

# Cellular Phone Production Testing— Digital Control of Automation

## Introduction

Producing cellular phones demands some level of automation control for test and measurement. Typically, testing is performed at two or three points in the assembly process and requires a variety of test instrumentation. In addition, some level of control is required of the test fixture associated with testing the phone's internal radio, such as setting the digital patterns of the handset, reading limit switches to determine if the phone is in position, or driving solenoids to create mechanical action in and out of the test fixture.

This type of control is closely tied to the testing process, so it's critical to design the digital I/O as part of the measurement test system. Several options are available to accomplish this. This application note will examine the design considerations involved.

## Design Considerations

Controlling the movement of the handset in and out of the test fixture and sending any required digital patterns to the phone are both integral parts of the testing process; therefore, these functions should be controlled from the test software. For instance, putting the phone in a particular test mode may require setting a few control bits on the handset. The most efficient way to accomplish this is by including it as a step with the test software, which provides full control over the timing of when the patterns should be applied to the handset.

Three design options are available to bring the digital input/output function into the test stand (as opposed to part of the overall line automation, e.g. industrial controller).

### Option 1. Use the test instrumentation's digital I/O capability.

Many Keithley products applicable to cell phone production testing include some digital I/O capability. For example, the Model 7001 Switch Mainframe has four open collector digital outputs and one TTL-compatible digital input.

The open collector outputs can be used to drive relays or solenoids directly and the TTL input is available to read a digital line or limit switch. These control lines are available right on the instrument, so they do not require any extra rack space and are controllable via the instrument's IEEE-488 bus commands. Therefore, reading and controlling these lines is included right in the main test code.

The main drawback of this option is the limited number of control lines available. If additional lines are needed, the next two options should be considered. However, if several instruments are available in the test stand, digital I/O from each instrument can be used to increase the overall number of available lines.



Figure 1. The rear panel of Keithley's 7001 Switch Mainframe has four open collector outputs and one TTL input for digital control applications.

### Option 2. Use high-density digital I/O cards.

Keithley offers several high-density digital I/O cards for control applications that require a high number of lines. For example, the 7020 digital I/O card has 40 open collector outputs and 40 TTL inputs on a single card. This card plugs into the Model 7001 or 7002 Switch Mainframe, giving full access and control of the I/O via the 7001's IEEE-488 bus connection.

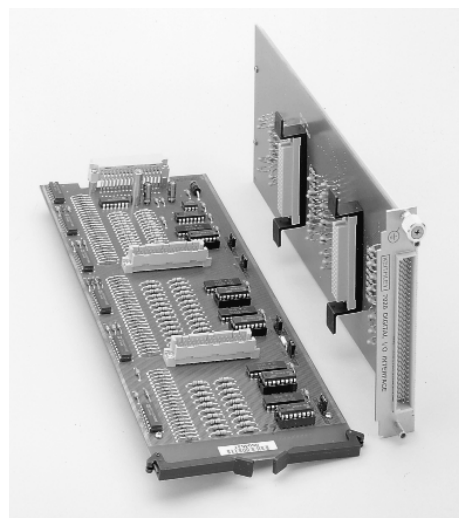


Figure 2. 7020 digital I/O card for Model 7001 and 7002 mainframes

As with Option 1, this configuration allows for tight integration into the test software and uses the available space

efficiently. It is likely that the test system will require the use of a switching mainframe to route measurement signals. The 7020 card fits into a rear panel slot on either the 7001 or 7002 mainframe.

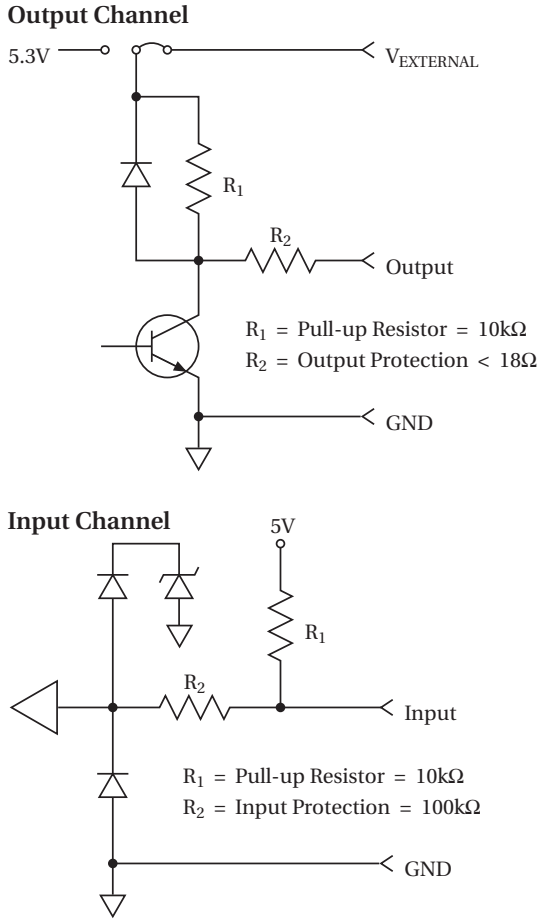


Figure 3. 7020 digital I/O card open collector output and TTL input configurations

