HT18 and HT19 for Electronic Line Switch

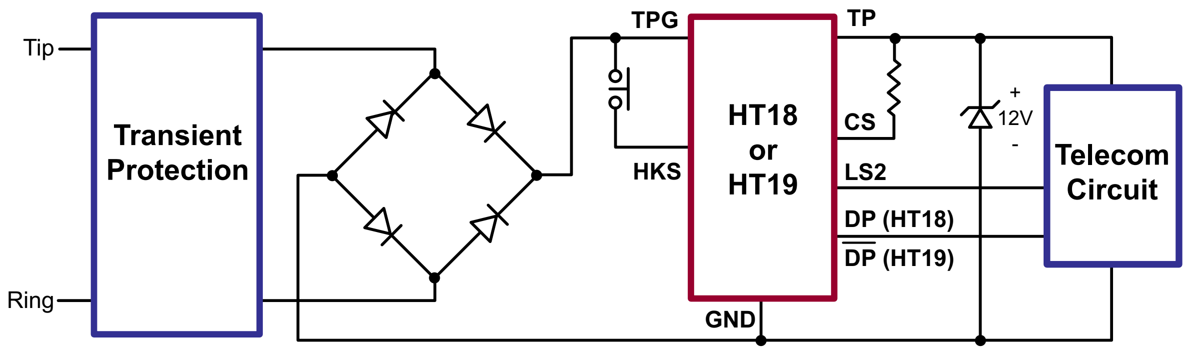
by Scott Lynch, Senior Applications Engineer

Introduction

The Supertex HT18 and HT19 are electronic line switches packaged in 8-Lead SOIC packages and are designed as replacements for the typical mechanical hook switch in telephone instruments. They connect the telephone's low voltage speech and dialing circuits to the incoming phone line when the handset is placed off-hook. The HT18 and HT19 perform this function via a solid state switch, thereby eliminating any reliability problems commonly associated with mechanical switches. Three low-level hookswitch control inputs are provided for design versatility and may be controlled directly from logic circuitry or from ordinary mechanical switches. The HT18 and HT19 are line-powered and especially useful in applications that require telephone operability when external power is lost or otherwise unavailable.

A solid state hook switch may be implemented using discrete components. However, this requires more components and board real estate compared to the integrated approach. A typical application circuit using the HT18 and HT19 is shown in Figure 1. The only difference between the HT18 and HT19 is their dial pulse pin. The HT18 has an active high dial pulse (DP), whereas the HT19 has an active low dial pulse ($\overline{DP}$).

Figure 1: Integrated HT18 and HT19 Electronic Line Switch Typical Application



HT18/HT19 Circuit Description

Figure 2 shows a block diagram of the HT18/19 line switch. Three control inputs are provided: HKS, LS, and DP/$\overline{DP}$. Internal pull-downs are provided for HKS and LS, while the DP input, (HT18), has an internal pull-down, the $\overline{DP}$ (HT19) has an internal pull-up. All of these inputs may be driven from single-ended sources, from push-pull sources, or left unconnected.

An inexpensive mechanical switch or magnetic reed switch is placed across TPG and HKS. This switch is used solely to detect hook status and is not subject to the line currents of a conventional hook switch. (The hook status switch will be referred to as the hook switch. The solid state switch used to connect the instrument to the phone line will be referred to as the line switch.) With the handset in the on-hook condition, the hook switch is open. When the handset goes off-hook, the hook switch closes, allowing microamperes of current to flow into the HKS pin. This current activates an internal charge pump power supply which is used to turn on the internal 18Ω MOSFET line switch, connecting TPG to TP. An external zener diode to clamp the voltage on the TP pin to ground is required. Nominal zener values of 15V or less are recommended.

For a hands-free speaker function, a push-on/push-off button switch can be connected across the TPG and HKS pins in parallel with the hook switch. This switch can be used to turn on the internal MOSFET line switch without lifting the handset. Alternatively, the LS pin can be driven from logic circuitry to implement the hands-free function.

Other control inputs are the DP/$\overline{DP}$, and CS pins. The DP/$\overline{DP}$ pin is used for pulse dialing or flashing.

