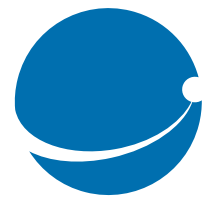


APPLICATION NOTE AN-114

# ITC117P Integrated Telecom Circuit



CLARE

Clare's Integrated Telecom Circuit (ITC117P) features combined circuitry in one 16 Pin SOIC package for:

- 1-Form-A Solid State Relay for use as Hookswitch
- Bridge Rectifier
- Darlington Transistor
- Optocoupler that can function as a ring detector or loop current detector

Typical applications for the ITC117P include:

- PCMCIA Designs
- Modem
- Fax
- Voicemail Systems
- Telephone Sets
- Computer Telephony

## Description

The ITC series integrates the major components found in a typical Data Access Arrangement (DAA), in a 16 lead SOIC package. As highlighted in figure 1, the 1-Form-A MOSFET SSR, Darlington transistor, bridge rectifier, and optical isolator comprise this integral design. Following is the functional explanation for each device:

### Hookswitch -

The ITC contains optically-coupled MOSFETs that function as a hookswitch in the DAA circuit. The hookswitch has a blocking voltage up to 350V, isolation voltage to  $3750V_{RMS}$ ,  $15\Omega$  RDS(on), and a maximum switching current of 120mA, making it ideal for Tip and Ring switching. The hookswitch is controlled by an LED that requires only 5mA to operate. This makes it an attractive device for battery-powered applications where power consumption needs to be minimized for prolonged battery life.

### Optocoupler -

An optocoupler is included in the ITC series package that can be used as a ring detector or loop current detector with the addition of a few passive components. The optocoupler is available with a standard phototransistor or a high gain Darlington transistor.

### Bridge/Darlington -

Referring to figure 2, a bridge rectifier (D2) and Darlington transistor (Q1) arrangement is included in the package for use in "dry" transformer and optical DAA designs. The bridge provides the function of current steering to maintain DAA operation and protect the Darlington during polarity reversals of Tip and Ring wires. The Darlington, with the addition of a few passive components, functions as an electronic inductor that has the effect of presenting a low resistance to the DC current across the telephone line, and a relatively high impedance for AC signals on the line. For a transformer based design, this enables the designer to use a small coupling transformer (T1) since the telephone loop current is diverted through the Darlington instead of the transformer windings ("dry transformer"). Without the electronic inductor, the loop current would have to flow through the transformer ("wet transformer"), however, since the telephone loop current can be as high as 120mA, the transformer would saturate, causing signal degradation unless the geometry of the transformer becomes much larger. This is especially true for high speed modems such as V.34bis, where return loss must meet or exceed 25dB. Return loss of 25dB is usually not attainable with a wet transformer, and if it is, the transformer is too large and expensive for the application. \*The best way to overcome this saturation and return loss problem is to "reroute" the loop current through the electronic inductor and AC couple the modem signal via C2 to the transformer, such that no DC current flows through the transformer. Return loss is a measure of mismatch between the terminating impedance and the line impedance, and can be determined from the following equation:

$$\text{Return Loss (dB)} = 20 \text{ Log } [(ZL+Z0)/(ZL-Z0)]$$

\* The ITC series can also be used with optically coupled DAAs such as those using Clare's linear optocoupler (LOC series). Since the LOC eliminates the transformer, the bridge Darlington's function is to sink loop current,

thereby seizing the phone line when going offhook and presenting a high AC impedance across the phone line. For additional design information on the electronic inductor, see the “Electronic Inductor Design” section of this application note.