The 7020 digital I/O card has open collector outputs that can be pulled up to a user supplied voltage or tied to the 5.3V level available on the cards. All input channels are protected from overloads up to 42V.

### Option 3. Use PC plug-in digital I/O boards.

Keithley's PIO-32 Series boards provide 32 channels of isolated digital I/O on a single board that plugs directly into any available I/O slot of any ISA-bus compatible computer. Three versions are available: the PIO-32IN has 32 channels of optically isolated digital input, the PIO-32OUT provides 32 channels of electro-mechanical relay output, and the PIO32I/O provides 16 channels of optically isolated digital input and 16 channels of electro-mechanical relay output.

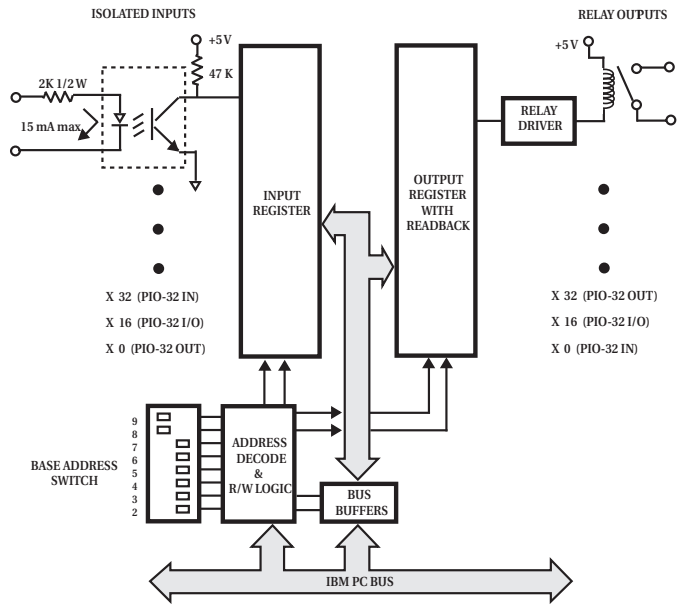


Figure 4. The PIO-32 Series provides isolated digital inputs.

The advantages associated with this approach include the potential for additional space savings—the boards fit inside the PC, so they don't take up any rack space. Also, the PIO-32 series cards provide fully isolated inputs and outputs. This last feature is important when interfacing to circuitry that is at different common mode voltages.

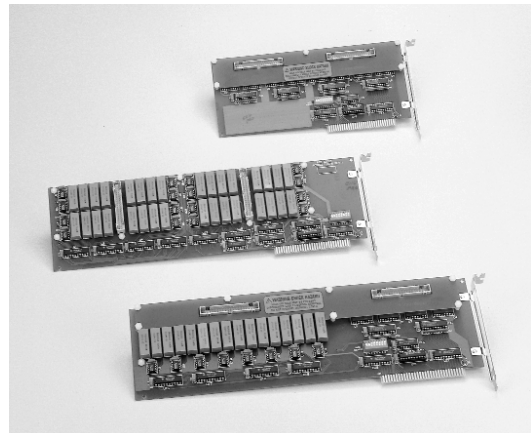


Figure 5. The PIO-32 Series cards plug directly into an ISA bus compatible computer.

# Summary

Several system design considerations must be taken into account when adding digital control to a cell phone production test stand:

1. Much of the digital control associated with testing a handset is tightly coupled with the testing and tuning of the radio, so it's usually desirable to control the digital I/O via the test software.
2. When choosing the hardware and test system layout, consider the number of digital lines required, which will help determine the most appropriate option.
3. Don't forget the importance of electrical isolation when choosing digital I/O hardware.

Keithley offers a wide range of rugged digital I/O options suitable for cell phone production testing applications. Other Keithley solutions designed specifically for production testing of telecommunications devices include fast transient response power supplies, total harmonic distortion meters, and microwave switching and signal routing systems.

Specifications are subject to change without notice.

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