AN2734
Application note

S-Touch™ design procedure

Introduction

The purpose of this application note is to provide the system/hardware engineers enough ground knowledge to start the design of capacitive touch inferface solutions with the S-Touch™ capacitive controller devices.

The document highlights the recommended step-by-step procedures to be followed for a successful S-Touch™ design-in: design flow, PCB layout, fabrication, assembly pre-production and production tests.

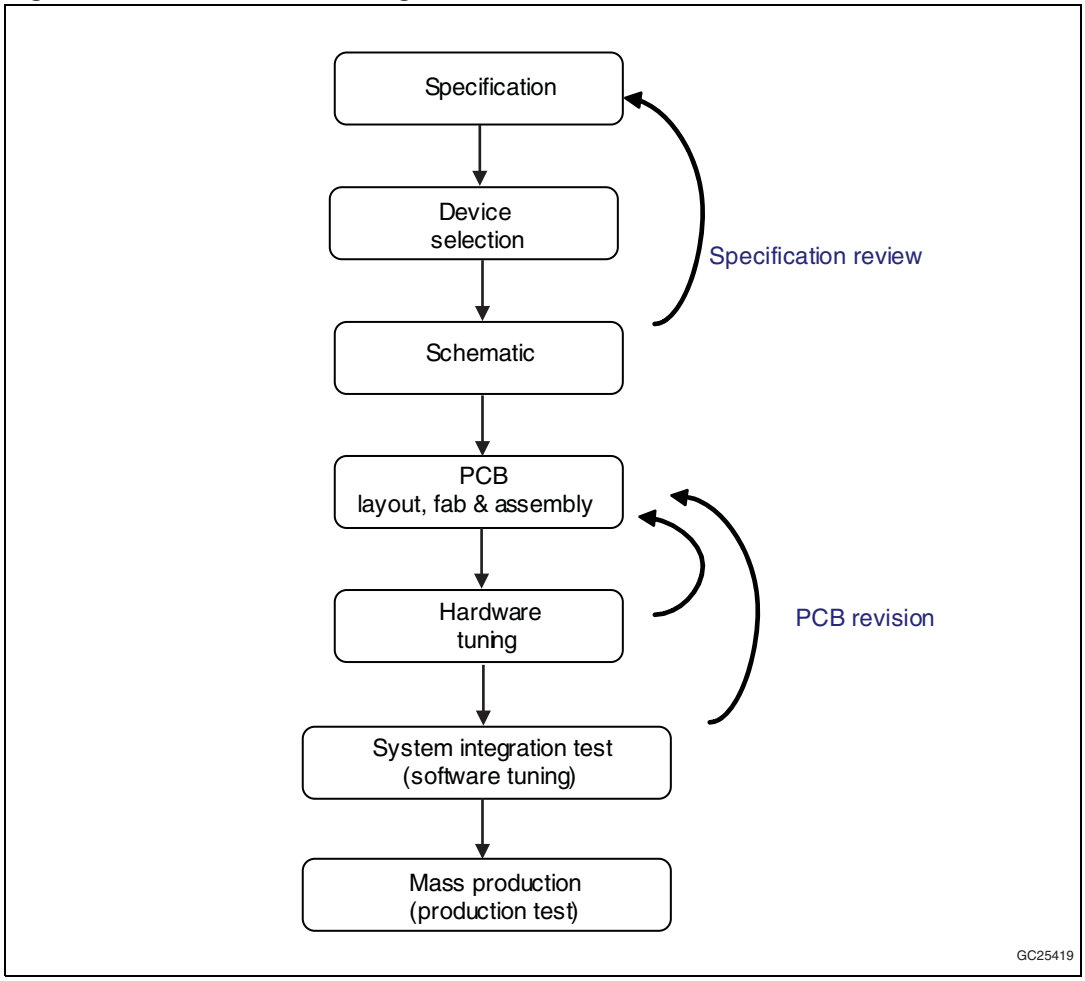
Each topic covered in this document is explained in detail in other application notes.

Contents

1 Touch module design flow

Figure 1 shows a simplified flowchart which describes the complete touch module design flow starting from the specification to the mass production test of the PCB and the overall system.

