S-Series SGD
Digital Signal Generator

Operating Manual

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About the SGD Digital Signal Generator

The S-Series SGD digital signal generator is a compact, easy to use, high performance signal generator for R&D, manufacturing and the field.

The SGD employs a large touch screen user-interface to provide a signal generator with unparalleled ease-of-use. With such a small form-factor, the SGD is as usable in the field as it is in the laboratory or on a production line. The wide-bandwidth IQ modulator exhibits excellent dynamic range, enabling the most demanding amplifier and receiver selectivity measurements. The use of Aeroflex's Fast Low Noise Synthesis (FLNS) technology, added to the experience gained through decades of developing advanced signal source products, ensures that signal purity and integrity have not been sacrificed in the quest for speed. With a comprehensive range of features and options, the SGD meets the needs for a general-purpose signal generator while offering the high performance required of demanding, critical receiver measurements or rapid manufacturing.

SGD Digital Signal Generator

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Welcome to SGD-3 and SGD-6

Welcome to the Help for the SGD-3 and SGD-6 S-Series Digital Signal Generators. These compact, easy to use, high performance instruments have a touch-screen interface that simplifies operation and is intuitive to use. This Help is intended to support you in operating the instrument, to provide detailed information about each function, and to provide examples of how to use the instrument for making measurements.

Please take time to read the safety information first.

About SGD gives information about the use and user of the instrument, together with patent information.

Installation is primarily for first-time users, with information on positioning and power connections.

Getting started gives information about front- and rear-panel connections, and explains how to use the touch screen.

Set up to generate details the setup screens and available generation modes, which include all common modulation schemes.

Maintenance covers routine maintenance and safety checks.

Associated publications

If you want to…	Refer to…
View safety information and basic setup and operation instructions in **pdf** format.	**SGD Digital Signal Generator Getting Started Guide** Part no. 47090/130 On the CD-ROM and at www.aeroflex.com/.
View safety information and basic setup and operation instructions in **printed** format.	**SGD Digital Signal Generator Getting Started Guide** Part no. 47000/130 Supplied with the instrument.
View operating information for the instrument in **html Help** format.	**SGD Digital Signal Generator Help** Part no. 47090/131 On the CD-ROM and at www.aeroflex.com/.
View operating information for the instrument in **pdf** format.	**SGD Digital Signal Generator Operating Manual** Part no. 47090/132 On the CD-ROM and at www.aeroflex.com/.
View operating information for the instrument in **printed** format.	**SGD Digital Signal Generator Operating Manual** Part no. 47000/132 Available as an optional extra.
View remote programming information for the instrument in **pdf** format.	**SGD Digital Signal Generator Remote Command Reference Manual** Part no. 47090/133 On the CD-ROM and at www.aeroflex.com/.
View remote programming information for the instrument in **printed** format.	**SGD Digital Signal Generator Remote Command Reference Manual** Part no. 47000/133 Available as an optional extra.
View detailed information about the structure and synthesis of different modulation types.	**IQ Creator User Guide** Part no. 46892/627 At www.aeroflex.com/.

Viewing the SGD Help file

Help

The SGD Help manual (part no. 47090/131, on the CD-ROM) provides html help on all aspects of installing and operating the instrument. You should be able to view the Help manual on all browsers although you may observe slight changes in presentation depending on the browser used.

Note: if you copy the Help manual file from the CD-ROM to your computer, be aware that, for security reasons, Windows® XP restricts access to HTML help (x.chm) files across network drives. If you try to view any html help file on a network drive, you will see an error message. You need to move such files to your C drive to view them. Of course, you can run the html Help manual directly from the CD-ROM.

Operating   manual

This operating manual (part no. 47090/132) provides the same information on installing and operating the instrument as the Help file, but in an A4 PDF format. It is installed on the CD-ROM. It is available also as a printed document, part no. 47000/132.

Safety

This section contains important information about protecting yourself and the instrument from harm.

Precautions

Precautions

These terms have specific meanings in this document:

WARNING

...information to prevent personal injury.

CAUTION

...information to prevent damage to the instrument.

Hazard symbols

The meaning of hazard symbols appearing on the instrument and in the documentation is as follows:

Symbol	Description
⚠	Refer to the operating manual when this symbol is marked on the instrument. Familiarize yourself with the nature of the hazard and the actions that may have to be taken.
☠	Toxic hazard

WARNING

Suitability for use

This instrument has been designed and manufactured by Aeroflex to generate low-power RF signals for testing radio communications apparatus.

If the instrument is not used in a manner specified by Aeroflex, or if it is damaged, the protection provided by the instrument may be impaired.

Aeroflex has no control over the use of this instrument and cannot be held responsible for events arising from its use other than for its intended purpose.

WARNING

After unpacking the instrument, inspect the shipping container and its cushioning material for signs of stress or damage.

If there is damage, retain the packing material for examination by the carrier in the event that a claim is made.

Examine the instrument for signs of damage; do not connect the instrument to a supply when damage is present, as internal electrical damage could result in a shock if the instrument is turned on.

General conditions of use

This product is designed and tested to comply with the requirements of BS EN 61010-1 'Safety requirements for electrical equipment for measurement, control and laboratory use', for Class 1 portable equipment and is for use in a pollution degree 2 environment. The instrument is designed to operate from an installation category II supply.

The instrument should be protected from the ingress of liquids and precipitation such as rain, snow, etc. When moving the instrument from a cold to a hot environment, it is important to allow the temperature of the instrument to stabilize before it is connected to the supply to avoid condensation forming. The instrument must only be operated within the environmental conditions specified in the data sheet, otherwise the protection provided by the instrument may be impaired.

This product is not approved for use in hazardous atmospheres or safety-critical applications.

WARNING

⚠ Electrical hazards (AC supply voltage)

This instrument conforms with IEC Safety Class 1, meaning that it is provided with a protective grounding conductor. To maintain this protection the power cord must always be connected to the source of supply via a socket with a grounded contact.

Be aware that the supply filter contains capacitors that may remain charged after the instrument is disconnected from the supply. Although the stored energy is within the approved safety requirements, a slight shock may be felt if the plug pins are touched immediately after removal.

Do not remove instrument covers as this may result in personal injury. There are no user-serviceable parts inside.

Refer all servicing to qualified personnel.

Fuses

Note that the internal supply fuse is in series with the live conductor of the power cord. If connection is made to a 2-pin unpolarized supply socket, it is possible for the fuse to become transposed to the neutral conductor, in which case, parts of the equipment could remain at supply potential even after the fuse has ruptured.

WARNING

⚠ Fire hazard

Make sure that only fuses of the correct rating and type are used for replacement.

If an integrally fused plug is used on the power cord, ensure that the fuse rating is commensurate with the current requirements of this instrument. See the data sheet for power requirements.

WARNING

☠ Toxic hazards

Some of the components used in this instrument may include resins and other materials that give off toxic fumes if incinerated. Take appropriate precautions, therefore, in the disposal of these items.

WARNING

⚠ Heavy instrument

The weight of this instrument may exceed the 18 kg (40 lb) guideline for manual handling by a single person. To avoid the risk of injury, an assessment should be carried out prior to handling, which takes account of the load, workplace environment and individual capability, in accordance with European Directive 90/269/EEC and associated national regulations.

WARNING

⚠ **Lithium**

A Lithium battery is used in this equipment.

As Lithium is a toxic substance, the battery should in no circumstances be crushed, incinerated or disposed of in normal waste.

Do not attempt to recharge this type of battery. Do not short circuit or force discharge since this might cause the battery to vent, overheat or explode.

WARNING

⚠ **Tilt facility**

When the instrument is in the tilt position, it is advisable, for stability reasons, not to stack other equipment on top of it.

WARNING

⚠ **Liquid crystal display (LCD) module**

The liquid crystal substance within the display panel used in this instrument is a toxic substance. If the display panel is damaged and any of the liquid crystal substance leaks out, do not allow it to come into contact with your mouth. If the substance comes into contact with your skin, immediately wash the affected areas with soap and water, and seek medical advice.

The display panel is made of glass. Therefore do not subject the instrument to mechanical shocks that might cause fractures.

Do not dispose of these modules, or any part of them, in domestic waste. Use only approved waste disposal methods.

Précautions

Les termes suivants ont, dans ce manuel, des significations particulières:

WARNING

...contient des informations pour éviter toute blessure au personnel.

CAUTION

...contient des informations pour éviter les dommages aux équipements.

Symboles signalant un risque

La signification des symboles de danger apparaissant sur l'équipement et dans la documentation est la suivante:

Symbole   Nature du risque

Reportez-vous au manuel d'utilisation quand ce symbole apparaît sur l'instrument. Familiarisez-vous avec la nature du danger et la conduite à tenir.

Danger produits toxiques

WARNING

Utilisation

Cet équipement a été conçu et fabriqué par Aeroflex pour générer des signaux RF de faible puissance pour effectuer des mesures sur des composants et des systèmes RF et hyperfréquences.

La protection de l'équipement peut être altérée s'il n'est pas utilisé dans les conditions spécifiées par Aeroflex, ou il est endommagé.

Aeroflex n'a aucun contrôle sur l'usage de l'instrument, et ne pourra être tenu pour responsable en cas d'événement survenant suite à une utilisation différente de celle prévue.

WARNING

⚠ Inspection visuelle initiale

Lors du déballage de l'instrument, examinez l'emballage ainsi que les matériaux de protection afin de détecter tout signe de contrainte ou de dommage. Dans ce cas, gardez l'emballage pour le faire examiner par le transporteur et présenter une éventuelle réclamation. Détectez également tout signe de dommage sur l'équipement; ne pas mettre sous tension un équipement présentant des dommages, tout dommage électrique interne pouvant provoquer un choc lors de la mise en route.

Conditions générales d'utilisation

Ce produit a été conçu et testé pour être conforme aux exigences des normes BS EN 61010-1 "Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire", pour des équipements Classe I portables et pour une utilisation dans un environnement de pollution de niveau 2. Cet équipement est conçu pour fonctionner à partir d'une alimentation de catégorie II.

Cet équipement doit être protégé de l'introduction de liquides ainsi que des précipitations d'eau, de neige, etc. Lorsqu'on transporte cet équipement d'un environnement chaud vers un environnement froid, il est important de laisser l'équipement se stabiliser en température avant de le connecter à une alimentation afin d'éviter toute formation de condensation. L'appareil doit être utilisé uniquement dans le cadre des conditions d'environnement spécifiées dans la fiche technique, toute autre utilisation peut endommager les systèmes de protection.

Ce produit n'est pas garanti pour fonctionner dans des atmosphères dangereuses ou dans les applications de securité critiques.

WARNING

⚠ Sécurité électrique (tension d'alimentation alternative)

Cet appareil est protégé conformément à la norme CEI de sécurité Classe 1, c'est-à-dire que sa prise secteur comporte un fil de protection à la terre. Pour maintenir cette protection, le câble d'alimentation doit toujours être branché à la source d'alimentation par l'intermédiaire d'une prise comportant une borne de terre.

Notez que les filtres d'alimentation contiennent des condensateurs qui peuvent encore être chargés lorsque l'appareil est débranché. Bien que l'énergie contenue soit conforme aux exigences de sécurité, il est possible de ressentir un léger choc si l'on touche les bornes sitôt après débranchement.

Ne démontez pas le capot de l'instrument, car ceci peut provoquer des blessures. Il n'y a pas de pièces remplaçables par l'utilisateur à l'intérieur.

Faites effectuer toute réparation par du personnel qualifié.

Fusibles

Notez que le fusible d'alimentation interne est en série avec la phase du câble d'alimentation. Si la prise d'alimentation comporte deux bornes non polarisées, il est possible de connecter le fusible au neutre. Dans ce cas, certaines parties de l'appareil peuvent rester à un certain potentiel même après coupure du fusible.

WARNING

⚠ Risque lié au feu

Lors du remplacement des fusibles vérifiez l'exactitude de leur type et de leur valeur.

Si le câble d'alimentation comporte une prise avec fusible intégré, assurez vous que sa valeur est compatible avec les besoins de la fiche technique.

WARNING

☠ Danger produits toxiques

Certains composants utilisés dans cet appareil peuvent contenir des résines et d'autres matières qui dégagent des fumées toxiques lors de leur incinération. Les précautions d'usages doivent donc être prises lorsqu'on se débarrasse de ce type de composant.

WARNING

⚠ Equipement lourd

Le poids de cet appareil peut être supérieur à la limite de 18 kg (40 lb), fixée pour le transport par une seule personne. Afin d'éviter tout risque de blessure, il est nécessaire de faire, avant le transport, une évaluation de la charge, des contraintes de l'environnement et des capacités de l'individu, en conformité avec la Directive Européenne 90/269/EEC ainsi que les recommandations Nationales concernées.

WARNING

☠ Lithium

Une pile au Lithium est utilisé dans cet équipement.

Le Lithium étant une substance toxique, il ne faut en aucun cas l'écraser, l'incinérer ou le jeter avec des déchets normaux.

N'essayez pas de recharger ce type de pile. Ne court-circuitez pas ou ne forcez pas la décharge de la pile car cela pourrait causer une fuite, une surchauffe ou une explosion.

WARNING

⚠ Position inclinée

Lorsque l'appareil est dans une position inclinée, il est recommandé, pour des raisons de stabilité, de ne pas y empiler d'autres appareils.

WARNING

☠ Module d'affichage à cristaux liquides

Ne pas démonter le module d'affichage à cristaux liquides.

La matière contenue dans l'afficheur à cristaux liquides utilisé dans cet appareil est une substance toxique. Si l'afficheur est endommagé ou si la matière des cristaux liquides s'écoule, il faut éviter de la mettre en contact avec sa bouche. En cas de contact avec la peau, laver immédiatement la surface touchée avec de l'eau et du savon et s'adresser à un service médical.

L'afficheur est en verre. Il faut donc éviter de lui faire subir des chocs mécaniques pouvant causer des dégâts.

Ne pas se débarrasser de ces modules ni d'aucun de leurs composants dans une poubelle à usage domestique. Utilisez uniquement les containers à déchets appropriés.

Vorsichtsmaßnahmen

Diese Hinweise haben eine bestimmte Bedeutung in diesem Handbuch:

WARNING

...dienen zur Vermeidung von Verletzungsrisiken.

CAUTION

...dienen dem Schutz der Geräte.

Gefahrensymbole

Die Bedeutung der Gefahrensymbole auf den Geräten und in der Dokumentation ist wie folgt:

Symbol   Gefahrenart

    Beziehen Sie sich auf die Bedienungsanleitung wenn das Messgerät mit diesem Symbol markiert ist. Machen Sie sich mit der Art der Gefahr und den Aktionen die getroffen werden müssen bekannt.

    Warnung vor giftigen Substanzen

WARNING

Eignung für Gebrauch

Dieses Gerät wurde von Aeroflex entwickelt und hergestellt um HF Signale geringer Leistung zum Test von Kommunikationseinrichtungen zu erzeugen.

Sollte das Gerät nicht auf die von Aeroflex vorgesehene Art und Weise verwendet werden, oder wenn es beschädigt ist, kann die Schutzfunktion des Gerätes beeinträchtigt werden.

Aeroflex hat keinen Einfluß auf die Art der Verwendung und übernimmt keinerlei Verantwortung bei unsachgemässer Handhabung.

WARNING

⚠ Sofortige visuelle Überprüfung

Nach dem Auspacken des Gerät es ist die Verpackung und das Ausfütterungsmaterial auf Druckstellen und Beschädigung hin zu überprüfen. Bei Feststellung von Beschädigung sollte die Verpackung, für den Fall daß Ansprüche an den Spediteur entstehen, sichergestellt werden. Begutachten Sie anschließend das Gerät auf Anzeichen von Beschädigung und verbinden Sie dieses nicht mit dem Netz falls solche vorhanden sind. Interne elektrische Beschädigung kann beim Einschalten zu einem Stromschlag führen.

Allgemeine Hinweise zur Verwendung

Dieses Produkt wurde entsprechend den Anforderungen von BS EN 61010-1 "Sicherheitsanforderungen für elektrische Ausrüstung für Meßaufgaben, Steuerung und Laborbedarf", Klasse I transportabel zur Verwendung in einer Grad 2 verunreinigten Umgebung, entwickelt und getestet. Dieses Gerät ist für Netzversorgung Klasse II zugelassen.

Das Gerät sollte vor dem Eindringen von Flüssigkeiten sowie vor Regen, Schnee etc. geschützt werden. Bei Standortänderung von kalter in wärmere Umgebung sollte das Gerät wegen der Kondensation erst nach Anpassung an die wärmere Umgebung mit dem Netz verbunden werden. Das Gerät darf nur in Umgebungsbedingungen wie im Datenblatt beschrieben, betrieben werden; ansonsten wird der vom Gerät vorgesehene Schutz des Anwenders beeinträchtigt.

Dieses Produkt ist nicht für den Einsatz in gefährlicher Umgebung (z.B. Ex-Bereich) und für sicherheitskritische Anwendungen geprüft.

WARNING

⚠ Elektrische Schläge (Wechselspannungsversorgung)

Das Gerät entspricht IEC Sicherheitsklasse 1 mit einem Schutzleiter nach Erde. Das Netzkabel muß stets an eine Steckdose mit Erdkontakt angeschlossen werden.

Filterkondensatoren in der internen Spannungsversorgung können auch nach Unterbrechung der Spannungszuführung noch geladen sein. Obwohl die darin gespeicherte Energie innerhalb der Sicherheitsmargen liegt, kann ein leichter Spannungsschlag bei Berührung kurz nach der Unterbrechung erfolgen.

Öffnen Sie niemals das Gehäuse der Geräte das dies zu ernsthaften Verletzungen führen kann. Es gibt keine vom Anwender austauschbare Teile in diesem Gerät.

Lassen Sie alle Reparaturen durch qualifiziertes Personal durchführen.

Sicherungen

Die interne Sicherung in der Spannungszuführung ist in Reihe mit der spannungsführenden Zuleitung geschaltet. Bei Verbindung mit einer zweiadrigen, nicht gepolten Steckdose kann die Sicherung in der Masseleitung liegen, so daß auch bei geschmolzener Sicherung Geräteteile immer noch auf Spannungspotential sind.

WARNING

⚠ Feuergefahr

Es dürfen nur Ersatzsicherungen vom gleichen Typ mit den korrekten Spezifikationen entsprechend der Stromaufnahme des Gerätes verwendet werden. Siehe hierzu im Datenblatt.

WARNING

☠ Warnung vor giftigen Substanzen

In einigen Bauelementen dieses Geräts können Epoxyharze oder andere Materialien enthalten sein, die im Brandfall giftige Gase erzeugen. Bei der Entsorgung müssen deshalb entsprechende Vorsichtsmaßnahmen getroffen werden.

WARNING

⚠ **Schweres Gerät**

Das Gewicht dieses Geräts kann über der 18 kg (40 lb) Grenze für Transport durch eine einzelne Person liegen. Zur Vermeidung von Verletzungen sollten vor einem Transport die Arbeitsumgebung und die persönlichen Möglichkeiten im Verhältnis zur Last abgewogen werden, wie in der EU-Regelung 90/269/EEC und nationalen Normen beschrieben.

WARNING

☠ **Lithium**

Eine Lithium Batterie ist in diesem Gerät eingebaut.

Da Lithium ein giftiges Material ist, sollte es als Sondermüll entsorgt werden.

Diese Batterie darf auf keinen Fall geladen werden. Nicht kurzschließen, da sie dabei überhitzt werden und explodieren kann.

WARNING

⚠ **Schrägstellung**

Bei Schrägstellung des Geräts sollten aus Stabilitätsgründen keine anderen Geräte darauf gestellt werden.

WARNING

☠ **Das LCD Modul**

Demontieren Sie in keinem Fall das LCD Modul.

Die Flüssigkristallsubstanz, die im Displaymodul dieses Gerätes enthalten ist, enthält giftige Substanzen. Falls das Displaymodul beschädigt wird und die darin enthaltene Flüssigkristall-substanz entweicht, so achten Sie darauf, daß diese Substanz in keinem Fall mit Schleimhäuten in Berührung kommt. Sollte die Substanz mit Ihrer Haut in Berührung kommen, so waschen Sie die betroffenen Hautpartien mit Wasser und Seife ab und geben sich in ärztliche Behandlung.

Das Display besteht aus Glas. Mechanische Einwirkungen können das Glas zerstören.

Entsorgen Sie diese Module oder Teile davon nicht über den normalen Hausmüll, sondern über eine geeignete Sondermüllverwertung.

Precauzioni

Questi termini vengono utilizzati in questo manuale con significati specifici:

WARNING

...riportano informazioni atte ad evitare possibili pericoli alla persona.

CAUTION

...riportano informazioni per evitare possibili pericoli all'apparecchiatura.

Simboli di pericolo

Il significato del simbolo di pericolo riportato sugli strumenti e nella documentazione è il seguente:

Simbolo   Tipo di pericolo

Fare riferimento al manuale operativo quando questo simbolo è riportato sullo strumento. Rendervi conto della natura del pericolo e delle precauzioni che dovrete prendere.

Pericolo sostanze tossiche

WARNING

Caratteristiche d'uso

Questo strumento è stato progettato e prodotto da Aeroflex generare segnali RF in bassa potenza per provare apparati di radio comunicazione.

Se lo strumento non è utilizzato nel modo specificato da Aeroflex, o è danneggiato, le protezioni previste sullo strumento potrebbero risultare inefficaci.

Aeroflex non può avere il controllo sull'uso di questo strumento e non può essere ritenuta responsabile per eventi risultanti da un uso diverso dallo scopo prefisso.

WARNING

⚠ Ispezione visiva iniziale

Dopo aver sballato lo strumento, ispezionare l'imballo e verificare che non vi siano segni di urti o deformazioni. Nel caso si dovessero riscontrate dei danni, conservare l'imballo per un'eventuale contestazione al cordiere.

Verificare che lo strumento non abbia segni di danni, nel caso si dovessero riscontrate tali segni, non dare alimentazione in quanto vi potrebbero essere dei danni interni causa di possibili shock.

Condizioni generali d'uso

Questo prodotto è stato progettato e collaudato per rispondere ai requisiti della direttiva BS EN 61010-1 'Safety requirements for electrical equipment for measurement, control and laboratory use' per apparati di classe I portatili e per l'uso in un ambiente inquinato di grado 2. L'apparato è stato progettato per essere alimentato da un alimentatore di categoria II.

Lo strumento deve essere protetto dal possibile ingresso di liquidi quali, ad es., acqua, pioggia, neve, ecc. Qualora lo strumento venga portato da un ambiente freddo ad uno caldo, è importante lasciare che la temperatura all'interno dello strumento si stabilizzi prima di alimentarlo per evitare formazione di condense. Lo strumento deve essere utilizzato esclusivamente nelle condizioni ambientali descritte nella scheda tecnica, in caso contrario le protezioni previste nello strumento potrebbero risultare non sufficienti.

Questo prodotto non è stato approvato per essere usato in ambienti pericolosi o applicazioni safety-critical.

WARNING

⚠ Pericoli da elettricità (alimentazione c.a.)

Quest 'apparato è provvisto del collegamento di protezione di terra e rispetta le norme di sicurezza IEC, classe 1. Per mantenere questa protezione è necessario che il cavo, la spina e la presa d'alimentazione siano tutti provvisti di terra.

Il circuito d'alimentazione contiene dei filtri i cui condensatori possono restare carichi anche dopo aver rimosso l'alimentazione. Sebbene l'energia immagazzinata è entro i limiti di sicurezza, purtuttavia una leggera scossa può essere avvertita toccando i capi della spina subito dopo averla rimossa.

Non rimuovete mai le coperture perché così potreste provocare danni a voi stessi. Non vi sono all'interno parti di interesse all'utilizzatore.

Tutte gli interventi sono di competenza del personale qualificato.

Fusibili

Notare che un fusibile è posto sul filo caldo del cavo di alimentazione. Qualora l'alimentazione avvenga tramite due poli non polarizzati, è possibile che il fusibile vada a protezione del neutro per cui anche in caso di una sua rottura, l'apparato potrebbe restare sotto tensione.

WARNING

⚠ Pericolo d'incendio

Assicurarsi che, in caso di sostituzione, vengano utilizzati solo fusibili della portata e del tipo prescritti.

Se viene usata una spina con fusibili, assicurarsi che questi siano di portata adeguata ai requisiti di alimentazione richiesti dallo strumento. Tali requisiti sono riportati nella scheda tecnica.

WARNING

☠ Pericolo sostanze tossiche

Alcuni dei componenti usati in questo strumento possono contenere resine o altri materiali che, se bruciati, possono emettere fumi tossici. Prendere quindi le opportune precauzioni nell'uso di tali parti.