The CS pin is used for setting the current limit value. An external current resistor is connected between TP and CS. The CS pin senses a small fraction of the current flowing through the internal MOSFET line switch. When in current limiting, the hook switch behaves like a constant current source.

HT18/19 Parameters

In this section, the importance of the primary electrical parameters of the HT18/19 and how they relate to the application are explained. The primary requirements for an electronic line switch for a handset are:

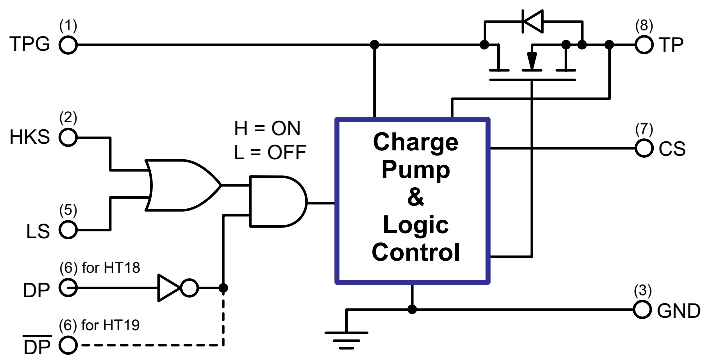
- High breakdown voltage
- Low leakage current
- Low switch resistance
- Low operating voltage
- T_{ON}/T_{OFF} switching time

Breakdown Voltage

The internal MOSFET line switch shown in Figure 2 must be able to withstand high voltages which come from ring voltages and residual voltages from lightning strikes. Ring voltages as high as $300V_{PP}$ superimposed on a DC offset of -52.5V can result in peak voltages just over 200V. The 350V rating provides an ample safety margin.

It is quite common for phone lines to encounter lightning surges. Even with proper lightning protection devices, voltage transients of 350V can be encountered. The guaranteed minimum breakdown voltage of 350V ensures devices will not be damaged.

Figure 2: HT18/HT19 Block Diagram



Protection

The HT18 and HT19 require secondary protection from overvoltage and overcurrent. The overvoltage protection must not allow the voltage between TPG and GND to exceed the IC's maximum rating. Placement of the overvoltage protection is usually directly between tip and ring.

Overcurrent protection is required to prevent excessive power dissipation in the HT18/HT19. This can occur when the HT18/19 goes into current limiting with a high input voltage. For example, if the HT18/19 is limiting at 150mA with an input voltage of 10V, power dissipation can approach 1.5 watts. To prevent failure of the HT18/19, an external fuse or other form of protection rated at less than the current limit value should be employed.

Figure 3 shows the typical current limit versus R_{SENSE}. When in current limiting, the power dissipation in the HT18/19 will increase, causing die temperature to rapidly rise. This temperature rise has the effect of lowering the initial current limit value. The steady-state value is dependent on several variables, including input voltage, output voltage, load current, ambient temperature, junction-ambient thermal resistance, and process variations.

The upper line represents the initial current limit. The lower line shows the steady state limit due to self heating effects with an output voltage of 5.2V and an input voltage of about 12V.

Low Leakage

Regulations require that devices connected to the public switched telephone network (PSTN) present an on-hook resistance greater than 5.0MΩ up to 100V. Lower resistances may give a false indication that the line is damaged. The HT18/19 are rated for 2.0μA max at 100V, equating to 50MΩ. Under low voltage conditions of 42.5V, the 2.0μA rating equates to 21.25MΩ, well within the requirements.

Switch Resistance

The amount of current flowing into the instrument will depend on how far it is from the central office. Currents can vary from 5.0 to 140mA. The switch resistance is important in both cases. For the high current condition where the instrument is close to the central office, the switch resistance should be kept low to minimize power dissipation. The HT18/HT19 are rated as 18Ω. The power dissipation is therefore $(140mA)^2 \times 18\Omega = 353mW$.

For the long loop condition, low current, 20mA is available. The phone needs to be fully functional under this condition. The amount of voltage available during this condition is 3.0V. The HT18/HT19 guarantee a switch resistance of 18Ω when conducting 20mA with an input voltage of only 3.0V, resulting in a drop across the line switch of only 0.36V.