Figure 1. Touch module design flow

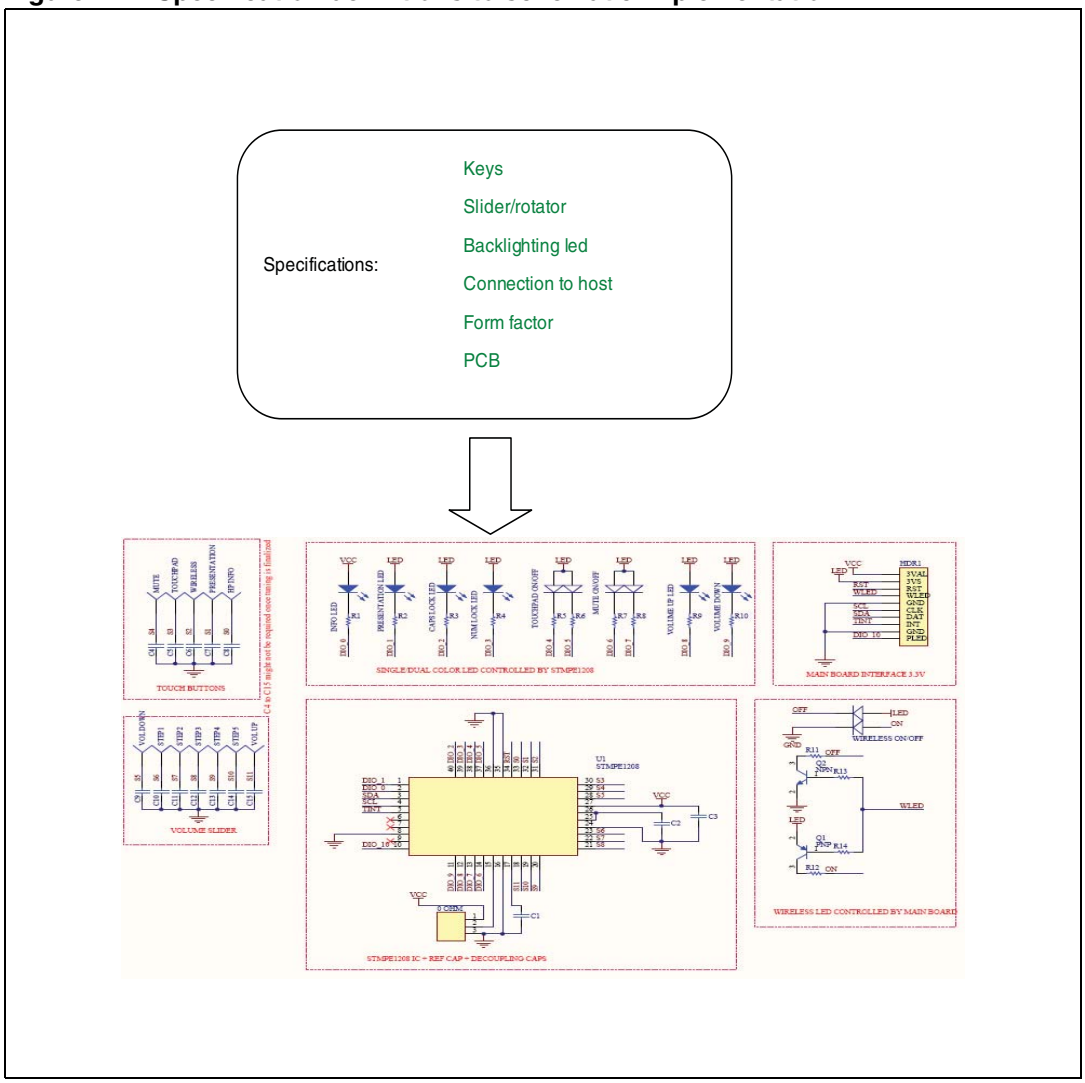


1.1 Touch module specifications

Before starting the design of a capacitive touch module, a clear specification should be defined to establish:

- Touchkeys number and functions
- Slider/rotator implementation
- LED backlighting - white LEDs or red LEDs, 5 V system or 3.6 V system etc
- Signal connections to the host system
- Module form factor