WARNING

⚠ Strumento pesante

Il peso di questo strumento può superare i 18 kg (40 lb) raccomandati come limite per il trasporto manuale da parte di singola persona. Per evitare rischi di danni fisici è bene quindi considerare il carico complessivo, le condizioni del trasporto e le capacità individuali in accordo con la direttiva comunitaria 90/269/EEC e con eventuali regolamenti locali.

WARNING

☠ Litio

Quest 'apparato incorpora una batteria al litio.

Poiché il litio è una sostanza tossica, la batteria non deve essere mai né rotta, né incenerita, né gettata tra i normali rifiuti.

Questo tipo di batteria non può essere sottoposto né a ricarica né a corto-circuito o scarica forzata. Queste azioni possono provocare surriscaldamento, fuoriuscita di gas o esplosione della batteria.

WARNING

⚠ Posizionamento inclinato

Quando lo strumento è in posizione inclinata è raccomandato, per motivi di stabilità, non sovrapporre altri strumenti.

WARNING

☠ Schermo a cristalli liquidi (LCD - Liquid Crystal Display)

Non disassemblare il modulo LCD.

La sostanza contenuta nello schermo LCD è tossica. Se il modulo LCD viene danneggiato e si ha una perdita di liquido, occorre evitarne il contatto con la bocca. In caso di contatto con la pelle, lavare immediatamente le aree interessate con acqua e sapone e contattare un medico.

Lo schermo LCD è di vetro, per cui non devono essere sottoposti a shock meccanici che possano causarne la rottura.

Il modulo LCD, il tubo CCFT o i loro residui vanno eliminati come residui speciali secondo la normativa vigente.

Precauciones

Estos términos tienen significados específicos en este manual:

WARNING

...contienen información referente a prevención de daños personales.

CAUTION

...contienen información referente a prevención de daños en equipos.

Símbolos de peligro

El significado de los símbolos de peligro en el equipo y en la documentación es el siguiente:

Símbolo   Naturaleza del peligro

Vea el manual de funcionamiento cuando este símbolo aparezca en el instrumento. Familiarícese con la naturaleza del riesgo y con las acciones que deban de tomarse.

Aviso de toxicidad

WARNING

Idoneidad de uso

Este equipo ha sido diseñado y fabricado por Aeroflex para generar señales de RF de bajo nivel para probar equipos de radiocomunicaciones.

Si el equipo fuese utilizado de forma diferente a la especificada por Aeroflex, o está dañado, la protección ofrecida por el equipo pudiera quedar reducida.

Aeroflex no tiene control sobre el uso de este equipo y no puede, por tanto, exigirsele responsabilidades derivadas de una utilización distinta de aquellas para las que ha sido diseñado.

WARNING

⚠ Inspección visual inicial

Tras desembalar el equipo inspeccione tanto la caja como el material de amortiguamiento para verificar si han sido forzados o dañados. Si encuentra daños, retenga el embalaje para que, en caso de reclamación, pueda ser inspeccionado por el transportista. Examine el equipo para verificar que no ha sufrido daños. No conecte el equipo a al alimentación cuando esté dañado, la avería interna podría originar una descarga al encender el equipo.

Condiciones generales de uso

Este producto ha sido diseñado y probado para cumplir los requerimientos de la normativa BS EN 61010-1 "Requerimientos de la normativa para equipos eléctricos de medida, control y uso en laboratorio", para equipos clase I portátiles y para uso en un ambiente con un grado de contaminación 2. El equipo ha sido diseñado para funcionar sobre una instalación de alimentación de categorías II.

Debe protegerse el equipo de la entrada de líquidos y precipitaciones como nieve, lluvia, etc. Cuando se traslada el equipo de entorno frío a un entorno caliente, es importante aguardar la estabilización el equipo para evitar la condensación. Solamente debe utilizarse el equipo bajo las condiciones ambientales especificadas en la hoja técnica, en caso contrario la propia protección del equipo puede resultar dañada.

Este producto no ha sido aprobado para su utilización en entornos peligrosos o la seguridad de las aplicaciones críticas.

WARNING

⚠ Nivel peligroso de electricidad (tensión de red)

Este equipo cumple las normas IEC Seguridad Clase 1, lo que significa que va provisto de un cable de protección de masa. Para mantener esta protección, el cable de alimentación de red debe de conectarse siempre a una clavija con terminal de masa.

Tenga en cuenta que el filtro de red contiene condensadores que pueden almacenar carga una vez desconectado el equipo. Aunque la energía almacenada está dentro de los requisitos de seguridad, pudiera sentirse una ligera descarga al tocar la clavija de alimentación inmediatamente después de su desconexión de red.

No retire las cubiertas del chasis del instrumento, ya que pudiera resultar dañado personalmente. No existen partes que puedan ser reparadas en su interior.

Deje todas las tareas relativas a reparación a un servicio técnico cualificado. Vea la lista de Centros de Servicios Internacionales en la parte trasera del manual.

Fusibles

Se hace notar que el fusible de alimentación interno está enserie con el activo del cable de alimentación a red. Si la clavija de alimentación de red cuenta con sólo dos terminales sin polaridad, el fusible puede pasar a estar en serie con el neutro, en cuyo caso existen partes del equipo que permanecerían a tensión de red incluso después de que el fusible haya fundido.

WARNING

⚠ Peligro de incendio

Asegúrese de utilizar sólo fusibles del tipo y valores especificados como repuesto.

Si se utiliza una clavija con fusible incorporado, asegúrese de que los valores del fusible corresponden a los requeridos por el equipo. Consulte la hoja técnica para comprobar los requisitos de alimentación.

WARNING

⚠ Aviso de toxicidad

Alguno de los componentes utilizados en este equipo pudieran incluir resinas u otro tipo de materiales que al arder produjeran sustancias tóxicas. Por tanto, tome las debidas precauciones en la manipulación de esas piezas.

WARNING

⚠ Instrumento pesado

El peso de este equipo podrá ser superior a la recomendación de 18 Kg (40 lb), lo que debe tenerse en cuenta. si va ser transportado manualmente por una sola persona. Para evitar el riesgo de lesiones, antes de mover el equipo deberá evaluar la carga, el entorno de trabajo y la propia capacidad, de acuerdo con la Directiva Europea 90/269/EEC y el Reglamento Nacional Asociado.

WARNING

⚠☠ **Litio**

En este equipo se utiliza una batería de litio.

Dada que el litio es una substancia tóxica las baterías de este material no deben ser aplastadas, quemadas o arrojadas junto a basuras ordinarias.

No trate de recargar este tipo de baterías. No las cortocircuite o fuerce su descarga ya que puede dar lugar a que la esta emita gases, se recaliente o explote.

WARNING

⚠ **Tener en cuenta con el equipo inclinado**

Si utiliza el equipo en posición inclinada, se recomienda, por razones de estabilidad, no apilar otros equipos encima de él.

WARNING

⚠☠ **Módulo de visualizador de cristal liquido**

No desmonte el módulo del Visualizador.

La sustancia que forma el Cristal Liquido del panel de visualización es tóxica. En caso de dañarse el visualizador y salir a exterior dicha sustancia, no permita que la misma entre en contacto con su boca. Si la sustancia se pusiera en contacto con su piel, lave inmediatamente las áreas afectadas con agua y jabón y busque asistencia médica.

El visualizador es de vidrio. Por tanto no lo someta a golpes que puedan romperlos.

No tire estos módulos, ni parte de ellos a la basura doméstica. Deshágase de ellos con métodos aprobados para residuos industriales

Anti-virus protection

The instrument is supplied without anti-virus protection software. We recommend that if you connect to the internet or accept files from portable media (for example, memory sticks), you install a proprietary anti-virus software product. Provided that you install the software in accordance with the manufacturer's recommendations, your Aeroflex warranty is not affected.

Aeroflex accepts no liability whatsoever for any loss or damage caused by viruses, worms, Trojan horses or other malicious programs downloaded through connection of the instrument to the internet, external storage devices or portable media.

About the SGD
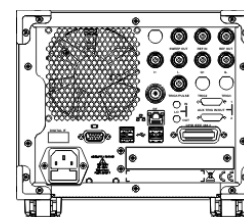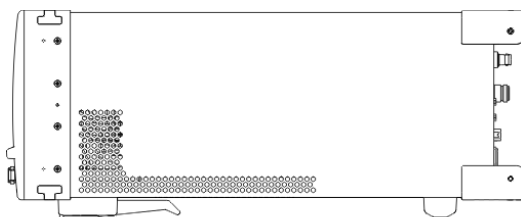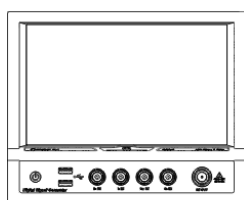
The Aeroflex SGD is a fast low-noise digital signal generator, packaged as a compact, bench-top instrument with touch-screen operation. It provides comprehensive features and options that satisfy the need for a general-purpose digital and analog signal generator, while offering the high performance required of demanding critical receiver measurements or rapid manufacturing.

The instrument software runs on a Windows® operating system that can be accessed for standard file-handling procedures. Many functions are protected however, to ensure correct operation of the SGD software.

In its base configuration, the SGD provides external vector modulation. Provided with any one of the arbitrary waveform generator ('AWG' or 'Arb') options is analog modulation, and the ability to create generic digital modulation (FSK, PSK, QAM) using **IQCreator** ®, Aeroflex's embedded waveform creation utility. This makes it possible to design and generate waveforms on-screen and to store them in the Arb. **IQCreator** ® options for the latest cellular and connectivity wireless standards are also available. List Mode and Arb Sequence Mode enable faster switching between stored frequencies, levels and waveforms. Other options provide pulse modulation, high power output, reverse power protection, removable hard disk, and connection via the rear panel.

Remote operation is provided through USB, Ethernet and GPIB interfaces. SCPI-like commands are used where possible.

Several S-Series products can lock together to form a unit that functions physically and electrically as a single integrated test instrument. Test applications (supplied by Aeroflex or created by you) then control the composite instrument, providing precisely the test capabilities that you need for the production line, the laboratory, or in the field.

The SGD is currently available in two frequency ranges:

SGD-3   100 kHz to 3 GHz

SGD-6   100 kHz to 6 GHz

Data sheet

For a product overview, technical specifications, and information about options and accessories, see the latest S-Series SGD data sheet (part number 46891/462) at aeroflex.com. A data sheet is also included on the CD-ROM delivered with the instrument.

Intended use

This instrument is intended for bench-top or rack installation, and operation under the conditions defined in *General conditions of use*. It is intended to be used by engineering personnel engaged in generating digital and analog RF signals relating to the design, development and testing of RF devices, sub-systems and modules.

It is assumed that you are familiar with the terms and concepts commonly used in RF measurements.

Power supply

Voltage range: 100 to 240 VAC (limit 90 to 264 VAC). The instrument configures automatically to voltages within this range.

Frequency range: 50 to 60 Hz (limit 45 to 66 Hz).

Power consumption: 160 VA max.

See also: Fuses

Disconnecting device

Heavy instrument

WARNING

This instrument is light enough to be handled by one person. However, if two or more instruments are attached together using the Aerolock mechanism, the combined weight of instruments may become more than 18 kg (40 lb), which exceeds the recommended maximum weight for manual handling by a single person.

In this case, *use two people* to lift the instrument. Lift it by the front surround and rear bumpers to avoid trapping fingers underneath.

Declaration of conformity

A copy of the EC declaration of conformity for the SGD Digital Signal Generator is available on request from Aeroflex Ltd.

China RoHS

A declaration of specified hazardous substances that applies when this product is exported to China is available on request from the Aeroflex help desk at www.aeroflex.com/ats/contact.cfm.

A copy of the declaration is provided by default with each shipment of the product to China.

Installation

When combined with other S-Series modules, this may become a heavy instrument; observe the warning about handling it.

Carry out an initial visual inspection before turning the instrument on.

Position the instrument carefully.

Check the installation requirements to ensure that cooling is not impaired.

Connect the instrument to the supply.

Switch the instrument on with the on/off switch.

Perform a goods-in check to establish that the instrument is functional.

Initial visual inspection

WARNING

After unpacking the instrument, inspect the shipping container and its cushioning material for signs of stress or damage.

If there is damage, retain the packing material for examination by the carrier in the event that a claim is made.

Examine the instrument for signs of damage. **Do not** connect the instrument to a supply when damage is present, as internal electrical damage could result in a shock if the instrument is turned on.

Positioning the instrument

CAUTION

Excessive temperatures may affect the performance of the instrument. Completely remove any protective plastic covering, and avoid standing the instrument on or close to another instrument that is hot.

Stability

If you stand the instrument on end on its rear-panel protectors, make sure that you provide support to prevent it from toppling over.

Ventilation

This instrument is air-cooled by a fan mounted on the rear panel. Air enters through ventilation holes on either side of, and underneath, the instrument, and expels through the fan outlet.

Before switching on the instrument, ensure that the fan outlet and the ventilation holes are not restricted. Leave a clearance of at least 50 mm (2 in). If you do not provide adequate clearance, internal temperatures will increase and may affect the instrument's performance adversely.

When two or more instruments are joined together, the design ensures that each instrument receives adequate airflow.

.

Power cord

When the instrument has to be plugged into a Class II (ungrounded) 2-terminal socket outlet, the power cord should either be fitted with a 3-pin Class I plug and used in conjunction with an adapter incorporating a ground wire, or be fitted with a Class II plug with an integral ground wire.

Fasten the ground wire securely to ground. Grounding one terminal on a 2-terminal socket does not provide adequate protection.

If a molded plug has to be cut off a power cord, dispose of it immediately. A plug with bare wires is hazardous if it is inserted into a live socket outlet.

The power cord is the instrument's disconnecting device.

Use only an approved and rated power cord-set, appropriate to the country in which it is to be used. Contact Aeroflex if in doubt.

Connecting to supply

The instrument is a Safety Class 1 product and therefore must be earthed. Use the supplied power cord or an appropriate replacement. Make sure that the instrument is plugged into an outlet socket with a protective earth contact.

Ensure that the AC supply is correctly connected to the instrument's power receptacle. For line power in the range 100 to 240 V~, the PSU automatically selects the appropriate range.

No manual voltage-range selection is provided.

Class 1 product

A Class 1 product contains basic insulation between live parts and exposed conductive parts such as the metal enclosure. Exposed conductive parts are connected to ground by a conductor. If a fault occurs and a live part contacts the enclosure of the product, a current flows in the ground conductor, tripping a protective device.

Category II supply

A Category II supply is a supply circuit for domestic or digital devices that may include transients with an average value; for example, a power supply suitable for household appliances and portable tools.

Pollution degree 2 environment

A pollution degree 2 environment is one in which normally non-conductive pollution occurs, but occasionally a temporary conductivity caused by condensation must be expected.

Disconnecting device

The detachable power cord is the instrument's disconnecting device, but if the instrument is integrated into a rack or system, an external power switch or circuit breaker is required.

Whatever the disconnecting device, make sure that you can reach it easily and that it is accessible at all times.

Use only an approved power cord no more than three meters long.

On/off switch

The on/off switch on the front panel does not isolate the instrument from the supply. Remove the power cord from the socket outlet to isolate the instrument.

To turn the instrument on, ensure that the power cord is inserted into the power supply receptacle on the rear panel. Then press the front-panel on/off switch. The instrument starts up Windows®. After that has loaded, the instrument automatically loads the SGD software and displays the digital signal generator screen.

AC fuses

The fuse-holder is integral with the 3-pin supply receptacle on the rear panel. To change the fuse, remove the power cord and then use a screwdriver to lever out the holder.

For the AC voltage range of 100 to 240 V, the fuse rating is T3.15AH250V.

One fuse is fitted, in the live line of the supply (see Precautions). It is a ceramic cartridge type, measuring $5 \, \text{mm} \times 20 \, \text{mm}$.

Replace a fuse only with an approved fuse of the same type and rating.

The plug attached to the power cord is fitted with a 5 A fuse also (in the UK only).

External equipment

Connect only equipment complying with the relevant IEC safety standards to the connectors on the instrument, in order to maintain the protection provided by the instrument.

To minimize electromagnetic interference (EMI), follow the following recommendations:

- Do not use connecting cables longer than 1 m.

- Use double-screened cables where possible.

- Items connected to the USB ports — for example, an external keyboard/mouse — can introduce interference.

Goods-in check

The following goods-in check confirms only that the instrument is functioning correctly. It does not verify conformance to the specification given in the data sheet.

1. Ensure that the correct fuse is fitted and that the supply is in the range specified on the data sheet.
2. Connect the instrument to the supply.
3. Press the on/off switch on the front panel. The instrument starts up and displays the digital signal generator menu.
4. If the instrument appears to be completely dead, do the following:

   Check that the power cord is providing power to the instrument.

   Check that the instrument's fuse has not blown.

Getting started

This chapter introduces you to the instrument's controls and connectors.

See also:

Controls and connectors on the front and rear panels of the instrument.

How the instrument's screen is laid out and what the different parts do.

About popup windows.

Generating signals.

Front panel
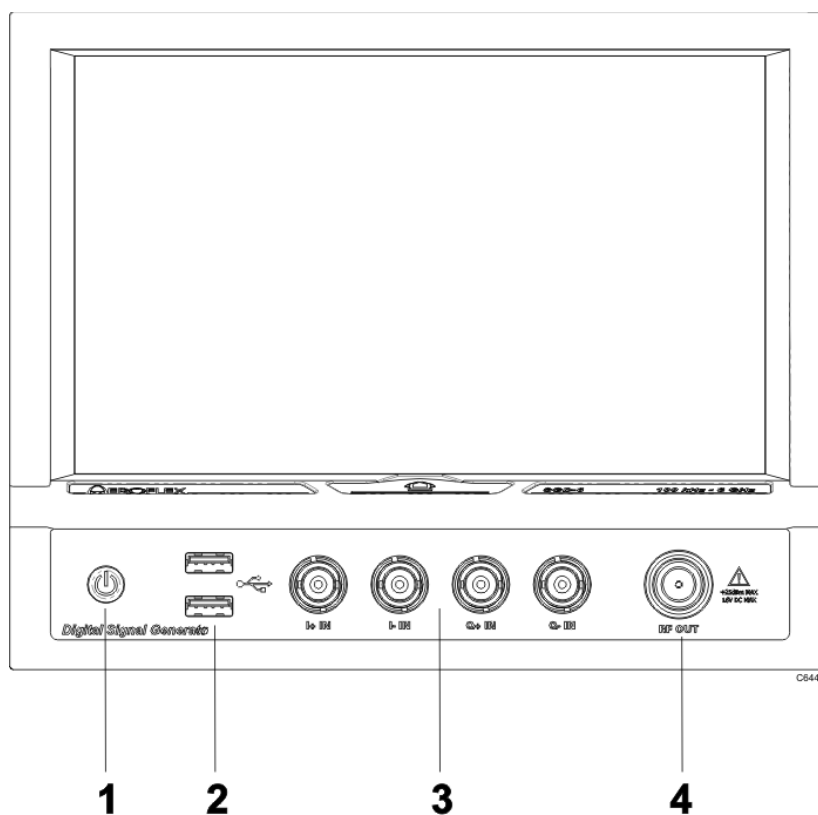
Front panel

See the data sheet for all available options.

1	On/off switch	Activates the instrument using a press on, press off action.
		Note: to completely remove AC line power from the instrument, you must disconnect the power cord.
2		Dual USB 2.0 socket. Used to transfer memory stores, ARB waveforms or other files, or to connect a mouse or keyboard.
3	I+, I-, Q+, Q- IN	Four BNC sockets, differential inputs, 100 Ω.
3	RF OUT	50 Ω N-type socket. Signal output.

Rear panel
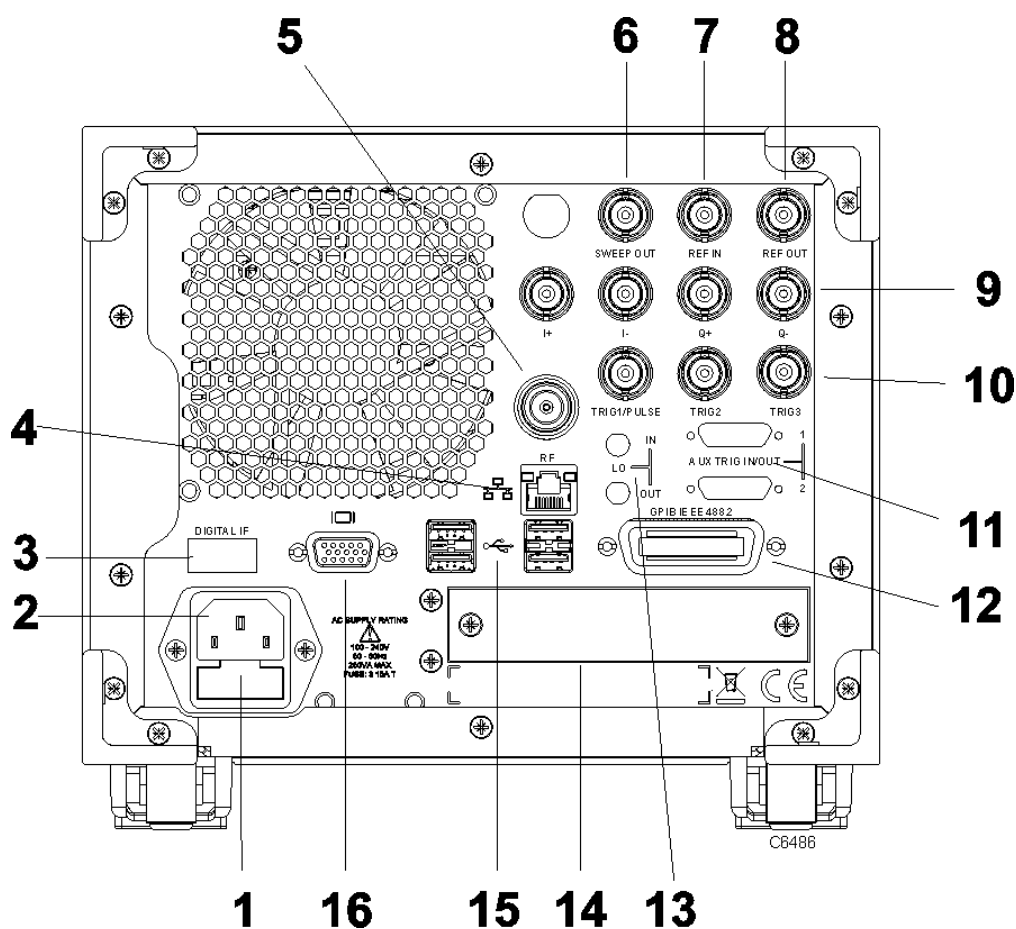
Rear panel

1	Fuse holder	Contains 5 x 20 mm AC line fuse.
2	Power supply receptacle	3-pin IEC C14 filtered panel-mounted male power inlet.
3	Digital I/O	For future use.
4		Ethernet connector for LAN (local area network), UUT (unit under test), inter-S-Series system connections.
5	RF	Option 007 only. 50 Ω N-type socket. The RF output is moved to the rear panel.
6	SWEEP OUT	50 Ω BNC socket: generates 0 to 10 V when the generator is sweeping.
7	REF IN	50 Ω/100 kΩ BNC socket: accepts reference frequency of 10 MHz at 200 mV to 2 V RMS.
		Damage level: -0.5 V/+3 V.

8	REF OUT	50 Ω BNC socket: 10 MHz at 2 V p-p into 50 Ω.
		Damage level: -0.5 V/+3 V.
9	I+, I-, Q+, Q-	For future use.
10	TRIG1/PULSE TRIG 2 TRIG 33	50 Ω BNC sockets (TTL/CMOS): accept external pulse/sweep triggers. A 0 V level starts the sweep or steps from point to point on a sweep. The sockets are pulled up to +5 V by 10 kΩ.
		Damage level is $\pm$5 V. See *Pulse modulation*.
11	AUX TRIG IN/OUT	For future use.
12	GPIB IEEE488.2	24-pin socket accepts a standard GPIB connector to allow remote operation of the instrument.
13	LO	For future use.
14	Removable hard drive	Option 005 only. Removable serial ATA 80 Gbyte 2.5 inch drive. Can be used to store instrument settings for removal to a secure area.
15		Four USB 2.0 sockets. Used to transfer memory stores, ARB waveforms or other files, or to connect a mouse or keyboard.
		Also provide electrical connections between multiple S-Series modules.
16		15-way D-type for connecting a VGA monitor.

