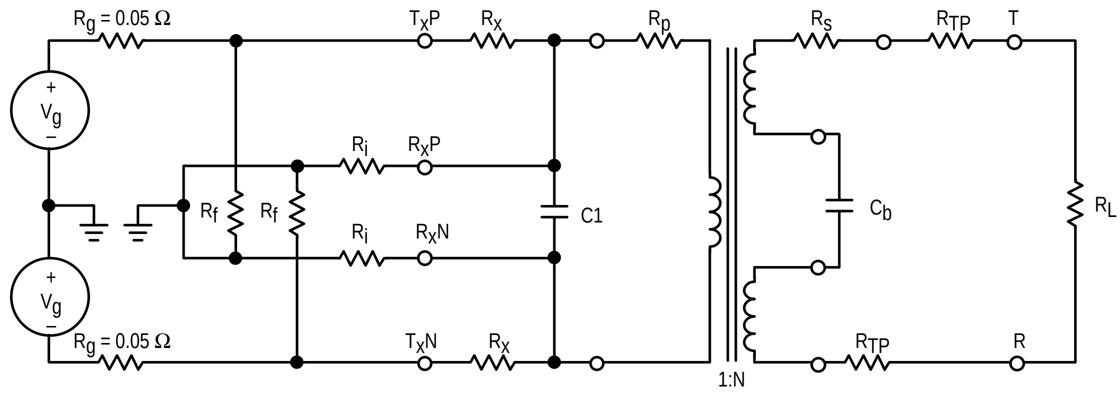

Figure E–2. Transmit Circuit Model

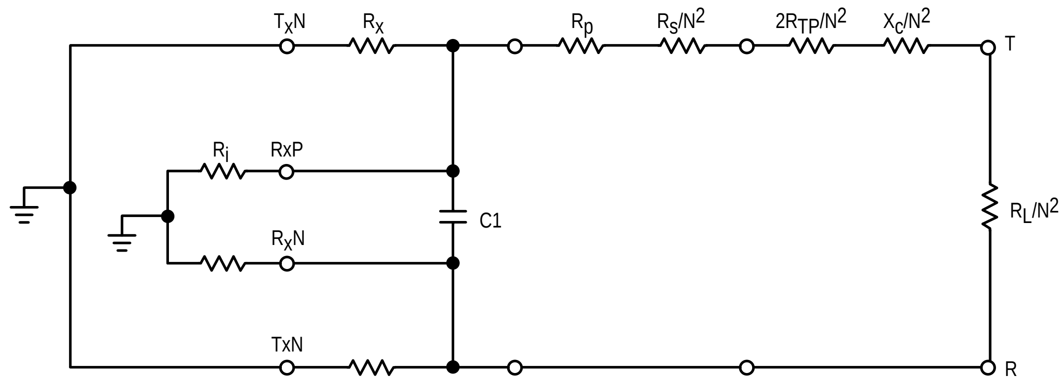

Figure E–3. Transformer Model

The transmit model is simplified to include the reflected impedances from the line side of the transformer. The output impedances of the transmit drivers are omitted here. This is shown in Figure E–3.

The impedance looking into the secondary side of the transformer must equal $R_L/(N^2)$ in order to terminate the line.

$$(2R_X * 2R_i) / (2R_i+2R_X) + R_p + (R_S + X_c + 2*R_{TP}) / (N^2) = R_L / (N^2) \qquad (1)$$

Rearranging and solving for Rx gives:

$$R_X = R_i * (R_L - N^2*R_p - 2*R_{TP} - R_S - X_c) / (X_c + R_S + N^2*R_p + 2*N^2*R_i + 2*R_{TP} - R_L) \qquad (2)$$

Substituting in values,

for a prototype transformer: $R_p = 7.9\ \Omega$ and $R_S = 8.2\ \Omega$

$$X_c = 1 / (j * 2 * PI * 40000 * 1E - 06) = - j4\ \Omega \text{ at 40 kHz}$$

$$R_i = 5000\ \Omega$$

$$R_{TP} = 5\ \Omega$$

we get:

$$R_X = 5000 * (135 - 7.9*1.25^2 - 8.2 - 2*5 + j4) / (- j4 + 8.2 + 7.9*1.25^2 + 2*5000*1.25^2 + 2*5 - 135)$$

$$= 5000 * (104.5 + j4) / (15520.5 - j4)$$

$$= 5000 * 104.6 < 2.19^\circ / (15520.5 < - 0.01^\circ)$$

$$= 33.7\ \Omega < 2.20^\circ$$

Since the reactive component is so small, having an angle of only 2.20° it can be ignored when doing this analysis.

The equation for calculating R_X can be reduced to:

$$R_X = R_i * (R_L - N^2*R_p - 2*R_{TP} - R_S) / (R_S + N^2*R_p + 2*N^2*R_i + 2*R_{TP} - R_L) \quad (3)$$

Substituting in values gives:

$$R_X = 5000 * (135 - 7.9*1.25^2 - 8.2 - 2*5) / (8.2 + 7.9*1.25^2 + 2*5000*1.25^2 + 2*5 - 135)$$

$$= 33.65\ \Omega$$

$$= 33.7\ \Omega$$

E.3 CALCULATION OF TRANSMIT NOISE FILTER CAPACITOR

Once the transmit series resistor values have been calculated, the transmit noise filter capacitor can be calculated for a 160 kHz cutoff frequency. This capacitor in conjunction with the transmit series resistors acts as a low pass filter to remove the high frequency switching noise in the output signal of the MC145572 TxP and TxN pins.

$$C1 = 1 / [2 * (2 * PI * f * R_X)] \quad (4)$$

$$C1 = 1 / [2 * (2 * PI * 160000 * 33.7)]$$

$$C1 = 0.015\ \mu F$$

The nearest commercial value can be used.

The analysis yields the following line interface circuit:

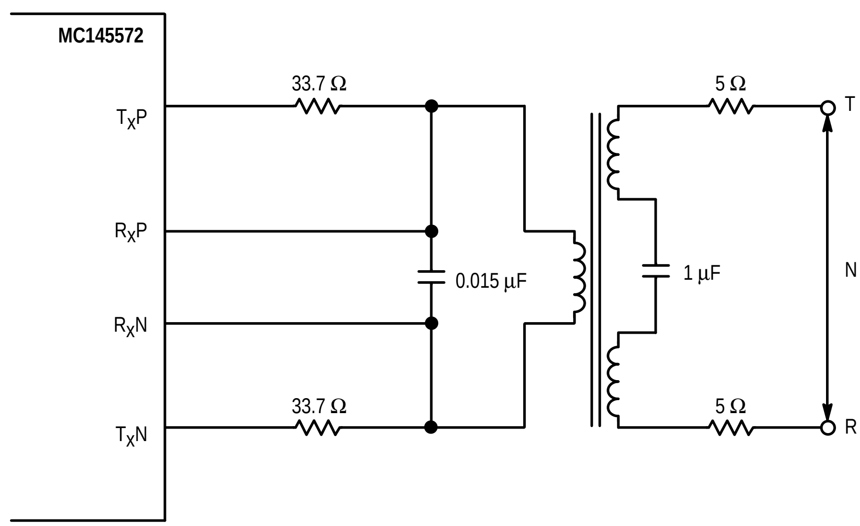

Figure E–4. Calculated Line Interface Circuit