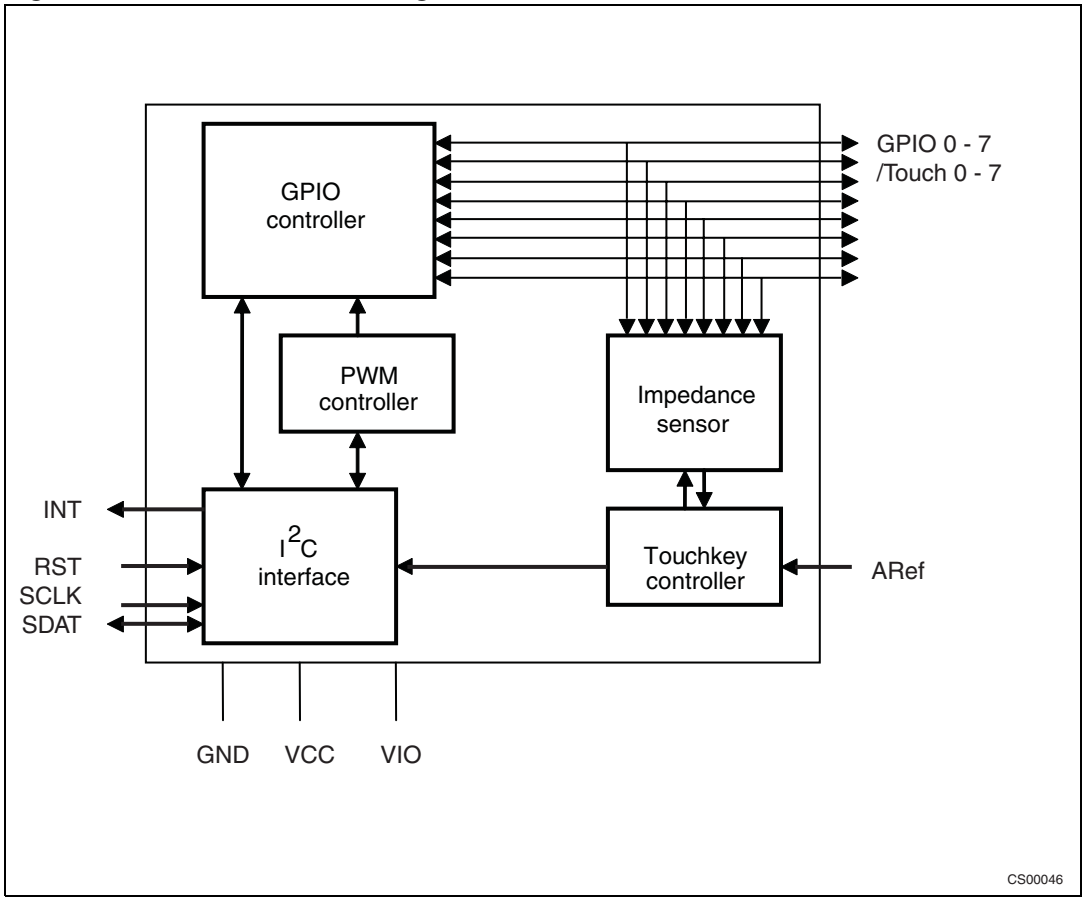
Figure 2. Specification definitions to schematic implementation



The next step to be performed after finalizing the module specification is to choose the most appropriate device from the S-Touch product family, based on the requirements of the target application.

The S-Touch devices have several sensor channels and various features. The STMPE821, for example, consists of 8 I/Os that can be used as either normal input/outputs or as touch sensor inputs. On a particular application, out of the eight I/Os, four I/Os can be used as capacitive touch key input and the other four can be used for the backlighting LED control. If the I/O is used for LED control, it can be configured as PWM output to create elaborate LED effects.

Figure 3. STMPE821 block diagram



For further details on S-Touch working principles and functional features, please refer to the application note AN2693: "S-Touch™ devices: system considerations".