Using a keyboard and mouse

You can use the instrument with or without keyboard and mouse (see Touch!).

If you are using keyboard and mouse, they need to be USB compatible. Plug them into the USB sockets on the front or rear panel.

If you are using the instrument without keyboard or mouse, you can access all Windows® functions through your fingertips. To access Windows, close down the SGD software by touching the Exit Application button on the menu tab, as explained in Accessing Windows.

Note: connecting a mouse and/or keyboard may compromise the EMC performance of the instrument.

Touch areas on the screen

Touch!

In this document, when we use the term 'touch', it describes the action of touching lightly on an area on the screen with a finger
or
clicking on that area with a mouse.

Touch areas on the screen

How the screen is laid out

This is a typical SGD screen, which is divided into a number of functional areas:
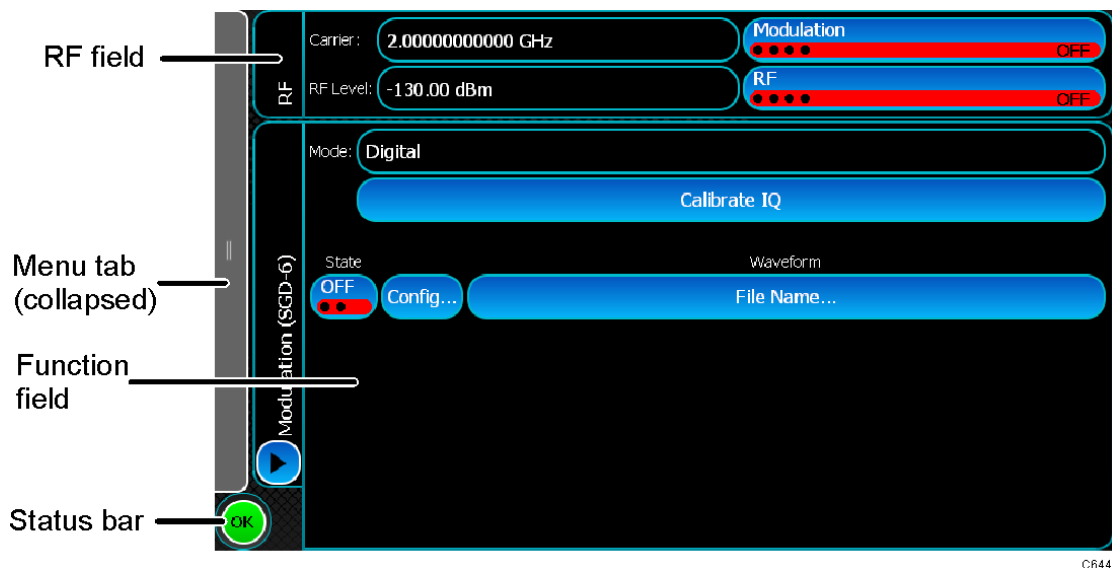
Typical screen layout

RF field

This displays the current RF frequency and RF level settings, and lets you change them using the popup keypad and slider. You can also enable or disable RF output and overall modulation.

Function field

In this field, you set up the signal's parameters and configure Modulation, Sweep, Pulse and RF Settings modes. Modulation setup is the default.

Touch the Forward button to see the Modulation, Sweep, Pulse and RF Settings modes.

The Home button takes you back to the Modulation field.

Status bar

Touch the Status button to see the current state of subsystems such as the frequency standard. Some error messages are displayed here.

Menu tab

The menu tab contains all the system functions. It is normally collapsed in order to make space for the main SGD menus. Touch anywhere on the menu tab to expand it:

Use the blue up and down arrows, or swipe with your finger, to scroll up and down the contents of the menu tab.
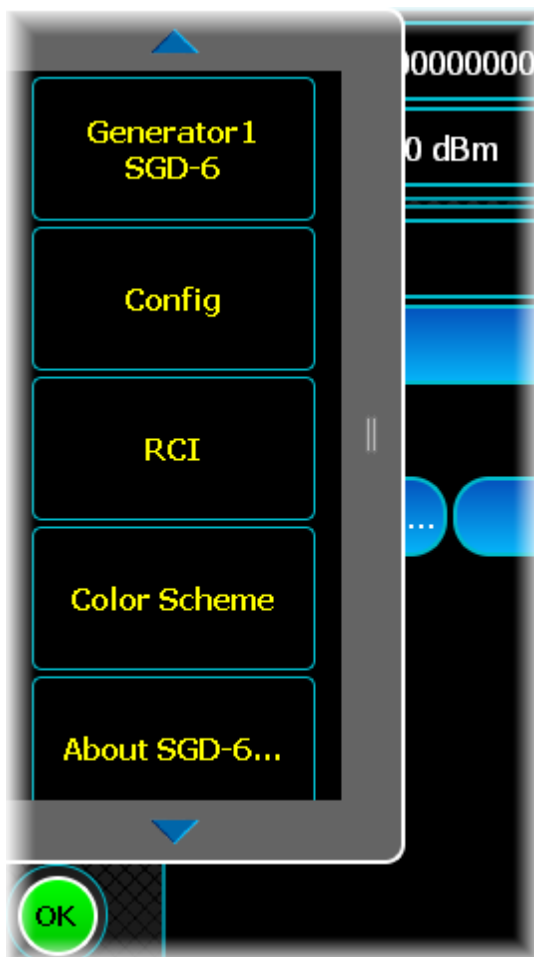
The menu tab does the following:

Store/Recall saves and recalls instrument settings.

The generator mode (*Generator1 SGD-6* is shown in the picture above) provides access to all the modulation schemes that the instrument can emulate.

Config provides access to the frequency standard, hardware information, power-on settings, available options and RF level offsets table.

RCI provides access to the remote control interface.

Color Scheme selects how the screen is presented, for higher visibility where required.

About... provides details of the instrument and its software.

Exit Application closes the SGD application.

Note: this menu tab changes to show a Power Meter button if an Aeroflex SPS Series Power Meter is used with the instrument.

Popups

To ensure that the screen is not cluttered with unnecessary information, the instrument displays a popup keypad, and sometimes a slider adjustment, that overlay the fixed window layout when numeric entries are required.

Popup keypad

In this example, the popup keypad lets you enter a new value of frequency. There are similar popup keypads for power level and voltage entries.
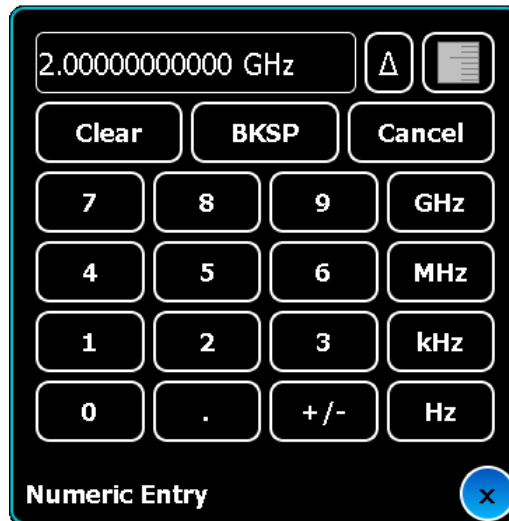
Popup keypad

Popup keypads are overlaid on the main window. They have a standard set of features:

- ⬤ button. Shows or hides the popup step control, where you can also define the size of a [frequency or power step](#).

- ⬤ button. Shows or hides the popup [slider](#).

- Clear button. Clears the current displayed value.

- BKSP button. Deletes the last entry.

- Cancel button. Closes the popup window without making any changes.

- X button. Closes the popup window.

Enter and confirm value

Enter the value required. The entry is confirmed when you touch the units key.

Step button

When you touch the step button ⬚ on a <u>popup keypad</u>, the 'Edit Step' dropdown menu appears.

Use this to:

- set the size of up/down step increments

- quickly change a displayed value using the step up/down arrows.

1. Touch Edit Step. The title at the bottom of the keypad popup changes from Numeric Entry to Step Entry to show that you are in Edit Step mode.
2. Now enter the step size, and terminate with a units key.
3. The popup keypad reverts to Numeric Entry.
4. Now touch the step button to use the up/down arrows

Slider

For all numeric entries, there is also a slider adjustment.

- The slider provides fast adjustment of a parameter. It consists of a high- and a low-resolution slider (as shown below). Drag the sliders with your fingertip to change the value.

Slider adjustment

Use the /10 and x10 factor buttons to increase or decrease the resolution of the sliders. To see how this works, set the top slider to maximum resolution (touch /10 repeatedly) and the lower slider to minimum resolution (touch x10 repeatedly). Now drag the lower slider. You can see that it acts as a vernier scale for the upper slider, which moves accordingly.

Error messages

System errors

System errors display because of an error notified by the system logic — for example, a failure to locate a training signal. A popup error message displays the information:
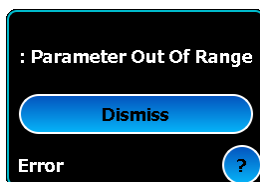
Touch Dismiss to clear the message popup. If another error occurs while the popup is visible, it shows that other system errors have been logged:
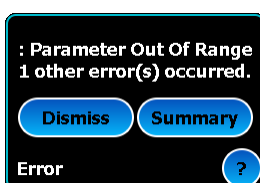
To see logged system errors

Touch Summary on the popup error message

or

Expand the status bar by touching the button. Touch the status bar to display the summary of logged system errors:

The summary provides a record of all errors that have occurred since the instrument booted. It can be erased only by re-booting the instrument.

Severity

Symbols in the column to the left of the error descriptions show the severity of the error. A red background shows the error is severe; a green background shows that the error is minor.

UI errors

UI (user interface) errors are less severe than system errors — for example, a UI error might occur if a frequency value is entered that exceeds the allowed range:

Error: Value is greater than maximum limit : 10.000000 MHz

Frequency standard errors

If the frequency standard experiences a fault — for example, a failure to locate an external signal — the button becomes red and an explanatory popup message appears. Touch the popup to dismiss the message.

Powering up

1. Plug the power cord into the power supply receptacle on the rear panel.

2. Press the on/off switch on the front panel. The instrument starts up, first loading Windows®, and then the SGD application.

Allow 10 minutes warm-up time for the instrument's circuits to stabilize.

Power-on settings

Touch the Config button (on the menu tab)...
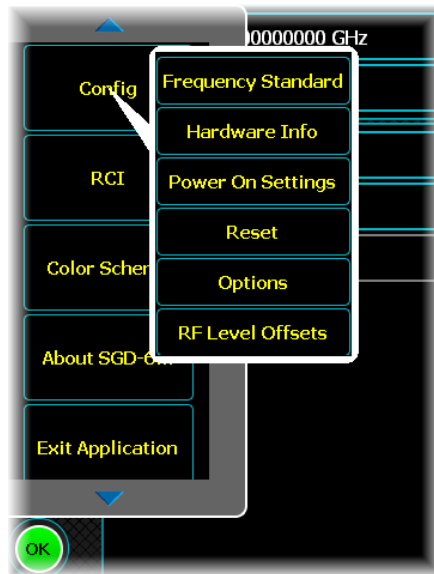
...and select Power On Settings from the drop-down menu.

From this screen, you can:

- Define whether the instrument starts up in the factory default setting, the last used configuration, or in a configuration saved in memory

- Define which memory location is used.
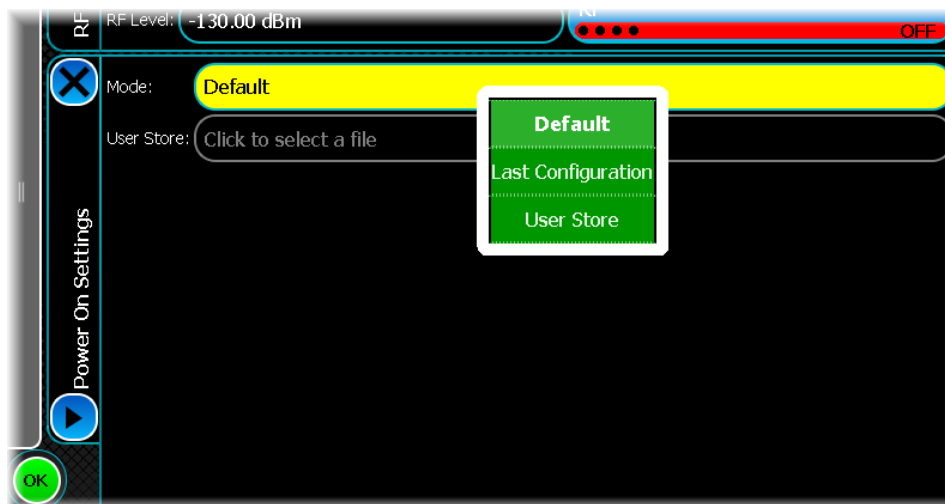
Mode

Touch Default to make the instrument start up with the factory default settings.

Touch Last Configuration to make the instrument start up with the settings used the last time it was powered up.

Touch User Store to make the instrument start up with previously stored power-on settings from the selected user store.

Factory default settings

The instrument reverts to the factory default settings at power-on (unless you have stored a different power-on memory location).

Touch Reset (on the Config menu) to revert to factory default settings at any other time.

Set up to generate

Step 1

Use the SGD to create a new waveform in any of the following modulation schemes:

SGD-x (general modulation setup)

Analog, Digital, External IQ modulation

1xEVDO

Analog (FM/RDS radio)

Bluetooth

cdma2000

FSK

GSM/EDGE

LR-WPAN

LTE FDD

LTE TDD

Multi-Carrier

PSK

QAM

TD-SCDMA

WCDMA

WLAN

Step 2

Generate the .aiq file of the waveform.

Step 3

Output the modulation.

Common functions

Some functions are common to many or all generation schemes:

RF parameters

Data source

Filter

Markers

IQ Impairments

Graphics

RF Settings

Frequency standard

RF level offsets

RF parameters
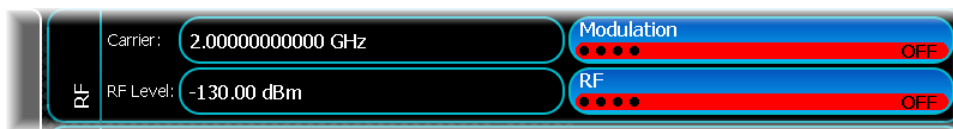
The RF field appears at the top of all modulation screens. Here, you set up carrier frequency and RF level, and enable/disable the RF output and overall modulation.

Carrier frequency
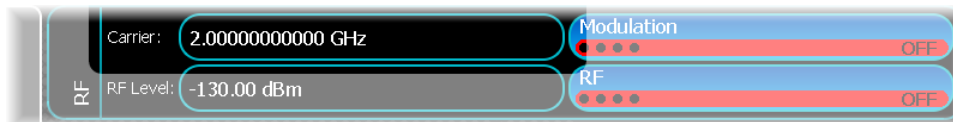
This shows the current carrier frequency setting. Touch the button to set a different frequency. Enter a carrier frequency in the range

   100 kHz to 3 GHz   SGD-3

   100 kHz to 6 GHz   SGD-6

and touch the appropriate units button to terminate.

Resolution varies according to the frequency selected: refer to the data sheet for values.

RF level
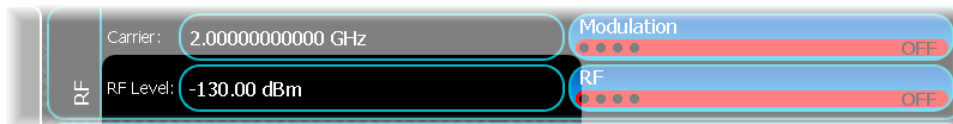
This shows the current carrier output level. Touch the button to set a different level from the popup keypad.

Select units:
dBm — power relative to 1 mW into 50 .
dBμV — voltage relative to 1 microvolt into 50 .

Power is limited to +13 dBm maximum, or +20 dBm if Option 003 is fitted. Voltage is limited to +125.99 dBμV.
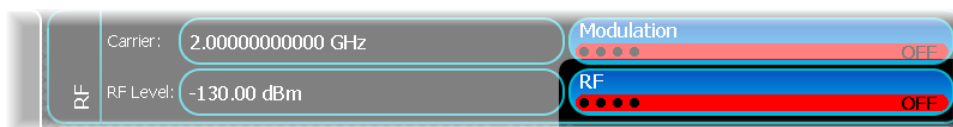
RF on/off

Switch the carrier ON or OFF at any time using the RF ON/OFF button .

This turns the RF output on and off, whilst retaining the 50 output impedance.

Modulation on/off

All modulation

Switch all modulation ON or OFF at any time using the Modulation ON/OFF *button* .

Individual modulation

When analog FM, AM or PM modulation is required (using the analog output mode), modulation from each source is also enabled or disabled by the individual modulation ON and OFF buttons *and* . For modulation to appear on the carrier, modulation must be enabled both with the Modulation ON/OFF button and the individual AM, FM and FM ON/OFF buttons.

Individual modulation ON/OFF buttons only reduce the modulation to zero, whereas the Modulation ON/OFF button completely disables the modulation system so that the instrument reverts to being a carrier frequency generator.

Data source

The data source is a function that is common to many modulation types.

Here is a typical example.
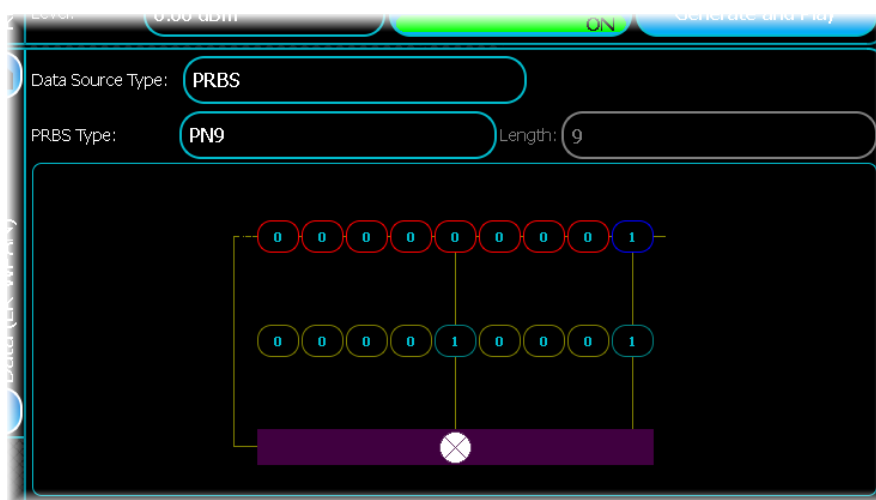
Data Source Type

Use this to select the type of data source, which is the bit sequence that you want to modulate. Select one of:

- PRBS (pseudo-random binary sequence)

- Repeating Pattern

- User Data.

PRBS Type

If you select PRBS as the data source type, you can select one of seven preset PRBS sequences, or a user-defined one, from the PRBS Type drop down box. The available options are All Ones, All Zeroes, PRBS, Random Bits, Repeating Pattern or a User data pattern file. The default is a PN9 sequence.

Toggle the seed (initial value) or tap mask (defines the bit positions affecting the next state) by touching the required bit.

The tap mask is fixed for the predefined PN sequences and cannot be altered. If you wish to change the mask, select PRBS Type User Defined.

Filter

Channel filtering is a function that is common to many modulation types.

Here is a typical example.
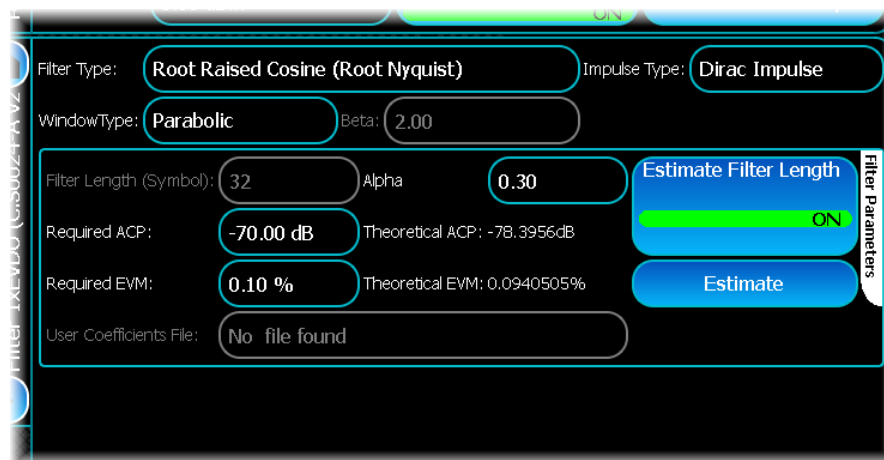
Filter Type

First, select the filter type. In this example, a Root Raised Cosine filter is selected.

Window Type

You can also select a Window Type function as part of the filter setup. The window enhances the stop band capability of the filter, but this can affect the EVM capability. Select the window that best suits your needs; generally, the Parabolic window is a good choice.

Impulse Type

Set a Dirac (impulse) or rectangular filter.

Alpha

Set the bandwidth of the filter: in this case, select a value of 0.3.

Filter Length

Next, define the Filter Length. If you know the length of filter required, enter the value; but if you are unsure, turn on Estimate Filter Length and touch the Estimate button. The instrument then calculates the filter length to give a filter that provides the ACP and EVM requested in the Required ACP and Required EVM controls. The new estimates are presented.

User Coefficients File

The SGD provides most of the common filter types that you are likely to need. You can also use your own filter by browsing from here.

Markers

Mark important events within the file, such as the location of a burst or the start of a TDMA slot or frame, by defining up to four markers. This marker function is common to many modulation types.
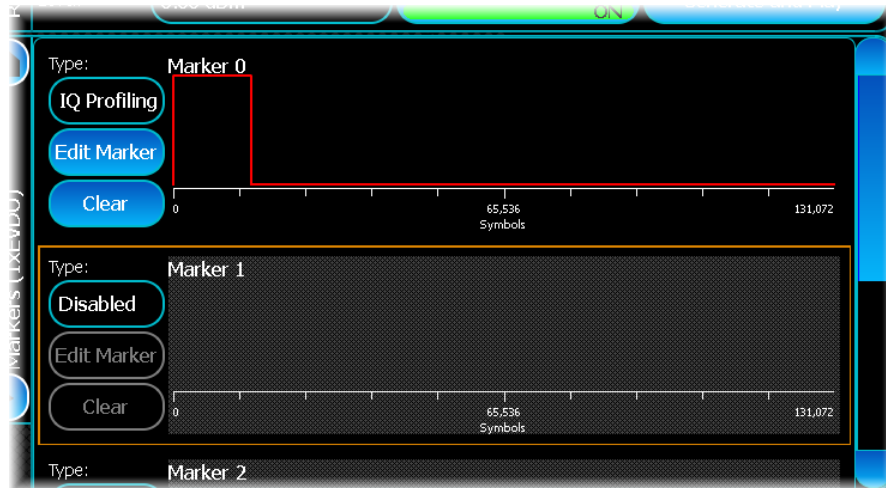
Here is a typical example:

Type

Use the Type control to select the type of marker you want.

Disabled

This removes the marker from the signal definition. If a marker is disabled, it retains its configuration.

IQ Profiling

With this type of bursting the profile is implemented by the instrument by profiling the IQ data. This lets you define multiple levels and adjacent slots.

If an IQ Profiling marker is selected, you are not able to configure any other marker as an IQ Profiling or RF Bursting marker.

General

This type of marker does not affect the signal being generated, but provides a marker that can be used for synchronization when used with a other signal generators.

Marker events

Each marker is a defined set of events where the marker turns on and off. If a particular marker is not disabled, you can add marker events to it. You can add or manipulate marker events by touching directly on the graphic or by using the event editing panel that is displayed by touching the Edit Marker button.

Creating a marker event

Add a new marker event by touching a specific marker and dragging left or right. As you do so, the marker graphic show the area you have selected, including the exact on and off time of the event you are adding.
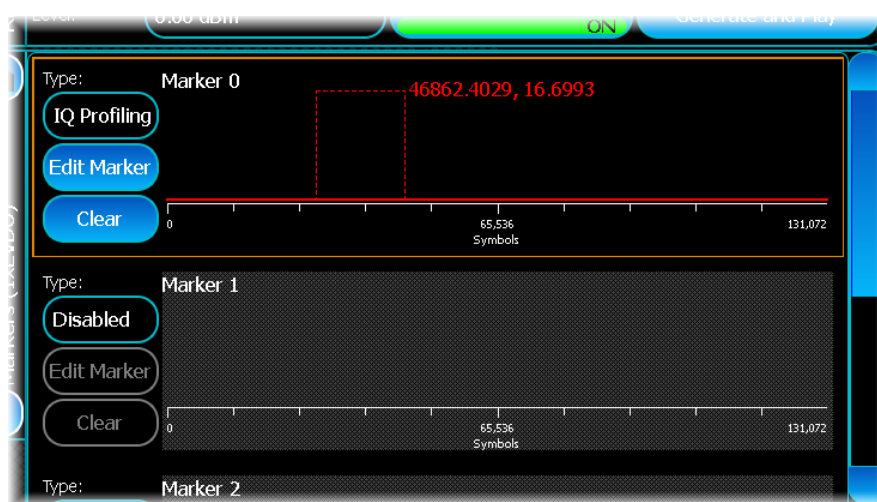
When you release, the new marker event is added and selected.