Low Operating Voltage

Consider a long loop condition where the phone is off-hook. 20mA will be flowing to the phone. A common situation would be for a second phone on the same line to go off-hook where the second user is not aware that the phone line is in use. More current will be drawn from the line and voltage will be further reduced. Under this condition, it is not necessary for the phones to be fully functional. It is, however, required that the speech circuitry be functional on both phones. This will allow the first user to inform the second user that the line is in use and to go on hook.

Further compounding the condition would be if one of the phones was old. The old phone would draw more current to maintain speech functionality. To provide more current for the old phone, the HT18/19 must operate under very low current and voltage conditions. The HT18/19 might draw only 5mA whereas the old phone will consume 20mA. The HT18/19 therefore guarantees a maximum of 30Ω switch resistance at 5.0mA with an input voltage of 2.0V.

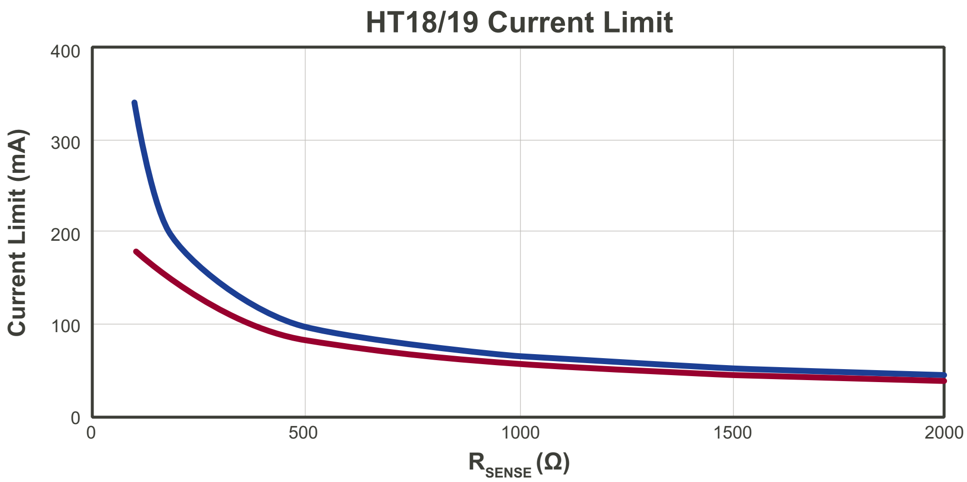
T_{ON}/T_{OFF} Switching Time

The DP pin for the HT18 and the $\overline{DP}$ pin for the HT19 are used for pulse dialing. Pulse dialing requires 40ms on-time and 60ms off-time. For proper pulse dialing recognition, T_{ON} and T_{OFF} must be less than 2.0ms. The HT18/19 guarantee a T_{ON} and T_{OFF} of no greater than 1.0ms, well within the requirements.

Conclusion

The HT18/19 are specifically designed to replace the mechanical hook switch in telephone handset applications. The strict electrical requirements imposed on telephone instruments has been taken into consideration. Designs currently incorporating a discrete electronic line switch will also benefit from the simplification and component reduction when redesigned for the HT18/19. The HT18/19 will allow for a more reliable, higher performance and more compact solution.

Figure 3: HT18/HT19 Current Limit



When in current limiting, the power dissipation in the HT18/HT19 will increase, causing the die temperature to rapidly rise. This temperature rise has the effect of lowering the initial current limit value. The steady-state value is dependent upon several variables, including input and output voltages, load current, ambient temp, junction-ambient thermal resistance, and process variations.

The upper line represents the initial current limit. The lower line shows the steady-state limit due to self heating effects, with an output voltage of 5.2V, and an input voltage of about 12V.

Summarizing the switch resistance and operating voltage requirements:

Condition	Current (mA)	Voltage (V)	Switch Resistance (Ω)
Short loop	130	4.3	18
Long loop	20	4.0	18
Long loop with 2 phones	5.0	2.0	30

Supertex inc.
1235 Bordeaux Drive, Sunnyvale, CA 94089
Tel: 408-222-8888
www.supertex.com