2 PCB layout, fabrication and assembly

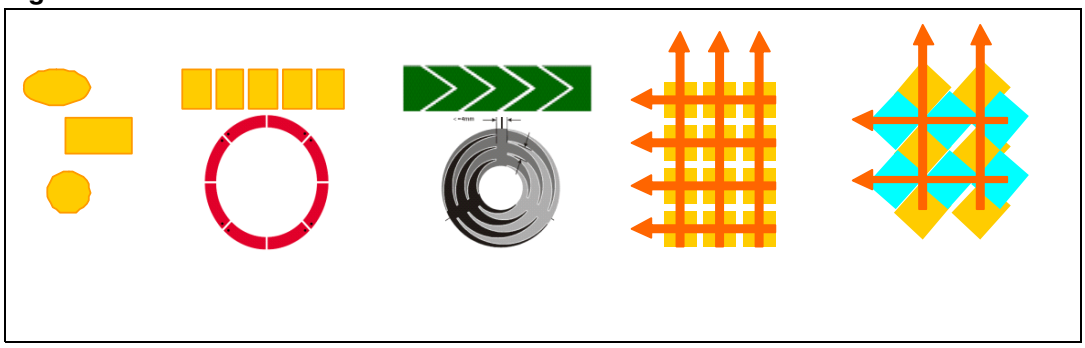
Measuring the capacitance of a sensor is quite simple. However, in order to obtain a reliable measurement of finger capacitance, in-depth technical knowledge is required.

Two conductive materials such as wire, traces or metal that are at different potentials and in close proximity to one another act as a conductive plate, forming a capacitor. Therefore, when designing the layout for the touch module PCB, some standard guidelines should be followed to route the sensor traces. Otherwise, crosstalk and disturbances between sensors and wires, traces and the metal plate reduce touch module performance.

Periodic sampling signals are used to measure the sensors' electrode capacitance. The presence of noise might disturb the sensing of the signal and cause false detection in touch keys and incorrect location reading in sliders or rotators.The controller IC can filter a low to moderate amount of noise. It is therefore recommended to design the PCB layout in such a way that the interaction between the external noise and the sensor/electrode circuitry is minimized.

There are a few different types of sensor electrodes: button, slider, rotator, matrix key and touch pad. Each one serves a specific function. Their shapes and sizes differ based on the application and form factor requirements.

Figure 4. Sensor electrodes



For further details on the PCB and layout considerations, please refer to application note AN2733 "S-Touch™ PCB and layout guidelines".

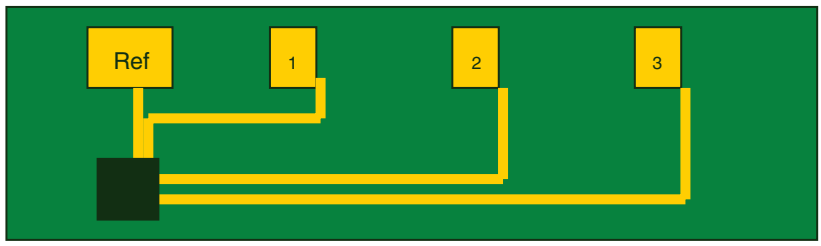
2.1 Pre-production tuning/test

Once the PCB fabrication is complete, the S-Touch controller IC and the passive components are assembled on the PCB.

2.1.1 Hardware tuning

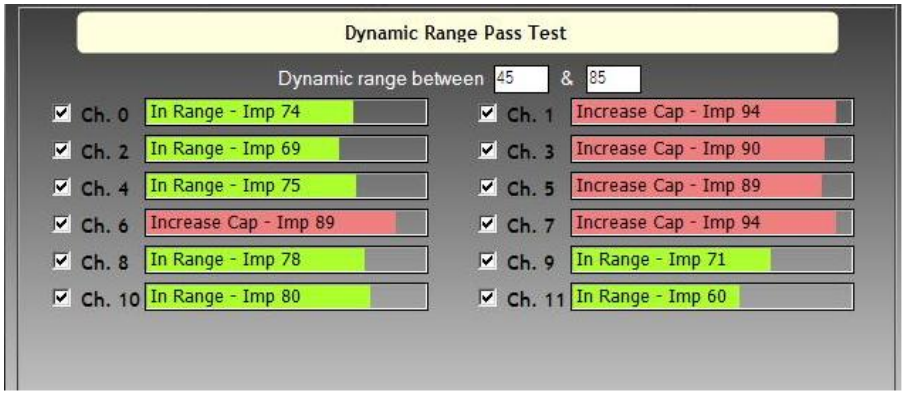
The reference and input tuning capacitors are populated on the PCB as part of a process called “hardware tuning”. This process is required due to the imbalance in the inherent capacitance between the capacitive lines (reference and sensor inputs, see *Figure 5*). The objective of the hardware tuning is to bring the no-touch impedance of all the unused sensor inputs within the dynamic range for touch detection.