Modifying a marker event

To move or modify a marker event, touch the center of the marker event. As you drag to the left or right, the marker event moves to the selected location. When you release, the marker event is modified to reflect the newly selected time.
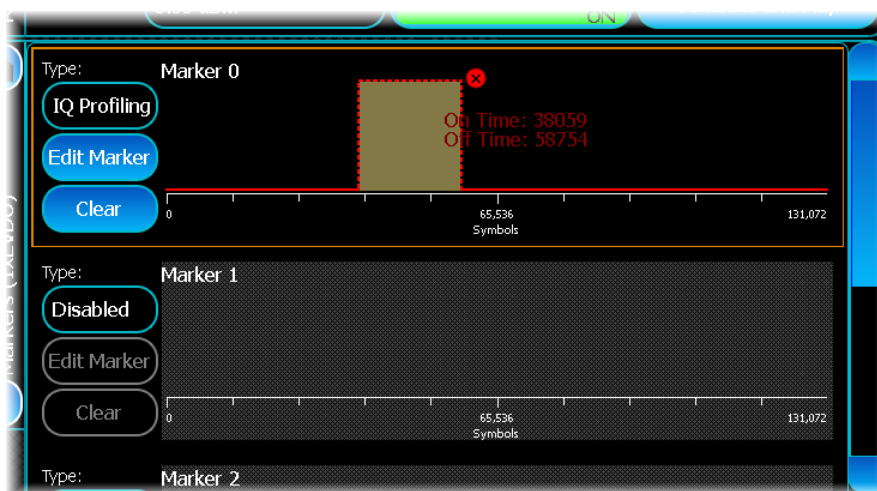
To change only the on or off time of the marker event, touch and hold the left or right edge of the event. When you move left or right, the on or off time moves to reflect the selected position. When you release, the marker event is modified to reflect the newly selected time.
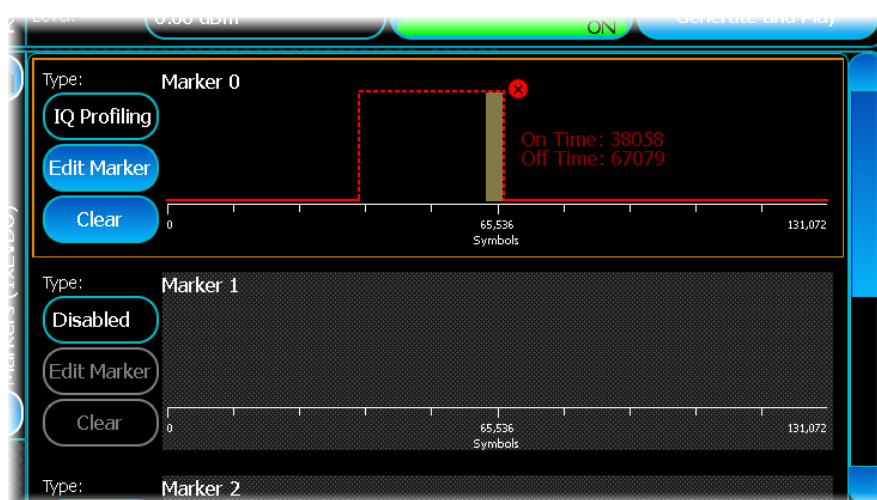
Removing a marker event

To remove a marker event, select the event by touching the red remove icon at the top right corner of the marker event.

Alternatively, when the marker event is selected, touch the Edit Marker button, and touch the Remove button on the Edit Marker screen.

Clearing a marker definition

To clear a marker definition of all events, touch the Clear button on the left of the marker graphic. This removes all events that are currently defined in the marker.

Marker conflicts

Sometimes the marker definition specified can be invalid; for example if one marker event overlaps another marker event. If this occurs, the marker graphic updates to show which marker events are currently invalid.

Auto-defined markers

Some modulation schemes can automatically define the marker event locations, based on frame or signal structure. In these situations, the first marker does not allow additional events, and only basic marker parameters are editable. A label at the top left corner of the marker graphic identifies an automatically defined marker.

Editing a marker

As well as the standard marker functionality, you can obtain a more detailed view of the current marker by selecting Edit Marker, which displays the Edit Marker screen.

For IQ Profiling markers, information is available for modifying the rising and falling profile times, and the profile shapes.

The Rise/Fall Profile Shape field lets you define the burst's rise and fall responses:

- Cosine gives a slower response with fewer sidebands;
- Gaussian gives a faster response, suitable for GSM testing;
- None gives an unshaped waveform with very fast rise and fall times.

For the Cosine and Gaussian responses you can specify a Marker Rise Time and Marker Fall Time.

This screen also lets you add, modify or remove particular marker events. To remove a marker event, select the item from the table and touch Remove. To edit a marker event, touch On Times, Off Times or Attenuation.

IQ impairments

You can add simulated IQ errors, AWGN and clipping to the generated signal. This is a function that is common to many modulation types.

Here is a typical example:

AWGN

Use this section of the IQ Impairments screen to add additive white Gaussian noise (AWGN) into the waveform.

State

Set this On to add AWGN to the waveform.

SNR

Set the signal to noise ratio in dB.

Noise Bandwidth

Set the noise bandwidth as a percentage of the sample rate.

Note that the bandwidth of the noise interference is set as a percentage of the sample rate. This means that with, for example, a sample rate of 400 kHz and a noise bandwidth of, say, 10%, the noise bandwidth is 40 kHz. If the noise bandwidth setting is kept at 10% and the sample rate is increased to, say, 800 kHz, then the new noise bandwidth is 80 kHz.

IQ Errors

Use this section of the IQ Impairments screen to add errors to a waveform.

Set the State button On to enable the parameters.

Enter values for skew, I and Q carrier leak, and gain imbalance.

Apply Clipping

Use this section of the IQ Impairments screen to clip the I or Q level of the waveform. This section is visible only in some modulation schemes (for example, CDMA) and not in others (for example, Generic).

Type

- Circle clips the IQ vector by the percentage specified.

- Square clips I and Q independently by the percentage specified.

- Pre filter clips the waveform before the selected filter is applied.

- Post filter clips the waveform after the filter is applied.

Level

This establishes the clipping level as a percentage of the signal amplitude.

Coupled

This button is enabled only if Circle clipping is enabled. It causes the I and Q levels to be clipped by the same amount.

Graphics

Use this to define the graphical display format for the signal you are generating. You can select the type of measurement to be displayed, and manipulate the trace and display as required. You can also add markers to the trace. If required, you can export the trace.

This screen is common to most modulation types.
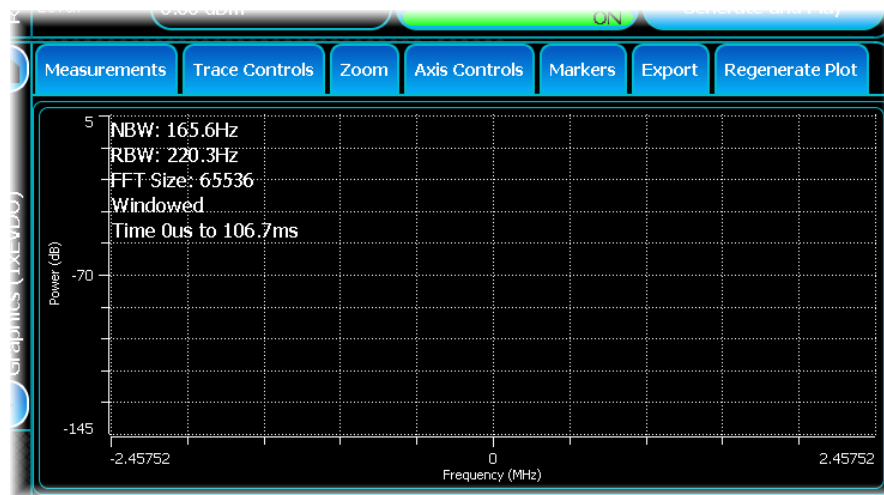
The following controls are accessed by the tabs at the top of this screen. Some of the functions are also accessible by touching on the graph area.

Measurements

To change the measurement type displayed, touch Measurements on the top menu bar. A menu of available measurement types appears. Select the measurement, and the graph updates automatically.

Regenerate Plot

To generate graphics data, touch Regenerate Plot on the top menu bar. This generates the file and displays the data in the graphics plot. After you have generated graphics data, you can regenerate at any time, by touching this option.

Zoom

The drop-down menu under this tab provides controls to enlarge and reduce the whole display, to select portions of the display for enlargement, and to change the scaling of the axes.

Auto-Scale

To ensure that the entire signal is visible; select Zoom, then Auto-Scale. This causes the X and Y axes to adjust automatically to show all the graph data. The scale on the Y axis is always a factor of 2, 5 or 10.

Change Scale

To change the X and Y axis scales for a given graph, select Zoom, then Change Scale. This displays the scaling screen:

The way you specify the scale of the X and Y axes depends on the type of data that the active graph is displaying. The different methods are as follows:

Frequency Centre, Span

Use this to specify a scale in terms of a center point and a span.

Power Reference, Scale/Division

Use this to specify a scale in terms of a reference, which is the maximum value of the display, and value for each division of the graph.

Minimum/Maximum

Use this to specify a scale in terms of a start and stop limit.

Changing the scale

Whenever you modify the scale using this screen, the new scale limits are automatically applied to the graph display, showing the new scale immediately.

However, these changes are only permanently applied when you touch Ok. If you touch Cancel at any time, the Graph display scales are reset to their original values.

Zoom In

Use this to zoom in on the information displayed on the Graph display panel. Select Zoom, then Zoom In. This enlarges by a factor of 2.

Zoom Out

To zoom out, select Zoom, then Zoom Out. This causes the graph display to zoom out on the x-axis by a factor of 2, maintaining the current central point. If the graph display cannot achieve this zoom factor (because doing so exceeds the graph's maximum scale limits) the maximum possible scale is set instead.

Zoom Selection

To select a region to zoom, select Zoom, then Zoom Selection. The graph now displays the co-ordinates of the mouse cursor. To zoom in on a region of the display graph, drag to select the region of the graph you want to zoom into.

After the zoom is finished, the Graph display reverts to its default selection mode.

Zoom Selection

Use this to zoom into a section of the graph. Drag to produce a square or rectangle, then let go.

Reset Zoom

This resets the zoom factor of the current graph's X and Y axes to their default values.

Axis limits

There are limits on the scales you are can enter on this screen. These are generally dependent on the measurement that is being made.

Trace Controls

Touching the graph area displays a menu that repeats some of the more commonly-used functions (for example, zoom and markers) available from the tabs at the top of the screen. The menu also contains controls not otherwise available.

Graticule

Hides or shows the graticule over the plot.

Markers

The Markers sub-menu lets you to control how markers are displayed on the graph. Use this to enable up to four markers and a delta marker.

Delta

The delta marker is manipulated in exactly the same way as normal markers. As the delta marker reports values relative to normal markers, a delta marker is displayed only if a normal marker is enabled.

When a delta marker is enabled, the marker table is updated with delta values:

All Markers Off

Use this to turn off all markers that are currently enabled.

Enable

Use this to turn a marker on or off. The first time a marker is enabled; it is automatically moved to the location you initially touched.

Track Peak

This enables a marker and automatically moves it to the highest Y value in the trace. When you select this option, the marker moves automatically whenever the trace data is regenerated.

Peak Find

This moves the marker to the highest value on the trace.

Last Peak

This moves the marker to the next highest peak relative to the current marker position

Next Peak

This moves the marker to the next lowest peak relative to the current marker position.

Peak Right

This moves the marker to the next peak to the right of the current marker position.

Peak Left

This moves the marker to the next peak to the left of the current marker position.

Axis Controls

Use this to modify the current units of the X or Y axis when either the X or Y axis is defined as either time, or frequency, depending on the type of measurement being displayed.

Export

Use this to export the trace data.

The supported export features are:

Print

Prints the current trace to a local printer.

Copy image to Clipboard

Copies the current trace, including any selected markers, to the clipboard so that it can then be pasted into other applications as a standard bitmap.

Export as Bitmap

Exports the current trace, including any selected marker information, as a bitmap to the hard drive.

Frequency standard

Touch the Config button (on the menu tab)...
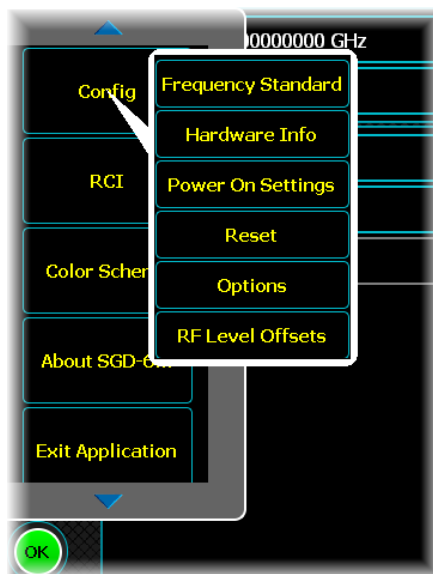
...and select Frequency Standard from the drop-down menu:
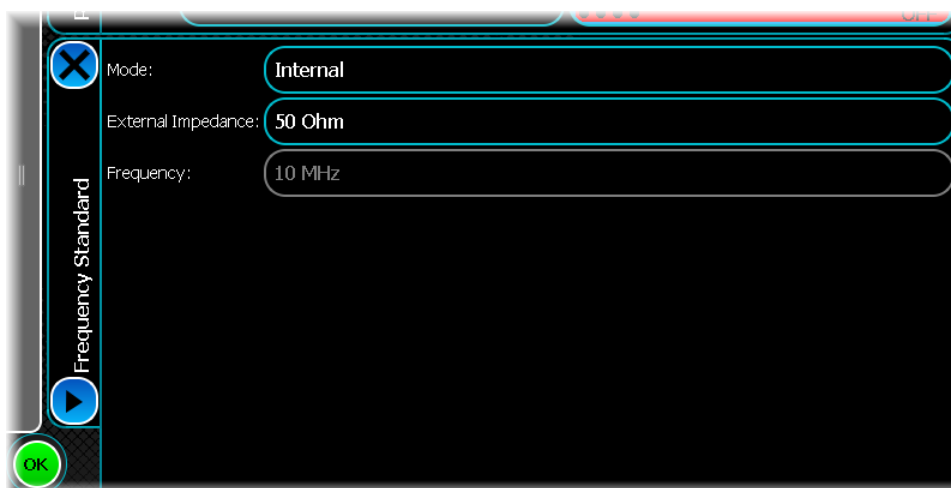
Internal or external standard

Select either the internal 10 MHz frequency standard or an external frequency standard. Select Internal or External from the Mode drop-down menu.

Apply an external frequency standard to the REFIN socket on the rear panel.

When the mode is set to External, the instrument locks to the external standard

External impedance

Use the drop-down menu to select low (50 ohm) or high (100 kohm) external impedance.

Frequency reference output

When the Mode is set to Internal O/P, the instrument outputs a 10 MHz square wave (2 V p-p into 50 ohm) as standard at the REFOUT socket on the rear panel.

RF level offsets

The RF level offsets table provides a means of compensating for losses and gains introduced into the signal path between the instrument and the unit under test. Losses and gains for items such as cables and amplifiers can be entered into the table and applied or removed individually.

Many good-quality cables and active elements are supplied with calibration data that can be entered directly into the RF level offsets table. Otherwise, you need to characterize items to establish their loss or gain values.

Touch the Config button (on the menu tab)...
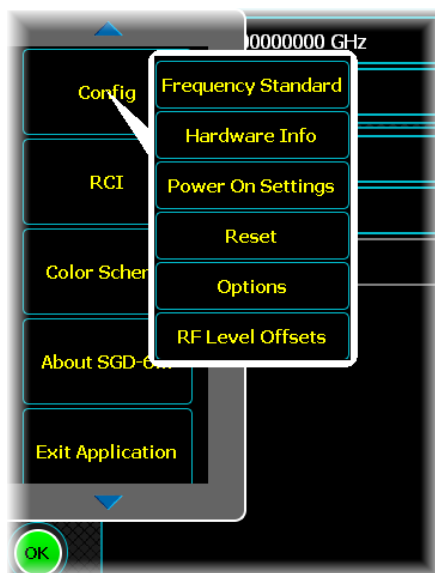
...and select RF Level Offsets from the drop-down menu:

Table

Add

Add a frequency/loss line to the table.

Frequency

Enter all the characterized frequencies for devices in the signal path between the instrument and the UUT.

State

Turn individual device offsets on or off.

Loss

Enter the loss at each frequency point. Note that loss is entered as positive value, gain as a negative value.

Remove

Touch a line to highlight it, and remove it.

State

Use this button to enable or disable all the entered losses.

Store

Touch Store. The popup shows the current file location.

Enter a file name using the virtual keyboard that pops up when you touch the File Name field.

When you touch Save, the instrument stores the current configuration and settings to the non-volatile memory or to the optional removable hard drive.

Recall

Touch Recall. A popup lets you browse for currently stored files.

Touch the file you want to recall, and the instrument is configured with the stored settings.

RF Settings

This function is common to many modulation types.

Here is a typical example:
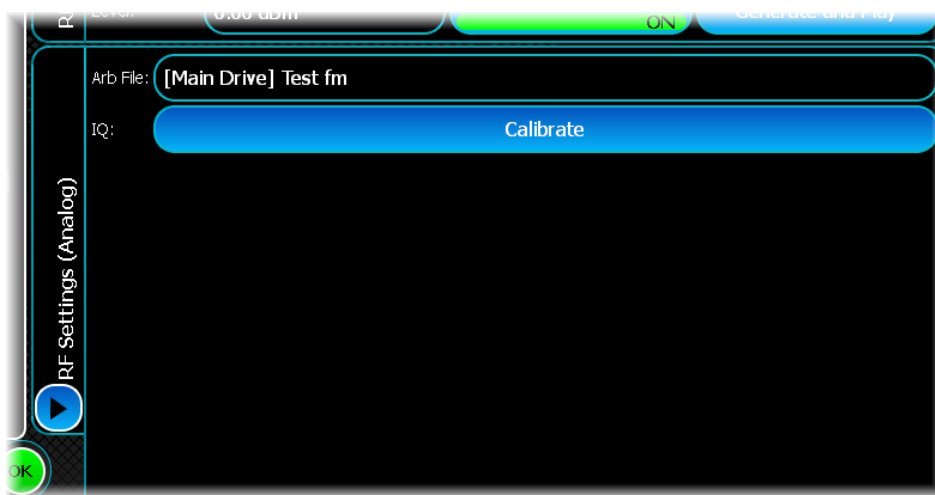
Arb File

Browse for the file that is to be played.

IQ Calibrate

For optimum vector performance, run a self-calibration to make sure that the instrument meets its specification. Touch the button to perform an IQ calibration at the current RF frequency.

Generating and playing a file

After you have set all the parameters required to create a waveform, you generate a .aiq file that stores the information and enables the Arb (arbitrary waveform generator) in the SGD to play the file.

This function is common to all modulation types.

Playing the waveform file

When creating a waveform in one of the modulation schemes, you can experiment with different waveform settings without saving the file every time. Touch Generate and Play whenever you want to play the waveform. The waveform plays almost instantly (depending on the size of the Arb file) and is output at the RFOUT socket. The SGD creates a temporary "Play.aiq" file.

Saving the waveform file

Touch Generate AIQ File when you are ready to save the file to the main drive: a dialog requests a file name, file location, and folder. If the modulation settings you are generating are not based on a saved file, the new file name is placed in a folder with the same name as the modulation scheme, on the main drive. The file is saved but does not play.

To play the file, go to the SGD Digital Modulation screen. Load the saved file and set the State button to On.
.
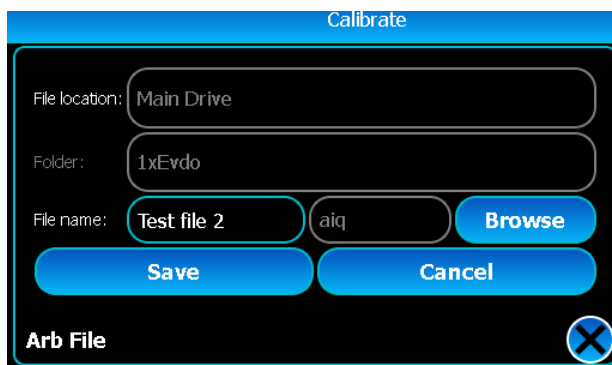
Select Save. The waveform file has now been created and saved.

Playing different files

If you are concurrently creating waveforms in different modulation schemes, you can skip between the modulation schemes, and the SGD automatically plays the appropriate waveform; so flicking between two or more test waveforms is quick and simple.

SGD-3/SGD-6 (default power-up screen)

Use this to:
- select and configure the Arb waveform(s) that you wish to output;
- set up frequency, level and list sweeps;
- control the integrated analog AM or FM signal generator.

If pulse modulation (Option 4) is fitted, you control it from here too.

[Modulation](#)

[Sweep](#)

[Pulse](#)

[RF Settings](#)

Sweep

Sweep capability allows comprehensive testing of systems, since measurements at single points do not necessarily give an overall indication of the performance.

You can:

- Define the parameter (frequency or RF level) that is to be swept

- Define whether the sweep is to be continuous or single-shot

- Define what triggers the sweep — sweep marker, arb marker, external trigger

- Define how the sweep is controlled (start/stop point, number of steps, time per step and size of step)

- Define markers that indicate when a specified parameter level has been reached.

Once started, the sweep can be stopped at any time, and the display indicates the current parameter values.

You can also operate the sweep in list mode and Arb sequence mode.

Sweep setup

- Select SGD modulation by choosing the SGD-3/SGD-6 generator mode on the menu tab.

- Touch the Forward button and select Sweep from the drop-down menu. The sweep screen looks like this:

Note that the full set of sweep control buttons appears only after you touch the Play button.

Type

Specify None, Frequency, Level, List or ARB Sequence sweep.

Mode

- *Single*: the sweep steps from the start value to the stop value and halts, displaying the stop value.

- *Continuous*: the sweep steps from the start value to the stop value, and then repeats.

Trigger Source

Specify the source for the trigger: sweep markers, arb markers or external triggers.

Trigger

Set up the trigger action as follows:

- *Off* disables the external trigger. Control the triggering manually using the Sweep control buttons.

- *Start* makes the external trigger start the sweep. During the sweep, further trigger inputs are ignored.
  At the end of the sweep the trigger latch resets, ready for the next input.

- *Start/Stop* makes the first external trigger start the sweep, and the next trigger pause it, so that you can (for example) investigate a particular point of interest. A further trigger causes the sweep to resume from the point at which it paused.
  The trigger latch resets after each start/stop.

- *Step* makes each external trigger increment the sweep by the size of one frequency step.
  The trigger latch resets after each step.

Start

Enter the start frequency or level for the sweep.

Stop

Enter the stop frequency or level for the sweep.

Step Time

Enter the step time (duration of the step) to a resolution of 1 ns.

Spacing

Specify linear or logarithmic spacing of the step points.

Step Mode

Specify whether the sweep is based on the size of step, or the number of steps.

Step Size

Enter the step size — in the range 1 Hz to the instrument's maximum frequency, or 1 dBm to 113 dBm — to a resolution of 1 Hz/1 dBm.

Step Points

Enter the number of frequency or level steps.

Sweep control

Use the buttons in the Control field to start, stop and pause the sweep operation.

Status messages show the current progress of the sweep.

Touch the Play button to start a sweep. If the sweep is set to Continuous it runs indefinitely.

Touch the Pause button to stop the sweep. Then use the and buttons to step the current value backwards and forwards.

Touch again to continue the sweep.

Whilst the sweep is paused, touch this button to decrease the current sweep frequency or level one step at a time .

Whilst the sweep is paused, touch this button to increase the current sweep frequency or level one step at a time.

Stop the sweep at any time by touching this button. The sweep halts and the frequency or level resets to its start value.