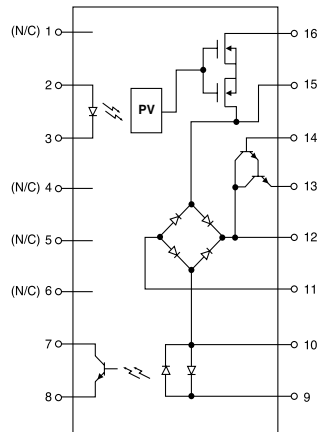


Figure 1. 16 Pin SOIC Package

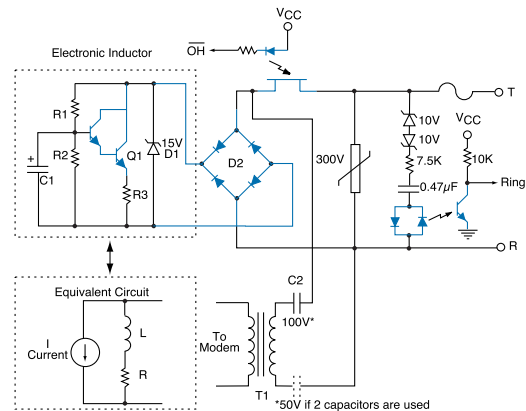


Figure 2. Typical Data Circuit

### Electronic Inductor Design

The electronic inductor approximates the operation of a discrete inductor by using a Darlington transistor, three resistors, and a capacitor. When used in a DAA application, the electronic inductor will present a relatively low resistance to DC currents, and a relatively high impedance to AC signals.

### Circuit Description

Figure 2 shows the electronic inductor in a typical telecom/datacom environment. Bridge D2 rectifies current on Tip and Ring for the electronic inductor only. This ensures line-polarity insensitivity required by most regulatory agencies. Diode D1 protects Darlington Q1 from excessive transient voltages when going offhook. The zener voltage should be less than the  $V_{CEO}$  of the Darlington (40V  $V_{CEO}$  in this case). R1 and R2 set the biasing point for Q1. C1 is used for AC rejection of signals at the base of Q1. C1 should be a good quality Tantalum rated at a minimum of 10WV. R3 is used to provide negative feedback for Q1 so that Q1 will not go into saturation over the loop current range. The AC signal path is coupled to the transformer via C2. C2 should have a working voltage of 100V, or 50V if two capacitors are used, one on each lead of the primary.

### DC Characteristics

The electronic inductor should be tailored to meet the following requirements:

- CO Battery (42.5 - 56.5VDC)
- Loop Resistance (400 - 1740 $\Omega$ )

Maximum allowed DC resistance of CPE (Customer Premise Equipment) in offhook mode (200 $\Omega$ ) per FCC 68.314(c1), (c2).

Minimum recommended DC resistance in offhook mode (90 $\Omega$ ) per EIA-496A, 4.2.2.1.

The two extreme conditions of operation are as follows:

1. Minimum Loop Current:

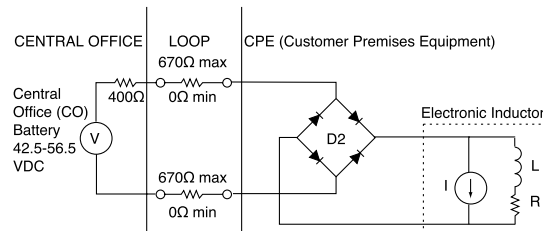
- CO battery drops to 42.5VDC.
- Loop resistance is 1740 $\Omega$ .
- Electronic inductor has the highest DCR

2. Maximum Loop Current:

- CO battery is 56.5VDC.
- Loop resistance is 400 $\Omega$ .
- Electronic inductor has the lowest DCR of 90 $\Omega$  resulting in a minimum loop current of 115mA.

## AC Characteristics

The AC characteristics of the electronic inductor circuit should ideally be equivalent to a high value inductor (see equivalent schematic representation in figure 3) i.e. 4 - 10H for best performance. The equivalent inductance of the electronic inductor can be approximated by  $L = (R1)(C1)(R3)$ . The ideal electronic inductor would have infinite AC impedance and a low DC resistance, however, practical considerations such as the size of the capacitor and cost usually limit the inductance of the circuit to between 4H and 10H. It is important that the capacitor be a good quality Tantalum rated at 10V or greater. Typical capacitance values for this capacitor are on the order of about 10 $\mu$ F.



**Figure 3. Typical Electronic Induction Connection to Central Office**

## Summary

The component and functional integration that the ITC series provides makes it an attractive solution for engineers designing DAA circuitry. Some of the major advantages that the ITC provides are:

- Small SOIC package promotes a 60% overall PCB space savings over conventional discrete component designs
- Overall cost savings
- Solid State performance means increased reliability
- Provides a single component solution to a many component problem, thus reducing inventory of various components
- High isolation voltage
- Low relay drive current

In addition, the ITC series may be used in conjunction with other Clare Semiconductor Group Products (such as the LOC110 which is mentioned elsewhere in this application note) to provide a complete optical solution for DAA design.



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