Figure 5. Imbalanced inherent capacitance



The hardware tuning process is described more in detail in the application note AN2801- Hardware tuning procedures.

Figure 6. Dynamic range tuning software



As shown in *Figure 6*, the hardware tuning process can be achieved more easily by using the provided software.

2.1.2 Software tuning

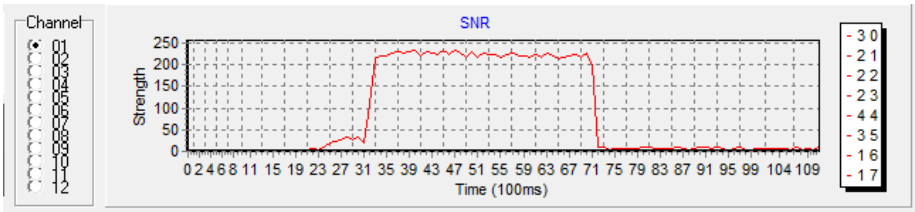
The next step is software tuning. The S-Touch devices are register-based which means that the host must configure the device for it to work properly. It is suggested to perform the software tuning with the panel overlay attached to the PCB and with the touch module assembled on the system.

When the touch module is assembled on the system, interactions with other components and noise on the system affect the operation. This is why the software tuning is performed on the system and not on the standalone touch module.

During the software tuning, the registers which control the sensitivity, noise filtering, calibration and some other related registers are tuned to get optimum values. Once the correct register values are tuned/validated properly, they are embedded as part of the host system code. Each time the system is powered up, the host initializes the S-Touch device with these register values.

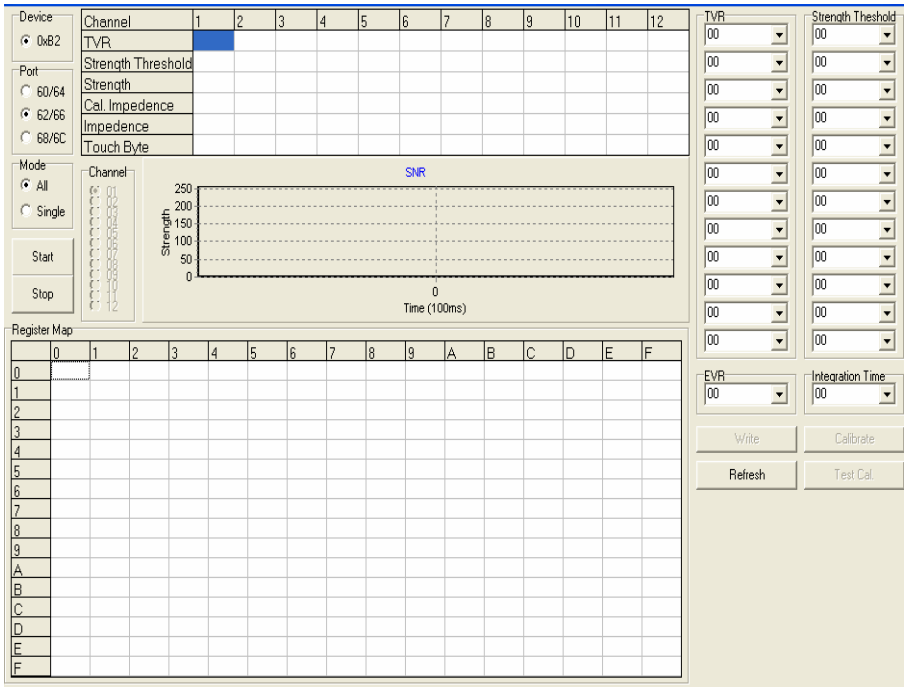
The final register values validated during the software tuning process provide the optimal configuration for the S-Touch registers, allowing the device to work properly in any condition.

Figure 7. Signal-to-noise ratio measurement



The system integration tests cover the signal-to-noise ratio measurement (*Figure 7*), water drop tests for systems operating in wet environments and touch failure ratio. It includes susceptibility to external disturbances such as external RF noise, effect of fluorescent lamp emissions, mobile phone emisissions, etc.

Figure 8. Signal-to-noise ratio tool



For complete software tuning guidelines, please refer to the application notes AN2802 “S-Touch registers descriptions” and AN2805 "System integration test".