Markers

You can define up to six markers for frequency or level. Each marker can be individually enabled. The marker output produces a positive-going pulse with a duration of one sweep step as the sweep passes a marker value.
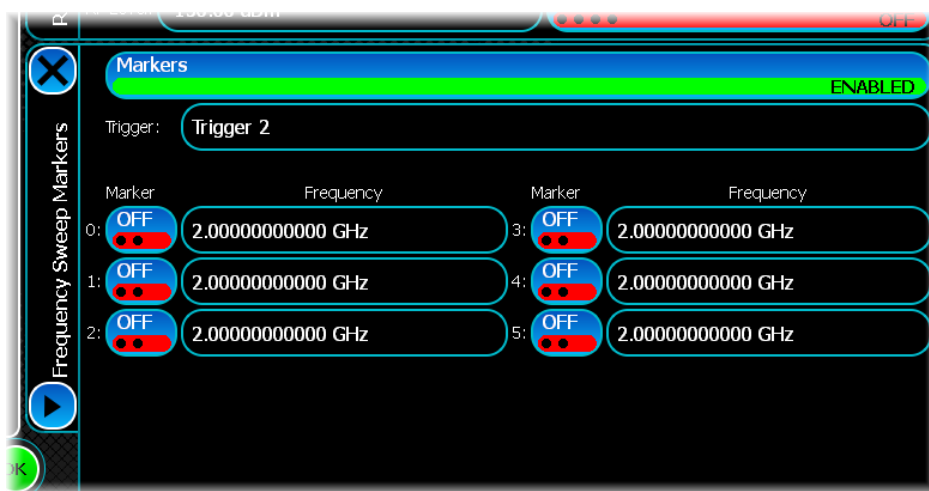
Set marker

To set a marker, touch the Frequency/Level field, enter the required value on the key pad, and terminate with the appropriate unit. Turn the marker ON.

Trigger

Select which rear-panel trigger output to use. The output is 0 V to +5 V nominal from 600   on the specified rear-panel trigger socket.

Enable markers

When all markers have been entered, enable markers...

...to activate the marker output on the rear panel.

Return to the Modulation screen.

List mode sweep

Introduction

Use list mode sweeping to sequentially set carrier level and frequency at a rate faster than is possible using frequency or level sweeps. In list mode, you can pre-define up to 1000 carrier frequencies and their associated levels in a table containing indexed entries of frequency and power. The instrument calculates the hardware settings needed to generate these values, and stores the settings. The settings can then be used to set the instrument's carrier frequency and level sequentially at a much increased speed compared to frequency or level sweeps. The instrument also stores dwell time settings. When playing list entries, the instrument configures itself to reproduce the stored settings. The list applies modulations that are in effect at the time of running, but the modulations cannot be changed during playing of the list.

List mode controls are effectively the same as those for frequency and level sweeps, the major difference being the addition of the list mode table. The Start and Stop buttons now define addresses rather than frequencies or levels.
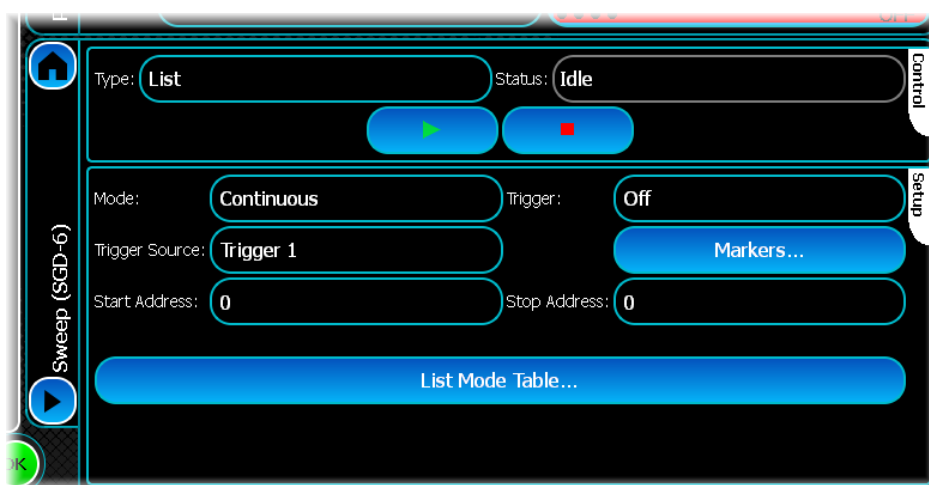
Mode,
Trigger,
Trigger Source
Markers controls: see frequency and level sweeps.

Start address

Enter the start address for the list sweep.

Stop address

Enter the stop address for the list sweep.

List Mode Table...

Use this to define the frequency, level and dwell values for each list address (channel). The table is populated with nominal values by default.
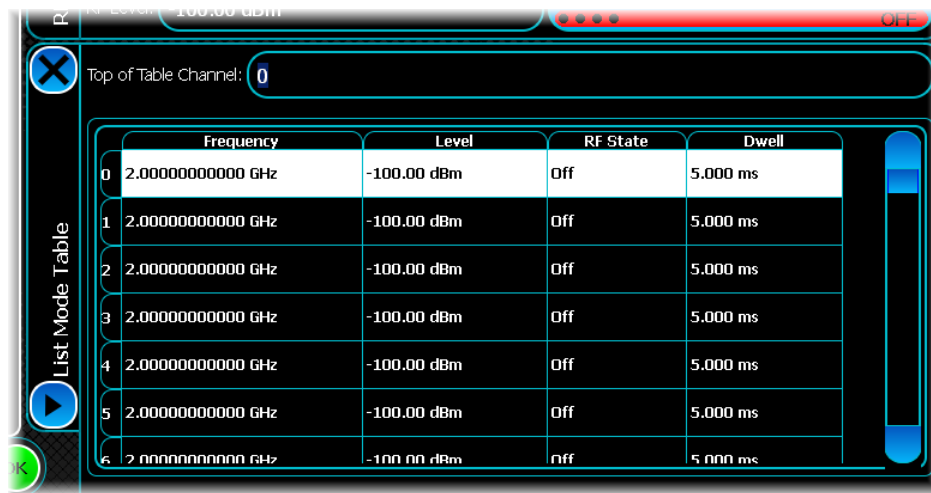
Top of Table Channel

The table displays 100 list mode entries at a time. Define the range of list mode addresses to be displayed by entering the starting value in this control.

Frequency/Level

Enter the frequency and power levels.

RF State

Set to On to activate the list mode address.

Dwell

Enter the time for which the output remains at each frequency/level in the list before moving on to the next address.

Note that dwell times remain active even when the RF State is Off, so if active addresses are separated by inactive addresses, there are delays between them defined by the sums of the inactive channels' dwell times.

Arb sequence sweep

Introduction

Use Arb sequence sweeping to run Arb files sequentially in a configurable pattern. The Arb files must be predefined. In Arb sequence mode, you can pre-define up to 1000 Arb sequences in a table containing configurable entries of frequency, power, RF state and play count. The instrument calculates the hardware settings needed to generate these values, and stores the settings. When playing Arb sequence entries, the instrument configures itself to reproduce the stored settings. The table applies modulations that are in effect at the time of running, but the modulations cannot be changed during playing of the table.

Arb sequence controls are effectively the same as those for frequency and level sweeps, the major difference being the addition of the Arb sequence table. The Start and Stop buttons now define Arb sequences in the table rather than frequencies or levels.
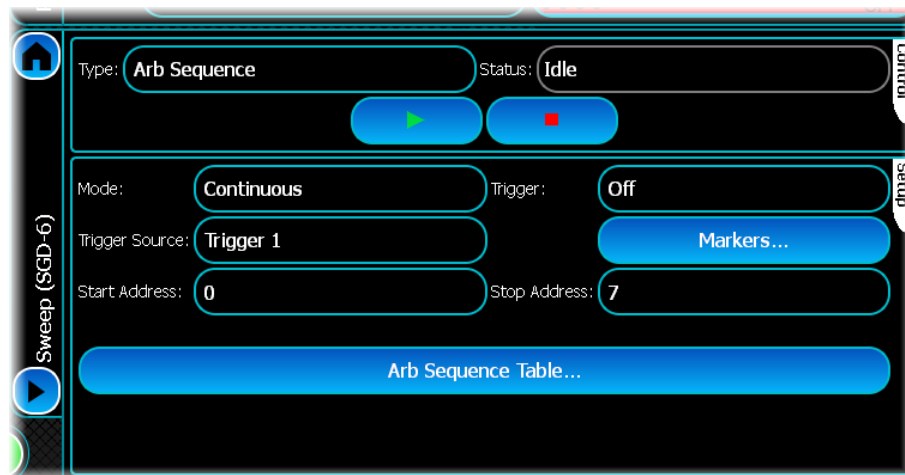
Mode,
Trigger,
Trigger Source
Markers controls: see frequency and level sweeps.

Start address

Enter the start address for the Arb sequence. This is the first address that is used when the sequence starts. Note that start address 0 corresponds to entry 1 in the Arb sequence table.

Stop address

Enter the stop address for the Arb sequence.

Arb Sequence Table...

This presents the Arb sequence as a series of rows within a table, each column representing a given parameter of that channel. Use this to define the frequency, level, RF state and play count for each Arb file.

The default table is empty to begin with; the picture below shows a table that contains some example Arb files.

Frequency/Level

Enter the frequency and power levels.

RF State

Set to On to activate the selected Arb file.

Play count

Enter the number of times the Arb file repeats.

File name

Use this control to add new files to the sequence. Touching this control presents the standard ARB file loading screen. When a file is loaded into the sequence it is automatically option-checked and added to the Arb catalog.

Touch this 'Add' button to add the file displayed in the File Name field to the end of the Arb sequence table. The 'Add' button is disabled if no valid file name is selected. Newly-added channels default to 2 GHz, -100 dBm, RF State On, with a Play count of 1.

Touch this 'Insert' button to insert the file selected using File name at the currently selected location. This moves all Arb channels below and including the selected channel down one position. The 'Insert' button is disabled if no valid file name is selected, or no channel is selected.

Touch the Store button to save the complete Arb sequence configuration to a file. This includes all channels and the start/stop addresses, but not the triggering configuration.

Touch the Recall button to load a complete Arb sequence configuration from a previously saved file.

Touch the Clear button to delete the entire Arb sequence table. A prompt asks you to confirm that you want to do this.

Touch the Remove button to delete the selected channel. All sequence and channel numbers are updated to reflect the new order.

Touch the Move up button to move the selected channel up one position in the Arb sequence table. The button is disabled if no channel, or the first channel, is selected.

Touch the Move down button to move the selected channel down one position in the Arb sequence table. The button is disabled if no channel, or the last channel, is selected.

Empty File field

An empty File field in the Arb sequence table means that the file has been deleted from the Arb catalog since the table was created, and so is not available for sequencing any more.

Pulse

*Note: this section applies **only** if you have fast pulse modulation (Option 004) fitted to your instrument.*

The carrier frequency can be pulsed, either from an external source applied to the TRIG/PULSE connector (TRIG 1/PULSE) on the rear panel, or from the internal pulse generator.

Pulse setup

- Select SGD modulation by choosing the SGD-3/SGD-6 generator mode on the menu tab.

- Touch the Forward button ▶ and select Pulse from the drop-down menu. The Pulse screen looks like this:
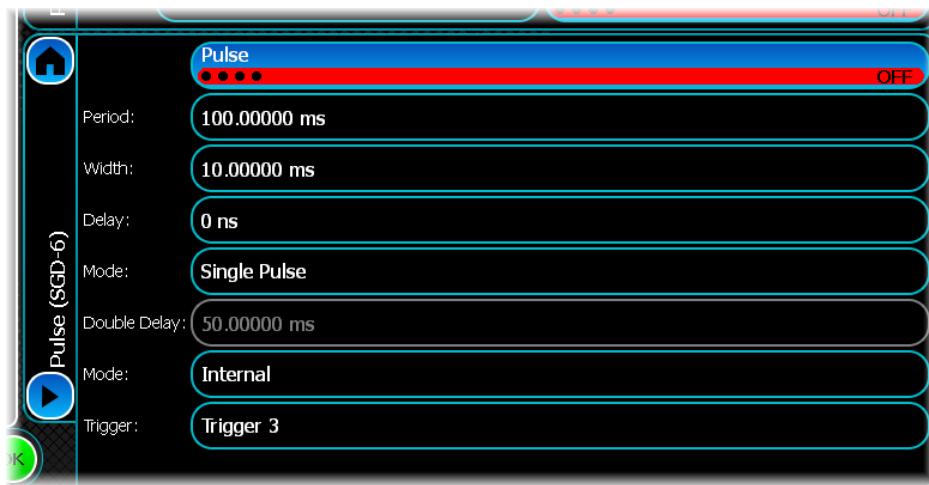
The following parameters apply for internal pulse modulation only.

Period, Width, Delay

Set these as shown on the timing diagram below.

Mode

Select Single or Double pulse mode.

Double Delay

If Double pulse is selected, set the *Double Delay* too.
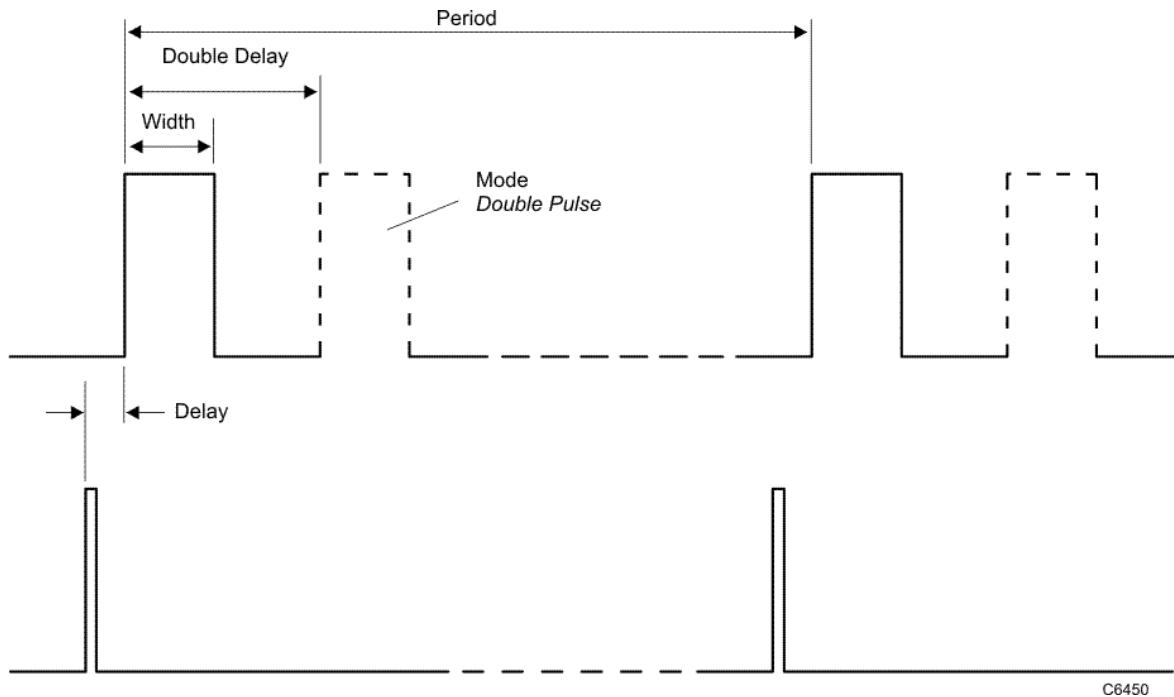
Trigger Mode

Internal

Set the trigger mode to Internal to use the internal pulse generator. The pulse generator now free-runs with the settings for period, width, delay and mode made above.

External

Set the trigger mode to External to control the carrier with the logic level applied to the TRIG/PULSE connector on the rear panel. A TTL/CMOS logical '1' (voltage between 3.5 and 5 V) allows carrier output, a logical '0' (voltage between 0 and 1.0 V) suppresses it. Turning pulse modulation OFF effectively applies a logical '1' allowing carrier output. The input impedance is 50 .

Trigger Source

Specify the source for the trigger: sweep markers, arb markers or external triggers.

RF Settings

Touch the *Forward* button ⏵ and select *RF Settings* from the drop-down menu. This displays the carrier phase and ALC setup screen:
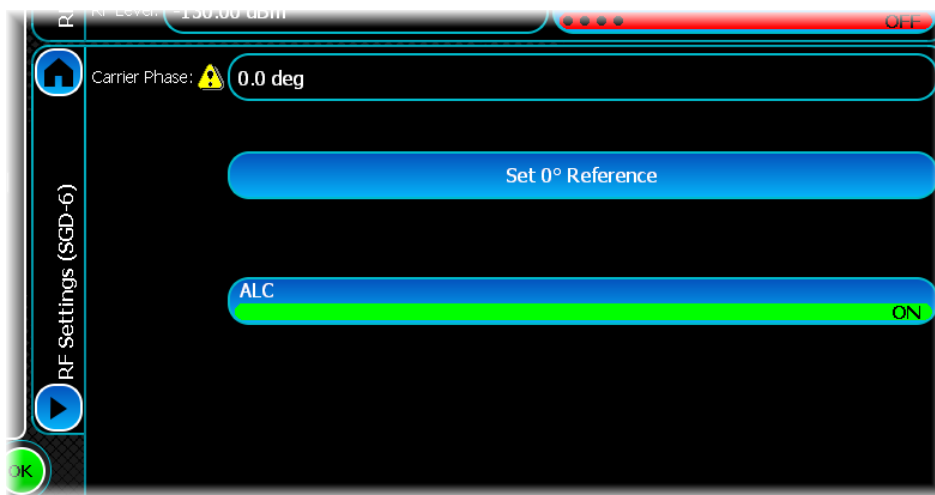
Carrier Phase

Adjust the phase offset of the carrier.

Yellow triangle

If you change the carrier frequency after setting the 0° Reference, the established phase relationship is upset. This is shown by the yellow triangle, which warns when the 0° reference is not set.

Set 0° Reference

Touch this button to establish the current phase shift as the reference value. The indicated phase shift value is set to 0° (and the yellow triangle disappears).

ALC

Turning off ALC disables the ALC loop and the leveling detector to improve intermodulation performance. When the ALC is disabled, the output power is frozen at the gain setting determined while the ALC was enabled.

Switch ALC ON or OFF at any time using the [ALC ON] button.

Analog, Digital, External IQ modulation

Select SGD modulation by choosing the SGD-3/SGD-6 generator mode on the menu tab.

Touch the Forward button and select Modulation from the drop-down menu. The modulation mode selection screen looks like this:
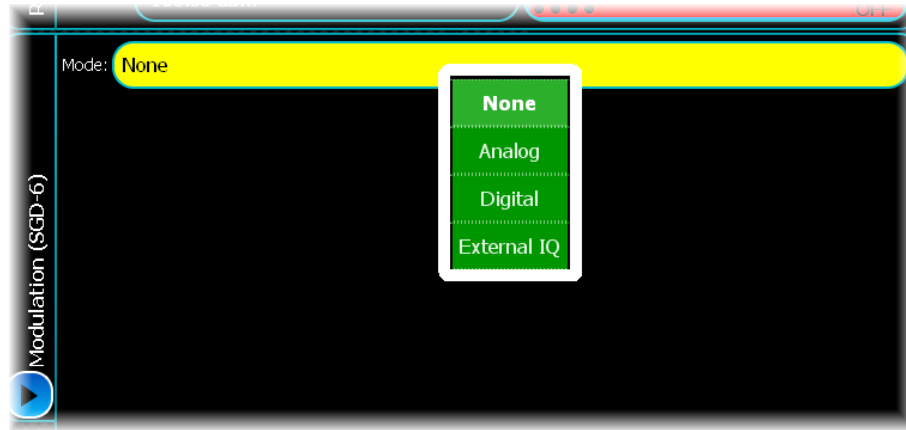
Use the Modulation screen to control the output of the SGD. Use it to select the generated .aiq file that you wish to run, and to calibrate the IQ.

Select from:

None

Analog

Digital

External IQ

Note: for FM mono/stereo radio broadcast generation, see Analog (FM/RDS radio).

Analog modulation

Mode: Analog

Use this mode to output up to two independent CW or modulated AM, FM or PM waveforms from the instrument's dedicated analog signal generator.
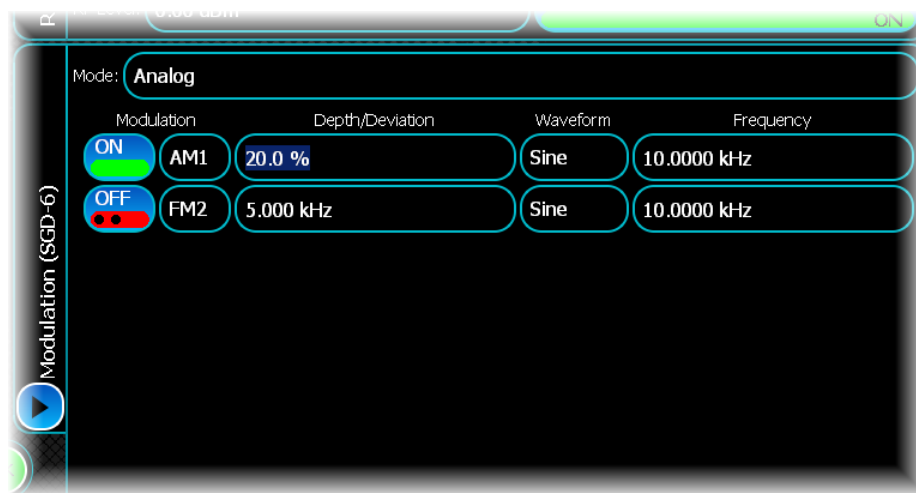
You define the modulation type and parameters in this screen. See Setting analog modulation for information.

You also enable or disable the individual source modulation.

The carrier can be amplitude, frequency, phase and pulse modulated from internal and/or external sources, using a combination of two internal sources.

Allowed combinations of internal sources are:

Up to two simultaneous AM

or

up to two simultaneous FM or PM

or

one AM and one FM or PM.

Note that FM and PM modulation are mutually exclusive.

Setting analog modulation
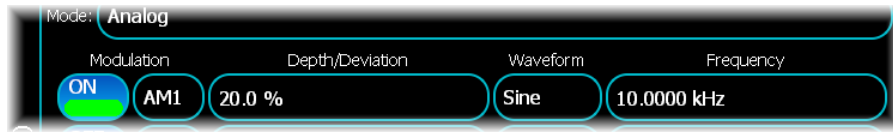
1. Touch any *Modulation* button and select the modulation type from the dropdown menu:
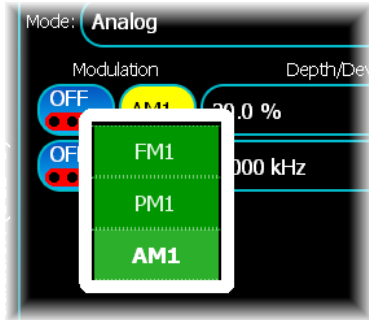
2. Touch the *Depth/Deviation* button.

    Use the popup numeric keypad to enter depth or deviation.

3. Touch the *Waveform* button and select the waveform shape from the dropdown menu:
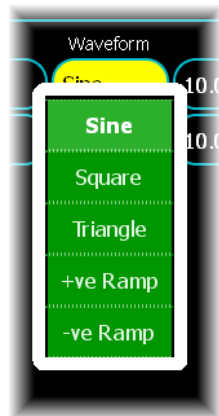
4. Touch the *Frequency* button.

    Use the popup numeric keypad to enter the modulating frequency.

Digital modulation

Mode: Digital

Use this mode to control the manner in which an Arb (arbitrary waveform generator) file is played. This file may be generated by the instrument, or it may be imported.
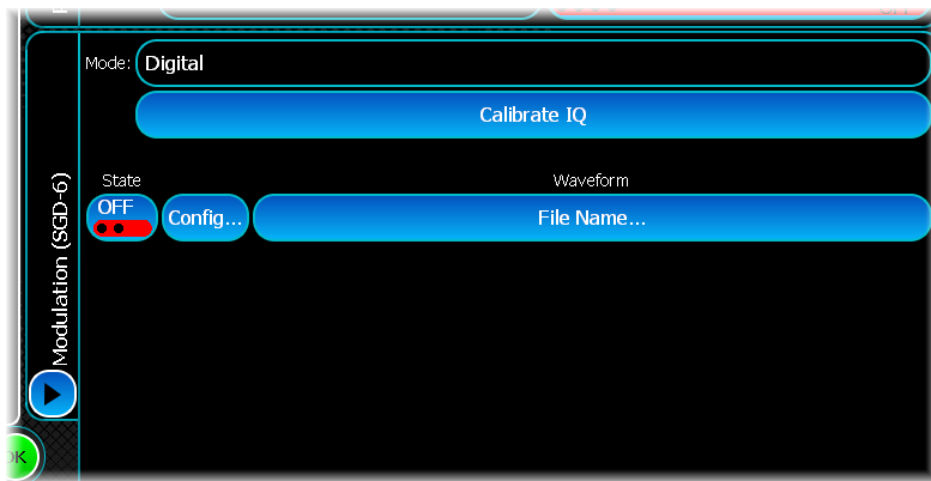
Calibrate IQ

For optimum vector performance, run a self-calibration to make sure that the instrument meets its specification. Touch the button to perform an IQ calibration at the current RF frequency.

