Diagnostic Modes for Products with Atmel® Capacitive-touch ICs

1. Introduction

There are many types of Atmel capacitive-touch integrated circuits (QT™ ICs) with interfaces as diverse as simple pin-per-key (PPK) to serial links for data communication. To support product development throughout production testing, it is often useful to obtain data from the QT IC by using the diagnostic modes in a product's main microcontroller (MCU).

This application note discusses the various points to be considered when designing diagnostic modes for your product.

The topics in this application note include:

- Diagnostic mode entry
- Diagnostic data output
- Displayed information
- Pass-through from QT IC to PC
- Production testing

2. Why Do I Need Diagnostics?

Making diagnostic information readily available encourages monitoring and promotes understanding of the product under development. It also permits the detection of unusual conditions or, in the event of a fault, the retrieval of useful information while the fault condition prevails.

3. Diagnostic Mode Entry

There are three basic methods of initiating diagnostic mode during product testing:

- Key sequence
- External command
- Option setting

3.1 Entry by Key Sequence

Key sequences are particularly useful because external equipment or product modifications are not required. However, the method is not always successful if the touch is not calibrated or if an error condition occurs.

A typical key sequence could be:

1. Press key **A** for 3 seconds, then release.
2. Press key **B** for 3 seconds, then release.
3. Press key **C** for 3 seconds, then release.

Diagnostic Modes for QT ICs

Application Note QTAN0016

10704A–AT42–10/08

This is preferable to a multi-key instruction such as:

1. Press key **A**, key **B** and key **C** simultaneously for three seconds, then release.

Multi-key instructions restrict the use of Atmel's Adjacent Key Suppression™ (AKS™) feature, available in many QT ICs, and may therefore require that key centers are more widely spaced.

3.2 Entry by External Command

Diagnostic mode can be initiated by external commands issued via RS-232, USB, or a similar communications protocol. The interface can also be used to log data. However, the disadvantages of this method are that:

- External equipment is required – which is not always convenient.
- Test results may be affected – for example by creating alternate paths to ground.

3.3 Entry by Option Setting

To initiate diagnostic mode, options such as jumpers, DIP switches, non-volatile memory settings, etc. can be read at start-up and/or during operation. This method is particularly useful for tests that cycle the product's power, but is not always convenient or easy to implement.

3.4 Mode Entry Considerations

Usually, it is advantageous to support all three methods of initiating diagnostic modes. If several diagnostic modes are used, consider using a single entry method to step through the modes (including normal display). The benefits are that:

- Operators need only remember a single key sequence or serial command.
- Code size is minimized.
- Additional diagnostic modes can be added without changing the base code or the product documentation.

If the product has an **OFF**, **CANCEL** or **CLEAR** key, it can be used to cancel all diagnostics: for example, by pressing the key for two or three seconds, or consecutively. This arrangement offers users an intuitive exit from diagnostic mode.

Diagnostic software builds (i.e. using #ifdef DIAG) are also an option, but they are inconvenient because the code is not available in the production compile. Often, optional code is not updated with software changes, so it may not be usable when needed. Moreover, special compiles may be necessary when product memory is limited.

4. Diagnostic Data Output

Diagnostic information can be read by using the product's own display and/or an external interface. The product display (for example, an LED or LCD) is particularly convenient because additional external equipment is not required.

An external interface such as RS-232 or USB allows data to be logged and commands to be entered. The disadvantage is that external equipment is necessary, which may affect test results (for example, by presenting alternate paths to ground).

External jigs with simple LED displays on PPK or binary interfaces are useful for products that are not equipped with an MCU.

5. Displayed Information

If the product does not have sufficient display elements to simultaneously present a set of information, consider the use of a single diagnostic mode that displays the data in a timed sequence (see Figure 5-1).

Figure 5-1. Example of Displayed Diagnostic Information

```
"QTL", Last Touched Key ID, Reference Level, Signal Level, Delta, Repeat.
If [n] keys are detected at same time: "QTn", First Key ID, Second Key ID ... Last Key ID, Repeat.
"QTS", Key Status Byte 0, Key Status Byte 1 ... Repeat.
"QTE", QT Error Byte 0 ... "QTF", QT FMEA Byte 0 ... Repeat.
```

Note that using an identifier in diagnostic modes is useful in understanding what is being displayed (for example, the identifiers “QTL”, “QTS” and “QTE” in Figure 5-1).

For products with PPK interfaces, it is useful to have a diagnostic mode that displays an idle pattern when no keys are pressed, and which cycles the identities of all pressed keys.

6. Pass-through from QT IC to PC

There are demonstration kits and matching PC software for many QT ICs. A diagnostic mode that passes data directly from the QT IC to the PC (as in the demonstration kits), allows the PC software to be used to diagnose and tune the product. In some circumstances it is necessary to configure the product's MCU to buffer data and thus accommodate different data rates and flow control signals such as DRDY.

7. Production Testing

By keeping production testing in mind during design, diagnostic modes can be embedded in production jigs.

Key-activated modes can be used by manual test operators to perform and view test results.

Modes selected via external interfaces allow automated test equipment to select tests, retrieve results for pass/fail logs, and monitor variations in product criteria over the production life of the product.

Headquarters

Atmel Corporation
2325 Orchard Parkway
San Jose, CA 95131
USA
Tel: 1(408) 441-0311
Fax: 1(408) 487-2600

International

Atmel Asia
Unit 01-05 & 16, 19/F
BEA Tower, Millennium City 5
418 Kwun Tong Road
Kwun Tong
Kowloon
Hong Kong
Tel: (852) 2245-6100
Fax: (852) 2722-1369

Atmel Europe
Le Krebs
8, Rue Jean-Pierre Timbaud
BP 309
78054 Saint-Quentin-en-
Yvelines Cedex
France
Tel: (33) 1-30-60-70-00
Fax: (33) 1-30-60-71-11

Atmel Japan
9F, Tonetsu Shinkawa Bldg.
1-24-8 Shinkawa
Chuo-ku, Tokyo 104-0033
Japan
Tel: (81) 3-3523-3551
Fax: (81) 3-3523-7581

Touch Technology Division
1 Mitchell Point
Ensign Way
Hamble
Southampton
Hampshire SO31 4RF
United Kingdom
Tel: (44) 23-8056-5600
Fax: (44) 23-8045-3939

Product Contact

Web Site
www.atmel.com

Technical Support
qprox.support@atmel.com

Sales Contact
qprox.sales@atmel.com

Literature Requests
www.atmel.com/literature

10704A–AT42–10/08