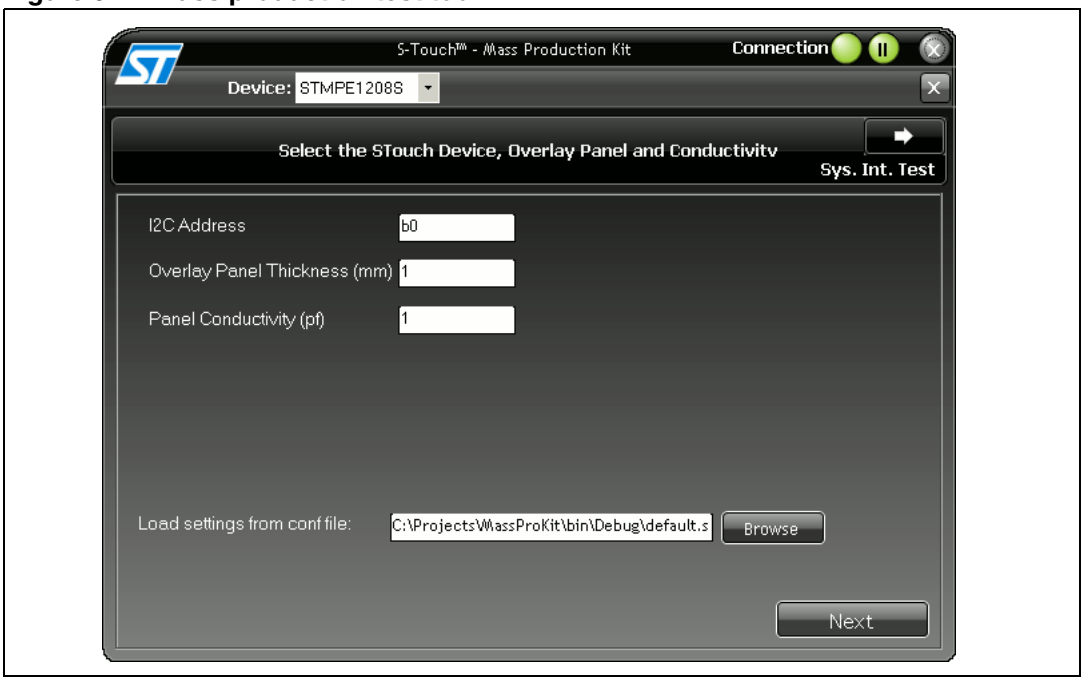
2.2 Production test

The production test consists of a module production test and a system integration production test.

The module production test is performed on the touch module PCB (without overlay panel) in order to screen any assembly and/or components failures.

The system production test is performed with the touch module (attached to the overlay panel) assembled on the system.

Figure 9. Mass production test tool



The system integration production tests can be performed automatically or manually. An automated test can be carried out using a metallic plate to simulate a finger touch and a manual test can be performed with a production operator manually touching the button to test its functionalities.

3 Conclusion

Below is a short summary table on the S-Touch design procedure.

Table 1. S-Touch design procedure

Step	Description	Notes	STMicroelectronics tools
1	System level functional definition	Define number of buttons/slider/wheel, approximate placement, board size, cover thickness/material	
2	Schematic design and PCB layout	Device selection, number of PCBs layers	PCB layout guidelines
3	Assembly of 5-10 boards for capacitance tuning	Tuning done with actual cover material	Dynamic range tuning tool
4	Software development/optimization based on 5-10 boards	Noise immunity setting,optimized sensitivity setting, SNR test	Reference code, software tuning tool, SNR tool
5	Assembly of 100-200 boards according to tuning results (step 3)	To check consistency/stability of the capacitive module in actual production condition	Mass production test software toolkit
6	Analysis of test (MP test, SNR test, noise test) results from 100-200 sets. Fine tuning of capacitance values if necessary	Results should be consistent with system level requirements	

4 Reference

1. STMPE821 datasheet
2. STMPE1208S datasheet
3. AN2693, S-Touch™ devices: system considerations
4. AN2733, S-Touch™ PCB and layout guidelines
5. AN2801, Hardware tuning procedures
6. AN2802, A programming guide for the touch module in capacitive S-Touch™ devices
7. AN2805, System integration test

5 Revision history

Table 2. Document revision history

Date	Revision	Changes
30-Apr-2009	1	Initial release.
15-Jan-2010	2	Removed reference to AN2806.