State

This sets the Arb On or Off.

- When the Arb is On, but not playing a waveform (the selected waveform is None), CW output is inhibited but may contain carrier leakage.

- When the Arb is On and playing a waveform (the selected waveform is a .*aiq* file), the waveform modulates the CW and appears at the RF OUT socket.

- When the Arb is Off, only CW passes to the RF OUT socket.

Config...

This defines the configuration of the Arb file: how it plays, how it triggers, and what markers are enabled.
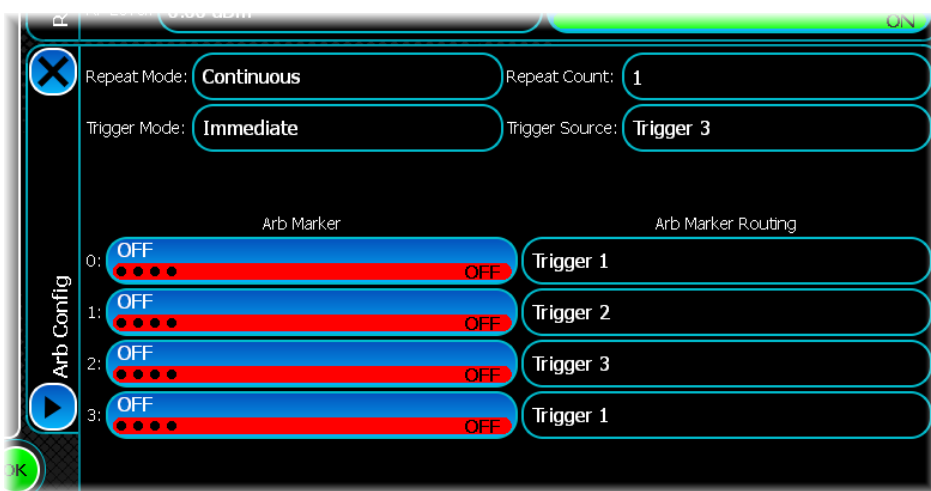
Repeat Mode

- *Continuous*: the Arb outputs the waveform from the beginning and then starts again when the end of the file is reached.

- *Single*: the Arb outputs the waveform once and stops, ready to play it again, for each trigger event.

- *Multiple*: the Arb starts playing the waveform at the trigger event, and repeats it for the number of counts set in the Repeat Count control.

Trigger Mode

This specifies how the Arb is triggered.

	Single mode	Continuous mode
Immediate	The waveform plays once, triggered internally. Stop and start it using the State button. No external trigger is used.	The waveform plays continuously and in full, triggered internally. Stop and start it using the State button. No external trigger is used.
Start	The first trigger starts the waveform. At the end of the waveform the trigger latch resets, ready for the next input. During the output, trigger inputs are ignored. The trigger can either be manual or from an external trigger input.	The first trigger starts the waveform running continuously. The instrument ignores any further trigger inputs. Stop generation of the waveform at any time by touching the State button; the trigger latch resets, ready for the next input. The trigger can either be manual or from an external trigger input.
Start/Stop	The first trigger starts the waveform, the next trigger stops it. The trigger latch resets after each start/stop. The trigger can either be manual or from an external trigger input.	The first trigger starts the waveform, the next trigger stops it. The trigger latch resets after each start/stop. The trigger can either be manual or from an external trigger input.
Gated	The external trigger functions as a gate (high=ON) on the output signal.	
Retrigger	Forces an immediate restart of the waveform from the beginning.	

Trigger polarity

The trigger inputs have pull-up resistors, so the closure of an external switch is treated as a trigger event.

Apply external triggers to the TRIG1, 2, 3 50 W BNC sockets (TTL) on the rear panel. A 0 V level triggers the Arb. The sockets are pulled up to +5 V by 10 kΩ.

Repeat Count

Use the numeric keypad to define the number of repeats of the waveform when Repeat Mode is set to Multiple.

Trigger Source

Use this to select which source to trigger from when using an external trigger. A dropdown menu lists the available trigger lines corresponding to rear-panel inputs (TRIG 1, 2 or 3), sweep markers, or Arb markers.

Arb Marker

Enable and disable up to four Arb markers that you may have created and generated for waveforms within individual modulation schemes.

Arb Marker Routing

Allocate the Arb markers to rear-panel trigger outputs.

Waveform

The Catalogue screen opens when you touch the Waveform button. Use this screen to manage the waveform files that you have previously generated or imported.

Waveform files are stored on the instrument's hard drive. The files are loaded into the Arb's memory (the Catalogue) to be played.

Load

Touch Load to move a file from the hard disk into the Arb catalog for playing. The loading screen appears:
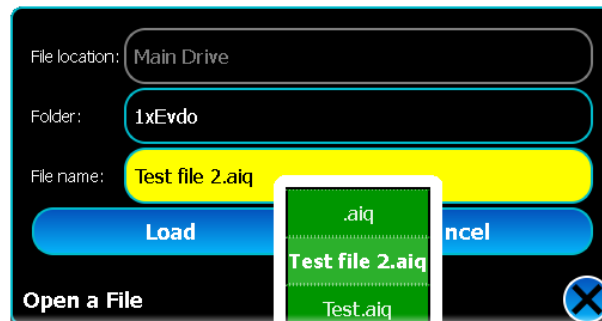
- File location: this is currently the main drive (hard disk).

- Folder: select a file from the appropriate folder. When you generate a waveform file, by default it is placed in a folder named after the modulation scheme.

- File name: choose from the drop-down list.

Touch Load: the file is placed in the Arb catalog.

Unload

Use this to remove an individual file from the Arb catalog. This does <u>not</u> erase it from the main drive.

Unload All

Use this to remove all files from the Arb catalog. This does <u>not</u> erase them from the main drive.

Select

Choose which of the displayed loaded files you want to play. Touch it to highlight it, and then touch Select.

The file is ready to play. Touch ⊗ to return to the Digital Modulation screen.

Delete

This permanently deletes selected files from the main drive (hard disk). You will be asked to confirm this choice. Once files are deleted, they must be generated or imported before they become available again.

If a file or files that you want to delete is currently in use by a channel within the Arb sequence table, a prompt appears to warn you of this. If you continue, the file is removed from the Arb sequence table also (and the channel is highlighted in red to notify you).

Store

Touch Store. The popup shows the current Arb file location.

Enter a file name using the virtual keyboard that pops up when you touch the File Name field.

When you touch Save, the instrument stores the file to the non-volatile memory or to the optional removable hard drive.

Recall

Touch Recall. A popup lets you browse for currently stored Arb files.

Touch the file you want to recall and load it.

External IQ modulation

Mode: External IQ

Use this mode to input external IQ signals on the front-panel I and Q connectors.
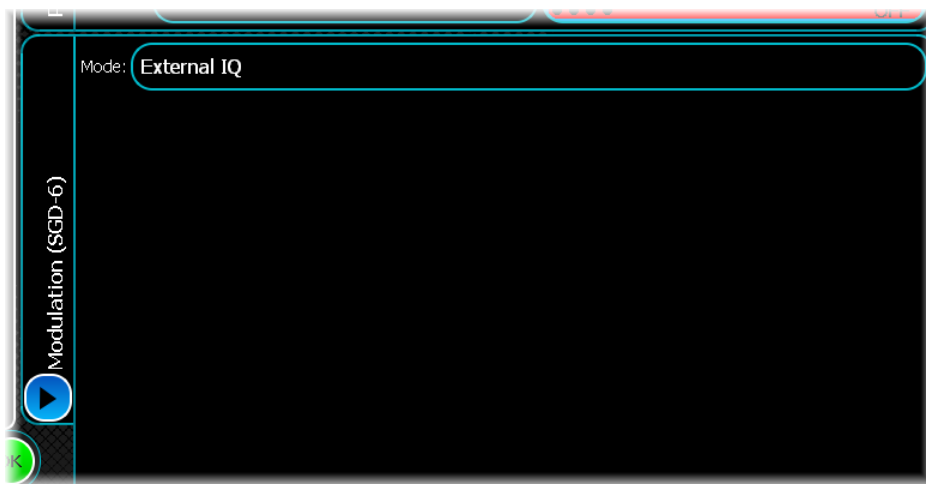
Levels

±0.707 Vpk on 'I or Q' or ±0.5 Vpk 'I and Q' for calibrated output into 100 Ω differential. Damage level ±2 V differential.

1xEV-DO

Use this to produce a waveform that simulates a 1xEV-DO Revision A carrier. The modulation scheme is defined in the 3gpp2 specification C.S0024-A version 2.

Configure 1xEV-DO generation using the following screens:

RF Settings

Modulation

Link Configuration

Filter

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for 1xEVDO.
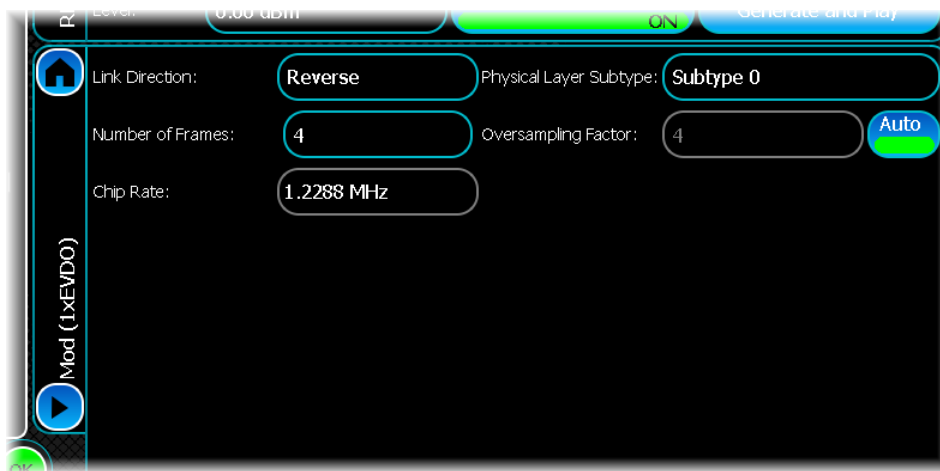
Link Direction

Use this to select forward or reverse link direction.

Number of Frames

Edit this to change the number of frames to generate. One frame is 26.67 ms (32768 chips) long, which is equivalent to 16 slots. The default is 1.

Chip Rate

This displays the chip rate, which is the same as that for cdma2000.

Physical Layer Subtype

Use this to choose the physical layer subtype you want to use. The default is 0.

Oversampling Factor

To oversample by an amount different to the default value of 4, disable the Auto button, then enter the required oversampling factor.

Link configuration

Use this screen to configure the reverse channel(s) for 1xEV-DO.

Configuring the Access Channel

To generate a Reverse Traffic Channel, select Access in the Select Physical Channel control. The Access Channel is the default channel.

Depending on whether you select physical layer subtype 0, 1 or 2, the parameters that you can set on this screen change: the picture shows the settings available when subtype 1 or 2 is selected.

Long Code Masks

The I and Q long-code masks are used to scramble the data. Define the two codes independently, entering the values in hex. The valid range is 0 to 3FFFFFFFFF and the default is 0 h.

Data Power

Use this to set the data gain relative to the pilot. The value is in dB with a range of -60 to 60 dB. The default is 0 dB.

Data Source

This displays the type of data selected for the Data Channel. The default is a PN9 sequence.

Number of Preamble Frames

This setting is available only when physical layer subtype 0 is selected. It sets the number of preambles (in frames) that are generated. The range of values is 1 to 10. The default is 0.

Preamble Length

This setting is available only when physical layer subtype 1 or 2 is selected. Use it to select the number of preamble slots that are generated. The default is 16.

Data to Preamble Power

This setting is available only when physical layer subtype 1 or 2 is selected. Use it to set the total signal power during the access frames relative to the power during the preamble. The value is in dB with a range of -20 to 20 dB. The default is 0 dB.

Number of Access Frames

Use this to set the number of access frames following the preamble, in frames, that are generated. The range of allowed values is 0 to 10. The default is 1.

Configuring the Traffic Channel

To configure the traffic channel when physical_layer_subtype 0 or 1 is selected, refer to Traffic channel subtype 0 or 1.

To configure the traffic channel when physical_layer_subtype 2 is selected, refer to Traffic channel subtype 2.

Traffic channel subtype 0 or 1

To generate a subtype 0 or 1 Reverse Traffic Channel, select Subtype 0 or Subtype 1 in the Physical Layer Subtype control. Then select Traffic in the Select Physical Channel control.
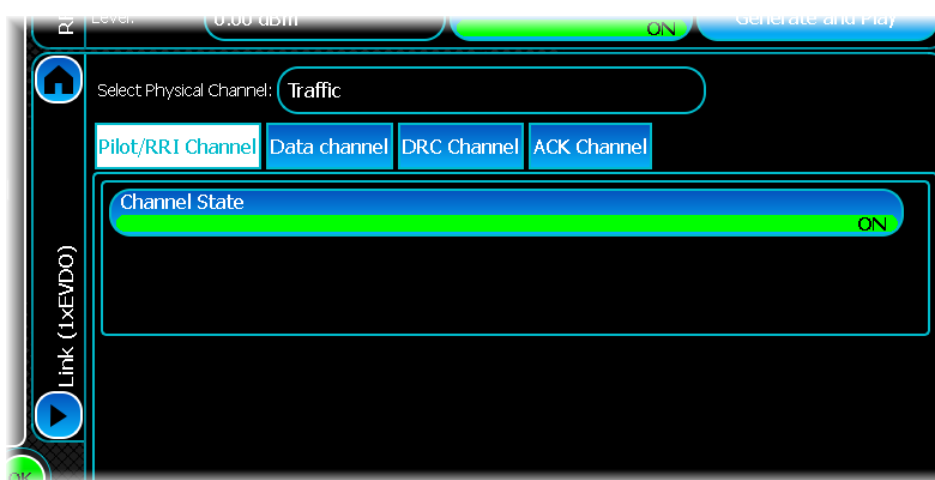
You can now set the following parameters:

Pilot and RRI Channel

The only parameter that you can set for the Pilot/RRI Channel is the channel state (On or Off). If

the state is Off, the Pilot/RRI channel is not transmitted. The default is On.

Data channel

To configure the data, select the Data channel tab

Channel State

The channel state button sets the state for the channel. When this Off, the data channel is not transmitted. The default is Off.

Data Rate

Set one of six data rates available for the Traffic Channel: 0, 9.6, 19.2, 38.4, 76.8 and 153.6 kbps. The default is 9.6 kbps.

Frame Offset

Use this to offset the starting slot of the traffic channel transmission. This is done in the Frame Offset control. The valid range of values is 0 to 3. The default is 1.

Data Source

This shows the type of data used by the data channel. Valid data types are All Zeroes, All Ones, PRBS, User Data and Repeating Pattern. To configure the data source that is used, touch the table cell. The default is a PN9 sequence.

Power

This is the gain of the Data Channel with respect to the Pilot Channel. The value is in dB and has a valid range of -60 to 60 dB. The default is 0 dB.

Number of Packets

This specifies the number of packets to transmit. The valid range of values is 1 to 100. Note that if you select a value that is larger than the number of frames set in the Number of Frames control, the latter takes priority. The default is 1.

DRC Channel

To configure the DRC channel, select the DRC Channel tab.

Channel State

Turn the DRC channel on or off using the Channel State button. If the button is off, the DRC channel is not transmitted. The default is Off.

The following DRC channel parameters can be set:

Power

This is the gain of the DRC channel with respect to the pilot channel. The value is in dB and has a valid range of -60 to 60 dB. The default is 0 dB.

Start Slot

The start slot defines the slot (there are 16 slots per frame) in which the DRC transmission is to start. Note that DRC transmissions are offset by half a slot, so if you set the start slot to 0, the DRC transmission actually starts half way through slot 0. This is in accordance with the standard. The default is 0.

DRC Value

The DRC value is used to request the Forward Traffic Channel data rate. The allowed DRC values lie between 0 and 15. The value is selected using the DRC Value box. The table shows the DRC value with the requested data rate and package length.

DRC value	Requested data rate (kbps)	Packet length (slots)
0	0	N/A
1	38.4	16
2	76.8	8
3	153.6	4
4	307.2	2
5	307.2	4
6	614.4	1
7	614.4	2
8	921.6	2
9	1228.8	1
10	1228.8	2
11	1843.2	1
12	2457.6	1
13	Invalid	N/A
14	Invalid	N/A
15	Invalid	N/A

The SGD lets you set DRC values 13, 14 and 15. The standard provides symbol values for these DRC values even though the higher-level protocol currently does not support them. The default is 00 h.

Gating

Request gated DRC transmissions by selecting the Gating button. In this case, only one slot of DRC is transmitted over DRC-length slots. The default is Off.

Length

This is the length of the DRC transmission in slots. The valid range is 1 to 8. The default is 1.

DRC Cover

The cover value defines the selected serving sector. Valid values range from 0 to 7. The default is 0.

ACK Channel

To configure the ACK Channel, select the ACK Channel tab.

Channel State

Turn the ACK Channel on or off using the Channel State button. If this control is Off, the ACK Channel is not transmitted. The default is On.

Start Slot

The start slot defines the slot (there are 16 slots per frame) in which the ACK transmission is to start. The valid range is 0 to 7. The default is 0 dB.

Power

This is the gain of the ACK Channel with respect to the Pilot Channel. The value is in dB and has a valid range of -60 to 60 dB. The default is 0 dB.

ACK/NACK Gap

This is the spacing between ACK and/or NACK bits. The valid range is 1 to 8. The default is 0.

ACK/NACK Pattern

Use this to select the pattern of acknowledge bits that are sent. A '0' refers to an acknowledge (ACK) and a '1' to a not acknowledge (NACK). The pattern can be set using the ACK(0)/NACK(1) Pattern edit box. The default is 01.

Traffic channel subtype 2

To generate a subtype 2 Reverse Traffic Channel, select *Subtype 2* in the Physical Layer Subtype control. Then select *Traffic* in the Select Physical Channel control.

You can now set the following parameters:

Long Code Masks

The I and Q long-code masks are used to scramble the data. You are able to define the two codes independently. The values are entered in hex. The valid range is 0 to 3FFFFFFFFF. The default is 0 h.

Pilot

To configure the pilot channel, select the Pilot channel tab, which defines the Pilot/RRI Channel State. If the pilot state button is Off, the pilot channel is not transmitted. The default is On.

Auxiliary Pilot

To configure the auxiliary pilot, select the Auxiliary Pilot tab.

Channel State

The auxiliary pilot channel can be turned on or off by using the Channel State button. If the button is off, the auxiliary pilot channel is not transmitted. The default is On.

Payload Threshold

The auxiliary pilot channel is transmitted during the nth half slot if the transmitted payload (on the data channel) during half slots n-1 or n+1 is greater than or equal to the specified threshold, and the Channel State is On. The default is 0, the range is 0 to 12288.

Power

If the auxiliary pilot channel is transmitted during the nth half slot, its power is specified relative to the maximum of the data channel gains during half-slots n-1 and n+1. The value is in dB and has a valid range of -60 to 60 dB. The default is 0.

RRI delay

Use the data /RRI delay control to delay the start of the first data frame (and therefore the start of the RRI channel) with respect to the beginning of the transmission. The delay is in slots and the range of valid values is from 0 to 15. The default is 0.
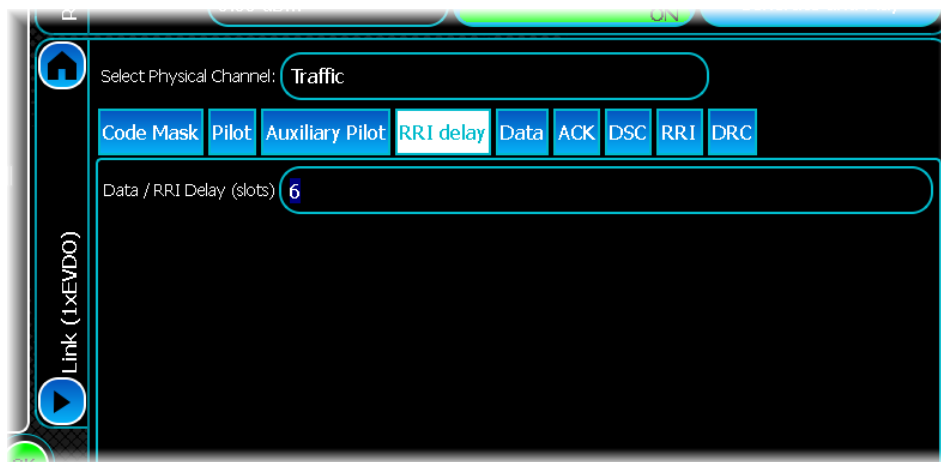
Data channel

To configure the data, select the Data tab

Configure the data channel using the table. Use the buttons to *Add…*,or *Remove* a channel.

A channel is a sequence of one or more packets that contain data from the same data source. Up to 16 separate channels can be configured. When transmitting packets on the data channel, the packets belonging to each channel are transmitted using 3 sub-frame interlacing. This means that packets from other channels can be transmitted on the intervening sub frames.

A graphical representation of a frame is given to illustrate which slots are occupied and which slots are available. If a slot is occupied, it is color-coded according to the channel, and the modulation is given. When any item in this table is selected, the corresponding packet is displayed within the graphic.

To add a new channel to the table, touch the Add… button. This adds a new line with which you can configure a channel's parameters:

You can set the following parameters when adding a channel:

Channel State

The channel state button sets the state for the channel. When this is Off, the data channel is not transmitted during the slots occupied by the channel. The default is On.

Frame Offset

The frame offset defines when the first slot in a packet is transmitted. The offset is relative to slot 0 of the first frame. The valid range of values is 0 to 1600. The frame offset must be a whole number of sub-frames (multiple of 4). If the value entered does not lie on a sub-frame boundary, the value is rounded down to the nearest whole sub-frame. The default is 0.

Number of Packets

This specifies the number of packets to transmit. The valid range of values is 1 to 100. The default is 1.

Payload (Bits Per Packet)

The payload specifies the number of bits transmitted in a packet before encoding or repetition is applied.

The SGD does not implement encoding or repetition. This means that selecting payload only affects the data channel by changing the type of modulation that is used. The payload selected also determines the value transmitted on the RRI channel and determines if the auxiliary pilot should be transmitted. The default is 128.

Number of Slots Per Packet

This specifies the number of slots per packet: 4, 8, 12 or 16 slots per packet. This corresponds to 1, 2, 3 or 4 sub-packets per packet. According to the specification, the data transmitted in a packet should be encoded or repeated so that it fills the required number of subpackets.

As the SGD does not implement encoding or repetition, increasing the number of slots per sub-packet simply increases the amount of data produced to fill the required number of subpackets. The default is 8.

Data Source

This shows the type of data used by the Data Channel. Valid data types are All Zeroes, All Ones, PRBS, User Data and Repeating Pattern. To configure the data source that is used, touch the table cell . The default is a PN9 sequence.

Power

This is the gain of the channel during slots occupied by the channel. The gain is relative to the Pilot Channel. The value is in dB and has a valid range of -60 to 60 dB. The default is 0 dB.

The SGD only generates the number specified in the Number of Frames edit box. This means that data channel transmission is truncated if the channels occupy slots that do not lie within the frames generated.

You can edit any of the parameters directly in the table, by touching the relevant cell.

ACK Channel

To configure the ACK Channel, select the ACK Channel tab.

Turn the ACK Channel on or off using the Channel State button. If this control is Off, the ACK Channel is not transmitted. The default is On.
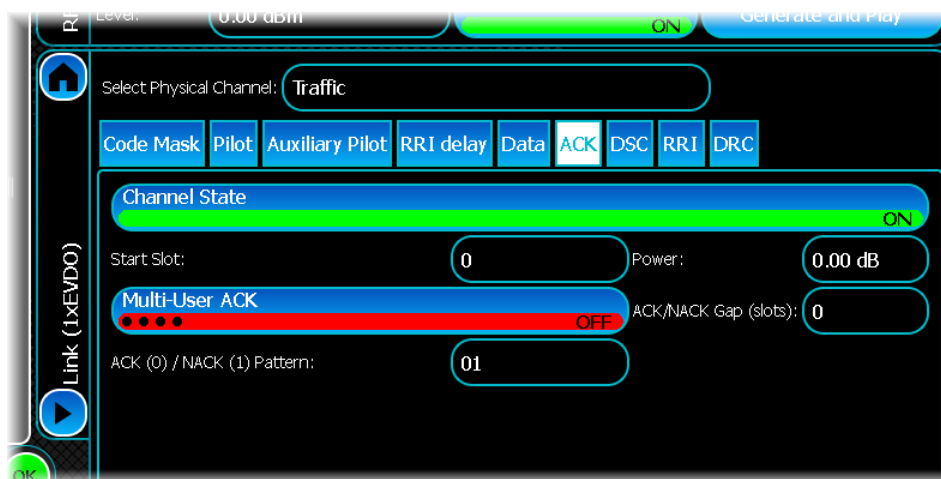
Power

This is the gain of the ACK Channel with respect to the Pilot Channel. The value is in dB and has a valid range of -60 to 60 dB. The default is 0 dB.

Start Slot

The start slot defines the slot (there are 16 slots per frame) in which the ACK transmission is to start. The default is 0 dB.

ACK/NACK Gap

This is the spacing between ACK and/or NACK bits. The default is 0.

ACK/NACK Pattern

Use this to select the pattern of acknowledge bits that are sent. A '0' refers to an acknowledge (ACK) and a '1' to a not acknowledge (NACK). The pattern can be set using the ACK(0)/NACK(1) Pattern edit box. The default is 01.

Multi-User ACK

If you select the Multi-User ACK button, the ACK channel behaves as if it were acknowledging a multi-user packet. Otherwise, it behaves as if it is acknowledging a single-user packet. The default is Off.

DSC Channel

To configure the DSC channel, select the DSC Channel tab.

The DSC Channel can be turned on or off by selecting or clearing the Channel State check box found in the DSC Channel frame. If this control is unchecked, the DSC Channel is not transmitted. The default is off (unchecked).
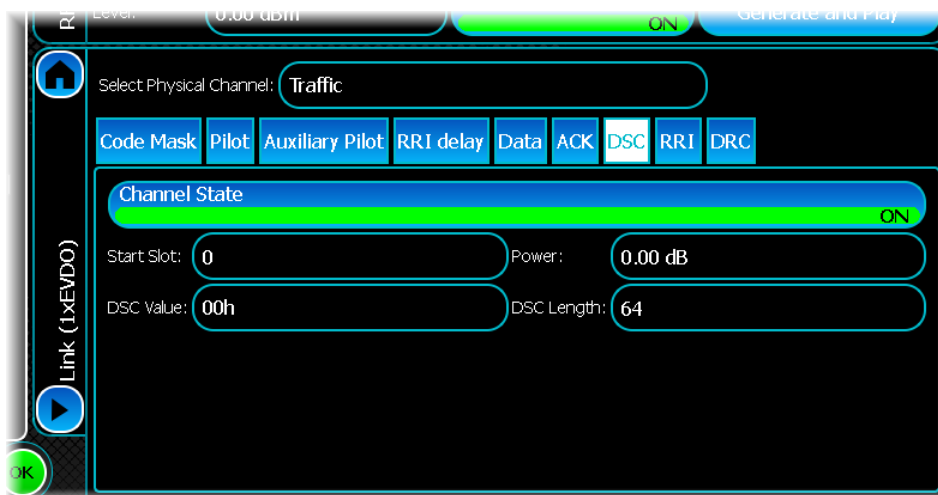
Set the following parameters using the DSC configuration dialog:

Start Slot

The start slot defines the slot (there are 16 slots per frame) in which the DSC transmission is to start. The default is 0.

DSC Value

The DSC value indicates to the access network the selected serving cell on the forward link. Valid DSC values are between 0 and 7. The default is 0.

Power

This is the gain of the DSC Channel with respect to the Pilot Channel. The value is in dB and has a valid range of -60 to 60 dB. The default is 0 dB.

DSC Length

This is the length of the DSC transmission in slots. The valid range is 8 to 256. The default is 64.

RRI Channel

To configure the RRI channel, select the RRI tab.

The following parameters can be set:

Channel State

Turn the RRI channel on or off using the Channel State button. If the button is Off, the RRI channel is not transmitted. The default is On.

Power

This is the gain of the RRI channel with respect to the Pilot Channel. The value is in dB and has a valid range of -60 to 60 dB. The default is 0.

The values transmitted on the RRI channel are dependent on the payload transmitted on the data channel.

DRC Channel

To configure the DRC channel, select the DRC tab.

Channel State

Turn the DRC channel on or off using the Channel State button. If the button is off, the DRC channel is not transmitted. The default is Off.

The following DRC channel parameters can be set:

Power

This is the gain of the DRC channel with respect to the pilot channel. The value is in dB and has a valid range of -60 to 60 dB. The default is 0 dB.

Start Slot

The start slot defines the slot (there are 16 slots per frame) in which the DRC transmission is to start. Note that DRC transmissions are offset by half a slot, so if you set the start slot to 0, the DRC transmission actually starts half-way through slot 0. This is in accordance with the standard. The default is 0.

DRC Value

The DRC value is used to request the Forward Traffic Channel data rate. The allowed DRC values lie between 0 and 15. The value is selected using the DRC Value box. The table shows the data rate and span of the canonical transmission format associated with each DRC value, where the canonical transmission format is defined as the transmission format with the largest physical packet size. The default is 0.

DRC value	Requested data rate (kbps)	Span (slots)
0	0	N/A
1	38.4	16
2	76.8	8
3	153.6	4
4	307.2	2
5	307.2	4
6	614.4	1
7	614.4	2
8	921.6	2
9	1228.8	1
10	1228.8	2
11	1843.2	1
12	2457.6	1
13	1536	2

DRC value	Requested data rate (kbps)	Span (slots)
14	3072	1
15	Invalid	N/A

The SGD lets you set the DRC value to 15. The standard provides symbol values for this DRC value even though the higher-level protocol currently does not support it.

Gating

Request gated DRC transmissions by selecting the Gating button. In this case, only one slot of DRC is transmitted over DRC-length slots. The default is Off.

Length

This is the length of the DRC transmission in slots. Valid range is 1 to 8. The default is 1.

DRC Cover

The cover value defines the selected serving sector. Valid values range from 0 to 7. The default is 0.

Analog (FM/RDS radio)

Use this to produce an FM mono, stereo or RDS radio broadcast waveform.

Touch the ▶ button, and configure FM analog generation using the following screens:

RF Settings

Modulation

RDS Common

RDS Group

Filter

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set FM mono/stereo and RDS radio broadcast modulation parameters.

Generation Type

Select the generation type: FM Mono, FM Stereo or FM RDS.

Oversampling Factor

To oversample by a different amount to the default value of 4, disable auto mode by touching the Auto button and enter the oversampling factor of your choice.

Generation Mode

The Generation mode can be either Auto or Manual. In Auto mode the signal length and sampling frequency are calculated automatically. In Manual mode, the sampling frequency and signal duration are user-defined.

In auto mode, the length of the signal is set so that the signal always wraps. For a FM signal the calculation used to set the sampling frequency automatically is based on Carson's bandwidth rule. Carson's rule states that 98% of the signal power is contained in a bandwidth of 2 x (f_m + F) where f_m = the highest modulating frequency, and

F = the frequency deviation. The sample rate is set to (4 × the bandwidth obtained from Carson's rule). If this calculation returns a value of less than 768 kHz, the sampling rate is set to 768 kHz.

Sampling Frequency

Use this to set the sampling frequency when the Generation Mode is Manual. The sampling frequency does not have an upper and lower limit but if the sampling frequency is set to less than the ($4 \times$ the bandwidth obtained from Carson's rule) a conflict is raised.

Signal Length Samples

This displays the length of the signal in samples when the Generation Mode is Auto.

Signal Length Time

Use this to set the signal length when the Generation Mode is Manual. The sampling length time cannot be less than 1 ms. When in manual mode, no checking is done to ensure that the signal wraps.

FM Parameters

Input Mode

The input mode configures how the left/right channels are configured.

The input mode can take on the following values:

Off (no audio)

Left only

Right only

Left = Right

Left = - Right

Left and Right

The input mode is applicable only when a stereo signal is being transmitted (when the Generation Type is FM Stereo/FM RDS). If the Generation Type is FM Mono, the input mode is ignored and the modulating signal is configured using the parameters for the Left channel.

The table shows how the FM stereo channels are configured for a given input mode. It is worth noting that when the input mode is Left = Right, or Left = -Right, the parameters for the right channel are ignored and the signal that is transmitted on the right channel is calculated from the configuration of the left channel.

Mode	Left channel parameters	Right channel parameters	Signal on left channel	Signal on right channel
Off	Ignored	Ignored	None	None
Left only	Used	Ignored	Left	None
Right only	Ignored	Used	None	Right
Left = Right	Used	Ignored	Left	Same signal as on the left
Left = - Right	Used	Ignored	Left	Signal on the left ✕ -1
Left, Right	Used	Used	Left	Right

The mono component in an FM stereo signal consists of left channel + right channel. The stereo component in a FM stereo signal consists of left channel - right channel. This means that when the input mode is Left = Right, no stereo component is transmitted; when the input mode is Left = - Right, no mono component is transmitted.

Left and Right Channel parameters

For Generation Type FM Stereo, you can configure the FM left and right channel parameters by selecting the *FM Left Right Parameters* button.

This shows the following dialog:
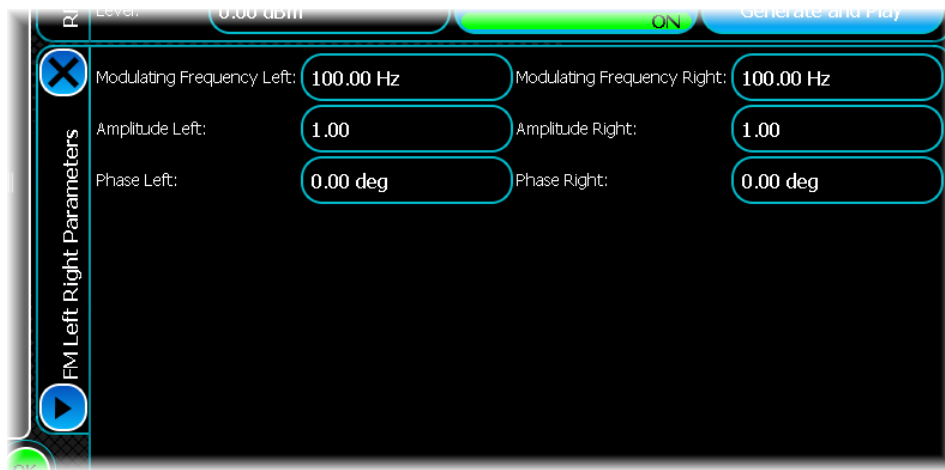
If you are configuring an FM Mono signal, this screen shows only a single set of frequency, amplitude and phase controls.

The following parameters can be configured for both the left and the right channels.

Modulating Frequency

This specifies the frequency of the tone to be transmitted on the channel. The modulating frequency can be in the range 100 Hz to 15 kHz.

Amplitude

This specifies the amplitude of the tone to be transmitted. This parameter is useful only when both the left and right channels are being transmitted. By configuring the amplitude of the left/right channel it is possible to configure the balance between the left and right channel.

Phase

This specifies the starting phase of the tone. The initial phase can be between +/-2 radians.

Deviation Parameters

Specify the deviation specific parameters of an FM signal by touching the FM Deviation Parameters button.

This shows the following dialog:
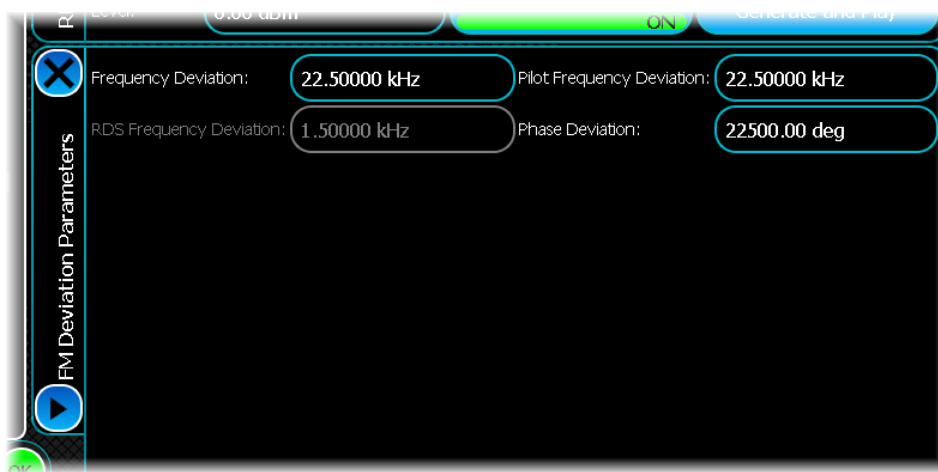
Frequency Deviation

The frequency deviation is specified in Hz and can take a value between 1 Hz and 5 MHz. In a mono signal the frequency deviation is the maximum frequency deviation (the maximum amount the modulated signal deviates from the carrier). In an FM stereo or FM RDS signal the frequency deviation parameter specifies the amount of deviation that is applied to the audio signal. The amount of pilot and/or RDS deviation can be specified separately.

In an FM stereo signal the maximum possible total deviation = audio frequency deviation + pilot deviation.

In an RDS signal the maximum possible total deviation = audio frequency deviation + pilot deviation + RDS deviation.

For the maximum total deviation to occur all the subcarriers of the signal have to peak at the same time. For example, in an RDS system the audio, the pilot and the RDS carriers would all have to be at their peak value for the maximum possible deviation to occur. If the peaks of the subcarriers do not line up the total deviation may be less than the potential maximum.

Pilot Frequency Deviation

The pilot frequency deviation controls how much the pilot signal causes the modulated signal to deviate from the carrier. The value is specified in Hz and can take any value from 0 to 75 kHz.

RDS Frequency Deviation

The RDS frequency deviation controls how much the RDS signal causes the modulated signal to deviate from the carrier. The value is specified in Hz and can take any value from 0 to 75 kHz.

FM Pre-emphasis Parameters

Edit the Pre-emphasis parameters of an FM signal by touching the FM Pre-emphasis Parameters button.

This shows the following dialog:
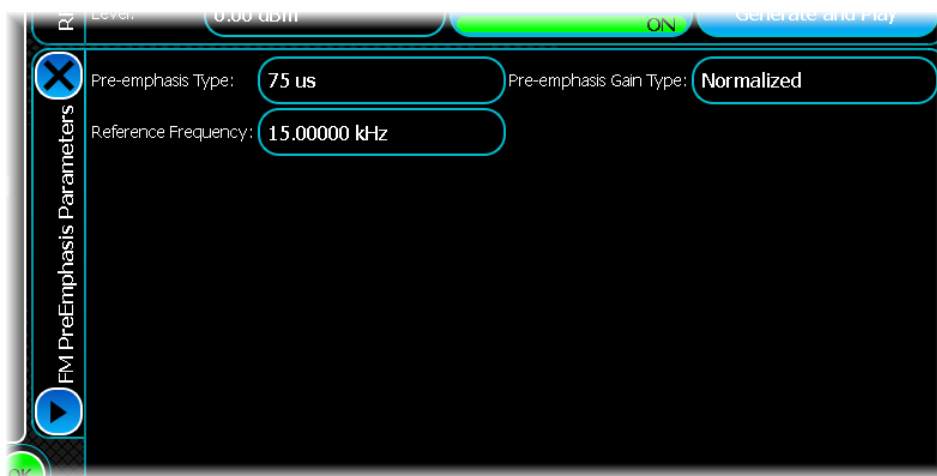
Pre-emphasis Type

Set the pre-emphasis to one of the following values:

- None

- 50 μs

- 75 μs

When the pre-emphasis is set to None, no pre-emphasis is applied; otherwise the pre-emphasis characteristic of the sound signal is identical to the admittance-frequency curve of a parallel resistance-capacitance circuit having a time constant of 50 μs or 75 μs.

Pre Emphasis Gain Type

Select a pre-emphasis gain type of Normalized or Not Normalized.

When the pre-emphasis gain type is normalized, the gains due to pre-emphasis are scaled relative to the pre-emphasis reference frequency; otherwise they are not. If the gain is normalized all pre-emphasis gains are divided by the gain that would be applied to the pre-emphasis reference frequency.

In normalized mode, signals transmitted at the pre-emphasis reference frequency are transmitted at 0 dB. Signals that require more gain than the Reference frequency (higher frequencies) are transmitted with a positive gain. Signals that require less gain than the reference frequency (lower frequencies) are transmitted with a negative gain.

Reference Frequency

When the pre-emphasis gain type is normalized, this parameter specifies the frequency to use to normalize the pre-emphasis gain. The value is between 100 Hz and 15 kHz.

RDS Common

Use the RDS Common screen to set common parameters for the RDS mode of operation.

This screen is enabled only if the Generation Type is set to FM RDS.
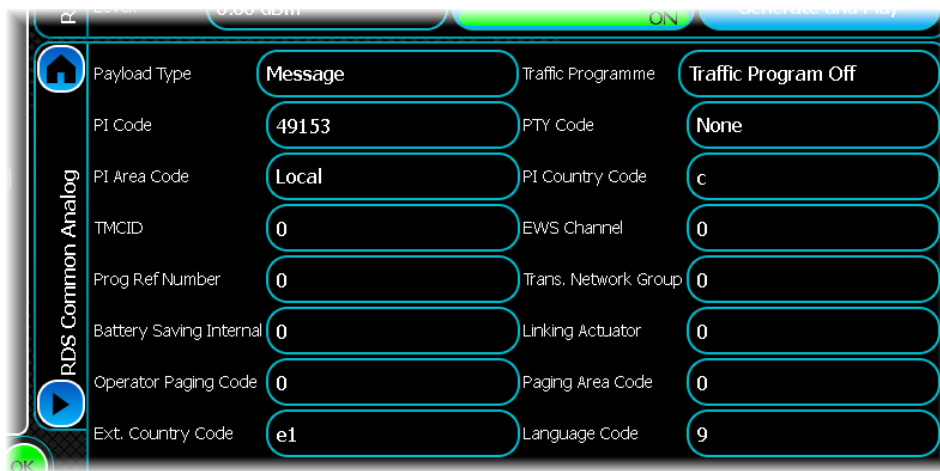
Payload type

The payload type can either be Bit Source or Message. When the payload type is Bit Source no encoding is applied to the bits transmitted.

The bit source can be configured to be one of the following:

- Zeros

- Ones

- PRBS

- Random

- User Data (From a file)

- Repeating pattern

When the payload type is Message, a fully-coded RDS message is produced. The type of message produced is dependent on the Message Type parameter.

PI Code

The PI (programme identification code) is a 16-bit value used to identify a programme. The PI code can take any value from 0 to 65535. The programme area code is currently read-only and is calculated from the PI area code, PI country code, and programme reference number.

PI Area Code

The PI area code forms bits b11 to b8 (where b0 is the LSB) of the PI code.

The PI area code can take one of the following values:

- Local = 0

- International = 1

- National = 2

- SupraRegion = 3

- R1 = 4

- R2 = 5

- R3 = 6

- R4 = 7

- R5 = 8

- R6 = 9

- R7 = 10

- R8 = 11

- R9 = 12

- R10 = 13

- R11 = 14

- R12 = 15

TMCID

The TMC (traffic message channel) ID is 12 bits long and can take any value from 0 to 4095.

The TMC ID is used to form a programme item number and slow labeling message (Version A).

The TMC ID is transmitted only when the variant code for the message is 1 (TMC ID).

Prog Ref Number

The programme reference number is used to form the last 8 bits of the PI code. The programme reference can take any value from 0 to 255.

Battery Saving Internal

This forms the first five bits of the paging information transmitted in every Version A programme item number and slow labeling message. The battery saving internal can take any value from 0 to 3.

Operator Paging Code

The operator paging code is used in two different variants of the version A programme item number and slow labeling message. It is transmitted with the extended country code when the variant code for the message is 0 (OPC/extended country). It is also transmitted when the variant code is 2 (paging identification).

Ext. Country Code

The extended country code is transmitted with the operator paging code in a version A programme item number and slow labeling message. The extended country code is transmitted only when the variant code for the message is 0 (paging/extended country). The extended country code is entered in hex and can take any value from 0 to 0xFF.

Traffic Programme

The traffic programme (TP) is used to indicate whether the programme carries traffic announcements.

PTY Code

The PTY code indicates the type of programme that is being transmitted.

The programme type is a 5-bit value and can take one of the following values:

• None = 0	• Weather = 16
• News = 1	• Finance = 17
• Current Affairs = 2	• Children = 18
• Information = 3	• Social Affairs = 19
• Sport = 4	• Religion = 20
• Education = 5	• Phone In = 21
• Drama = 6	• Travel = 22
• Culture = 7	• Leisure = 23
• Science = 8	• Jazz Music = 24
• Varied = 9	• Country Music = 25
• Pop Music = 10	• National Music = 26
• Rock Music = 11	• Oldies Music = 27
• Easy Music = 12	• Folk Music = 28
• Light Classical = 13	• Documentary = 29
• Serious Classical = 14	• Alarm Test = 30
• Other Music = 15	• Alarm = 31

PI Country Code

The PI country code forms the first 4 bits of the PI code. The country code is entered in hex and can take any value from 0x1 to 0xF.

EWS Channel

The EWS channel ID is 12 bits long and can take any value from 0 to 4095.

The EWS channel ID is used to form a programme item number and slow labeling message (Version A). The EWS Channel ID is transmitted only when the variant code for the message is 7 (identification of EWS channel).

Trans. Network Group

The transmitter group designation forms the first three bits of the paging information transmitted in every Version A programme item number and slow labeling message. The transmitter group designation can take any value from 0 to 7.

Linking Actuator

The linking actuator is a single bit that is first bit transmitted in block 3 of every Version A programme item number and slow labeling message. The value can be either 1 or 0.

Paging Area Code

The paging area code is transmitted with the operator paging code in a version A programme item number and slow labeling message. The paging area code is transmitted only when the message variant code is 2 (paging identification).

Language Code

The language code is 12 bits long and can take any value from 0 to 4095. The language code is used to form a programme item number and slow labeling message (Version A). The language code is transmitted only when the variant code for the message is 3 (language codes).

RDS group version type parameters

Use the RDS Common screen to set common parameters for the group version and type parameters of an RDS signal.

This screen is enabled only if the Generation Type is set to FM RDS.

Group Type

The group type can take one of the following values:

- 0 Basic tuning and switching

- 1 PIN slow labeling code

- 2 Radio Text

- 3 (Version A only) ODAAID

- 4 (Version A only) Date and time

- 10 (Version A only) PTYN

- 14 EON

Note: the group type is ignored when the message type is composite.

Message Type

The message type specifies the type of message to transmit (when the payload type is Message).

The message type can take one of the following values:

- Basic tuning and switching
- Radio Text
- Date and time
- PIN slow labeling code
- ODAAID
- EON
- PTYN
- Composite

When the message type is Composite the Group Type is ignored; otherwise the selection of the message type is limited to the message type(s) transmitted using the specified group type.

A composite message can be made up of any (non-composite message type). When the message type is Composite, the composite message type dropdown list appears. This can be used to configure the messages that make up the composite message.

Composite Msg. Type

A composite message can be made up of multiple messages. When the message type is Composite, the composite message type dropdown list appears. This can be used to configure the messages that make up the composite message. Each of the messages in the composite message can be included/excluded by switching the message on /off.

Basic tuning and switching (Group Type 0)

Group Version

The group version can be A or B. The group B version of the message does not transmit alternative frequency information.

Decoder ID

The decoder ID transmits information about the signal to help the receiver decode it properly. The decoder ID is made up of the following fields:

Decoder ID0

Set to Stereo or Mono

Decoder ID1

Set to Artificial or Not Artificial.

Decoder ID2

Set to Compressed or Non-compressed

Decoder ID3

Set static PTY or dynamic PTY. This indicates whether the PTY Transmitted/the PTY(s) Referenced in an EON message can change.

Music or Speech

Set to music or speech: indicates whether music or speech is being transmitted.

Traffic Announcement

Use this to set the TA bit: can be set to On or Off. This is used in conjunction with the TP bit to transmit information about traffic announcements.

PSN String

This is string of eight characters that is used to indicate the programme service name.

Alt. Freq. (1) Type (Group Version A only)

It is possible to configure two alternative frequencies. For each alternative frequency, a frequency type LF, MF or VHF can be set.

Alt. Carrier Freq. (1) (Group Version A only)

The alternative carrier frequency can be between 153 kHz and 107.9 MHz

Programme item number and slow labeling message (Group Type 1)
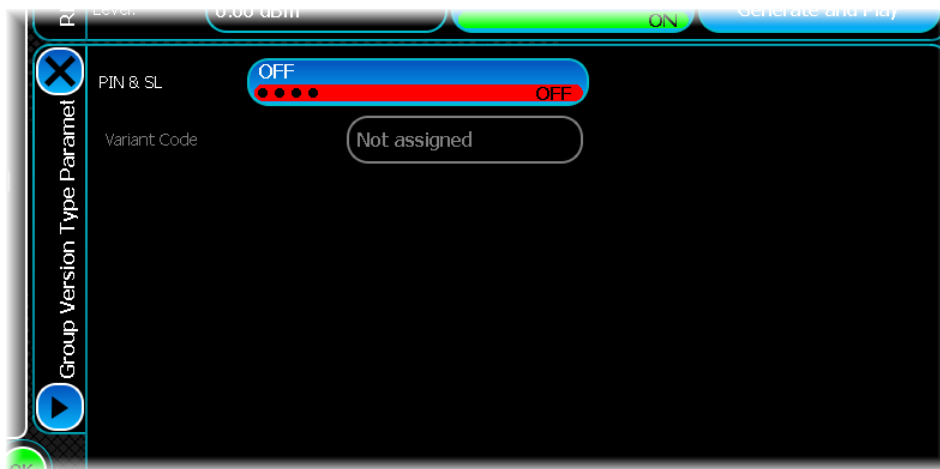
Group Version

The group version can be A or B. Version B of the message does not transmit slow labeling.

Variant Code (Group Version A only)

The variant code specifies the type of information to be transmitted in the message.

The variant code can take the following values:

- Extended Country Code

- TMC ID

- Paging ID

- Language Code

- Not Assigned

- Not Assigned 1

- Broadcaster

- EWS Channel

Radio Text (Group Type 2)
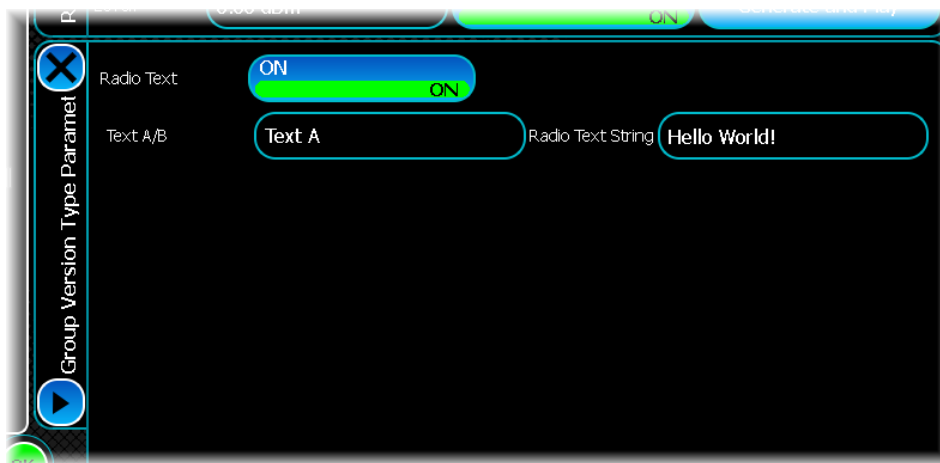
Group Version

The group version can be A or B. Version B of this message transmits text at half the rate of the version A.

Text A/B

Set to A or B. In an RDS signal the A/B field changes from A to B or vice versa when the radio text string needs to be cleared.

Radio Text String

This contains the RDS text to transmit.

ODAAID (open data application identifier) (Group Type 3)

Open data applications are applications that are not part of the RDS standard. An open application identifier message is used to identify groups that are used to transmit data for an open data application.
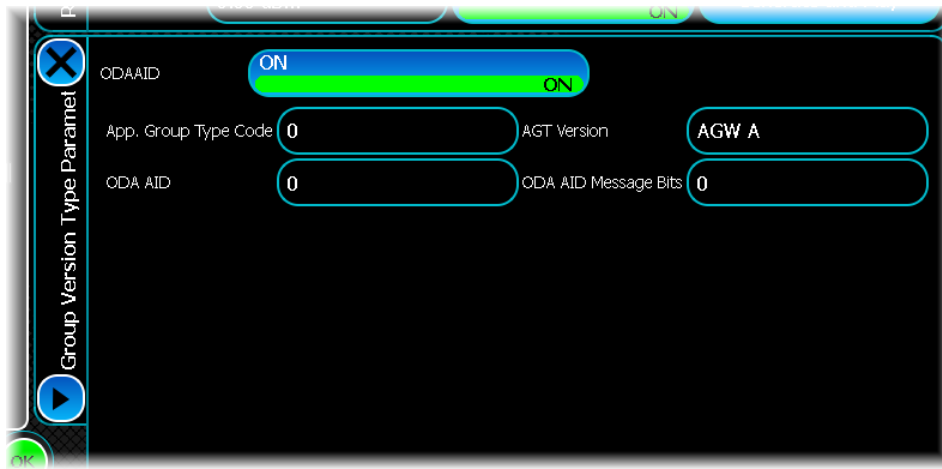
Group Version

This message can only be transmitted using the Group version A.

Application Group Type code

This indicates the group type (and version) code that is used to transmit the open application data.

This field can take one of the following values:

- 3B

- 4A

- 4B

- 5A

- 5B

- 6A

- 6B

- 7A

- 7B

- 8A

- 8B

- 9A

- 9B

- 10A

- 10B

- 11A

- 11B

- 12A

- 12B

- 13A

- 13B

- 14A

- 14B

- 15A

- 15B

- Fault

ODA ID

This open data application ID field is 16 bits long and can be set to any value from 0 to 65535. This field is used to identify the application that will transmit the data.

ODA AID Message Bits

This is a 16-bit value that contains message bits for the open data application. This field can take any value from 0 to 65535.

PTYN (programme type name) (Group Type 10)

Group Version

This message can only be transmitted using group version A

PTY Name

This field can be set to A or B. In an RDS signal the A/B field is changed from A to B or vice versa whenever the PTY name is changed

PTYN String

This is an eight-character string used to describe the programme type.

EON (enhanced other networks information) (Group Type 14)

Group Version

A Version A and a version B of this message exist. Version B of this message does not transmit the EON information field or the EON variant code.

EON Info (Version A only)

This field contains the EON information. This field is a 16-bit value and can take any value from 0 to 65535. The meaning of the bits transmitted in this field depends on the EON variant code.

Country Code Other N/w

This is the PI country code for the other network. The PI country code forms the first four bits of a PI code. The value is entered in hex and can take any value from 0x1 to 0xF.

Prog Ref Number

This is the programme reference for the other network. The programme reference number is used to form the last eight bits of a PI code. The programme reference can take any value from 0 to 255.

TA Other N/w

This is used to indicate the state of the TA bit on the other network. The TA bit is used together with the TP bit to transmit information regarding traffic announcements.

PTY Other N/w

This is the PTY code for the other network.

A PTY code indicates the type of programme that is being transmitted. The programme type is a five-bit value that represents one of the following:

• None = 0	• Weather = 16
• News = 1	• Finance = 17
• Current Affairs = 2	• Children = 18
• Information = 3	• Social Affairs = 19
• Sport = 4	• Religion = 20
• Education = 5	• Phone In = 21
• Drama = 6	• Travel = 22
• Culture = 7	• Leisure = 23
• Science = 8	• Jazz Music = 24
• Varied = 9	• Country Music = 25
• Pop Music = 10	• National Music = 26
• Rock Music = 11	• Oldies Music = 27
• Easy Music = 12	• Folk Music = 28
• Light Classical = 13	• Documentary = 29
• Serious Classical = 14	• Alarm Test = 30
• Other Music = 15	• Alarm = 31

PI Code Other N/w

This is a 16-bit value used to identify a programme transmitted on the other network. The PI code can take any value form 0 to 65535. The programme area code is currently read-only and is calculated from the PI area code, PI country code and programme reference number.

PI Area Code Other N/w

This is the PI area code for the other network. The PI area code forms bits b11 to b8 (where b0 is the LSB) of a PI code.

The PI area code can take one of the following values:

- Local = 0

- International = 1

- National = 2

- SupraRegion = 3

- R1 = 4

- R2 = 5

- R3 = 6

- R4 = 7

- R5 = 8

- R6 = 9

- R7 = 10

- R8 = 11

- R9 = 12

- R10 = 13

- R11 = 14

- R12 = 15

TP Other N/w

The traffic programme (TP) is used to indicate whether the other network is transmitting a programme that carries traffic announcements.

EON Variant Code (Version A only)

This specifies the type of EON information that is transmitted in this message. The EON variant code can be set to any value from 0 to 15.

Bluetooth

Use this to produce a waveform that simulates a Bluetooth modulation conforming to IEEE 802.15. The modulation scheme is defined in Bluetooth specification Version 2.1 + EDR [volume 2].

Touch the ▶ button, and configure Bluetooth generation using the following screens:

RF Settings

Packet

Payload

Modulation

Address/Power

Markers

IQ Impairments

Graphics

Packet

Use this screen to define the packet type, the number of packets, whether PAD packet is included, the polling period and the packet header settings for transmission.
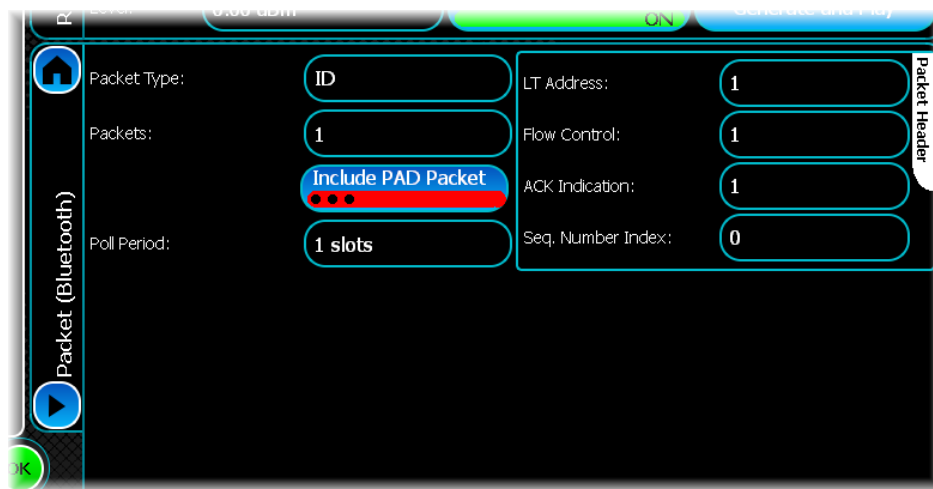
Packet Type

Use this to set the packet format/type that is to be generated.

Packets

Use this to set the number of packets to be generated for transmission. This does not include the PAD packet. This means that if you enable PAD packet, the total number of packets generated is equal to the number of packets + 1.

Include PAD Packet

Set this button On to insert a PAD packet (which is similar to a NULL packet) at the end of the packet transmission in the next applicable transmission slot. By default, PAD packet insertion is Off. This control is not applicable to LE test packets.

Poll Period

Master and slave devices exchange information by alternating packet transmission in TDD mode over a defined slot-boundary based on packet format. The poll period sets the number of inactive slots between the transmissions of the packets. This allows the return packets to be received in the inactive slots. The default value is 0 slots.

It is recommended to set the poll period equal to the number of slots that are occupied by the packet type selected for transmission. For example, if the packet type is set to DH3, the poll period may be set to 3.

Packet Header

These settings are not applicable to LE test packets.

LT Address

Use this to set the LT_ADDR (logical transport address) field in the packet header.

Flow Control

Use this to set the flow control bit in the packet header.

ACK Indication

Use this to set the ARQN bit in the packet header.

Seq Number Index

Use this to set the SEQN bit in the packet header.

Payload

Use this screen to set general payload parameters for Bluetooth.
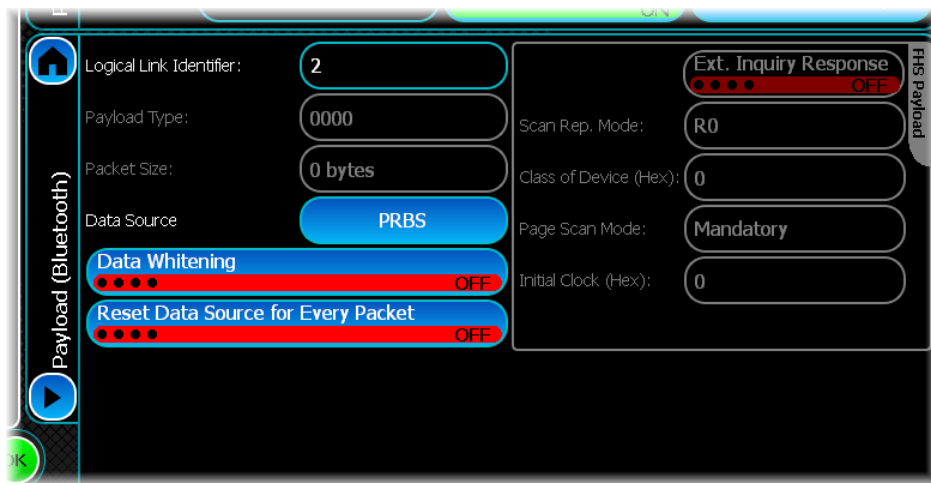
Logical Link Identifier

Use this to set the Logical Link Identifier field of the payload header.

Payload Type
This field is applicable for LE Test packets only, and sets the payload type in the packet header.

To create a valid LE Test packet, set this field according to the Payload Type table and the selected data source. The instrument does not enforce that the payload type field matches the selected data source. The allowed values are from 0 (binary value: 0000) to 15 (binary value: 1111). The default value is 0000.

Payload Type

Payload type b3b2b1b0	Payload description (in transmission order)
'0000'	PRBS9 sequence '1111 1111 1000 0011 1101'
'0001'	Repeated '1111 0000' sequence
'0010'	Repeated '1010 1010' sequence
'0011'	PRBS15 sequence
'0100'	Repeated '1111 1111' sequence
'0101'	Repeated '0000 0000' sequence
'0110'	Repeated '0000 1111' sequence
'0111'	Repeated '0101 0101' sequence

Packet Size

Enter a packet size. This is dependent on the packet type selected for generation.

Data Source

Use this to set the data type. Allowed data types are All Zeros, All Ones, Random, Repeating Pattern and User Data.

Data Whitening

This button enables or disables the scrambling performed on the packet. By default, it is Off.

Reset Data Source for Every Packet
This sets the behavior of the payload data bits to be generated for each packet. By default, this button is Off. If this button is On, the same data bits are used for every packet.

FHS Header

Ext. Inquiry Response

This button is enabled only if the FHS packet type has been selected for transmission. By default, this button is Off. Set the EIR field in the FHS payload by turning the EIR button On.

Scan Rep. Mode

Use this to set the SR field in the FHS payload. It is enabled only if the FHS packet type has been selected for transmission.

Class of Device

This field is enabled only if the FHS packet type has been selected for transmission. By default, this field is set to 0. The class of device is a 24-bit field in the FHS payload.

Page Scan Mode

This field is enabled only if the FHS packet type has been selected for transmission. By default, this field is set to Mandatory mode.

Initial Clock

This field is enabled only if the FHS packet type has been selected for transmission. By default, the value is set to 0. Set the CLK27-2 field in the FHS payload by editing the value in the Logical Transport Address box.

Modulation

Use this screen to set general modulation parameters for Bluetooth.
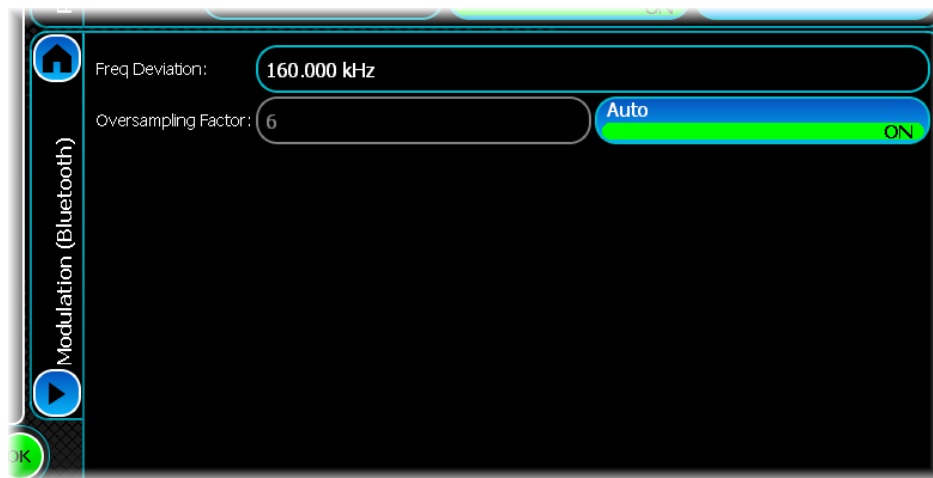
Freq Deviation

Use this to enter the frequency deviation, which represents the maximum shift away from the transmit frequency in one direction for the GFSK part of the packet. The default value is 160.0 kHz, which corresponds to a modulation index of 0.30.

Oversampling Factor

This sets the oversampling factor used in the filtering process. The default oversampling factor is 6. If you need to oversample by a different amount, disable auto mode by turning the Auto button Off and enter the oversampling factor of your choice

Address and power

Use this screen to set the Bluetooth power profile and device address.
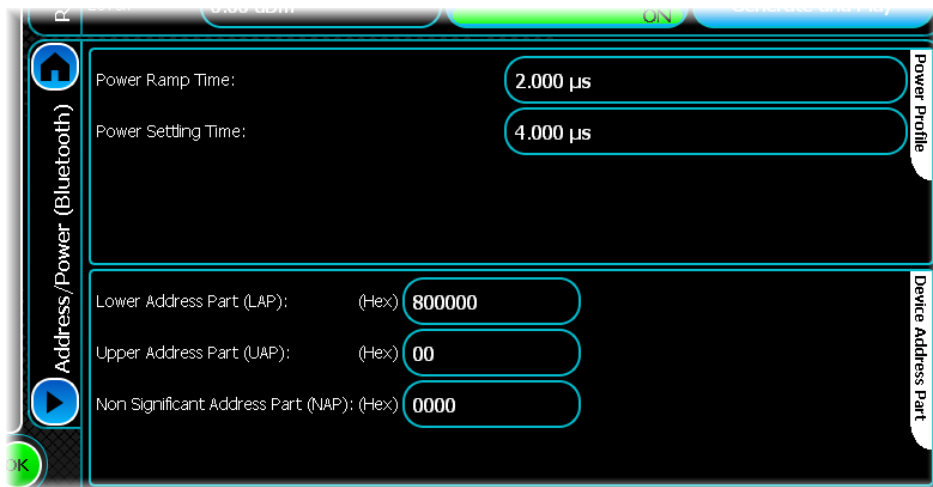
Power Profile

You can set the power ramp time and the power settling time of the burst packets as shown below. The ramp-up time is the time taken for the output power of the signal to increase from below -40 dB to within +/-3 dB of the final output power X dBm. Settling time is the time taken for the output power of the signal to reach within better than +/-1 dB of the final output power X dBm. t_{P0} is the time at which first bit of the preamble begins.
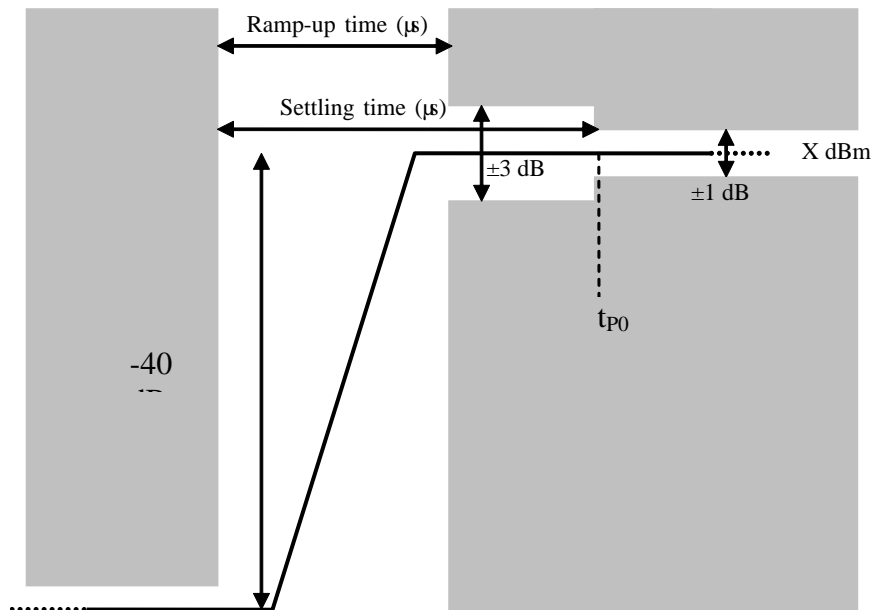
Power Ramp Time

Use this to set the power ramp time. By default, the power ramp time is set to 6 µs.

Power Settling Time

Use this to set the power settling time. By default, the power settling time is set to 6 µs.

Device Address Part

The Bluetooth device address is 448 bits long. You can set the individual fields of the BD_ADDR: LAP, UAP and NAP. These settings are not applicable to LE Test packets.

Upper Address Part (UAP)

The upper address part of the Bluetooth address is 8 bits long. By default, all the bits are set to 0x00. Use the UAP field to set the appropriate hexadecimal value.

Lower Address Part (LAP)

The lower address part of the Bluetooth address is 24 bits long. By default, all the bits are set to 0x800000. Use the LAP field to set the appropriate hexadecimal value.

Non Significant Address Part (NAP)

The non-significant address part of the Bluetooth address is 16 bits long. By default, all the bits are set to 0x0000. Use the NAP field to set the appropriate hexadecimal value.

cdma2000

Use this to produce a waveform that simulates cdma2000 (3GPP2). The modulation scheme is defined in 3GPP2 specification C.S0002-C.

Touch the ▶ button, and configure cdma2000 generation using the following screens:

RF Settings

Modulation

Channel settings

Filter

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for cdma2000.
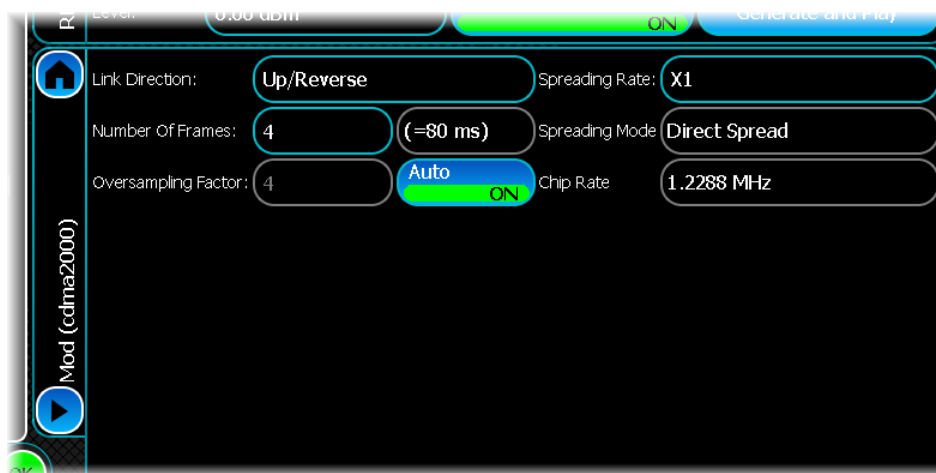
Link Direction

Use this to select forward or reverse link direction.

Number of Frames

Edit this to change the number of frames to generate. The length of the resulting waveform is shown in brackets.

Oversampling Factor

To oversample by an amount different to the default value of 4, disable the Auto button, then enter the required oversampling factor.

Spreading Rate

Use this to select the required spreading rate, x1 or x3. This selection affects the type and number of radio configurations that are available.

Spreading Mode

Fixed at Direct Spread

Chip Rate

This displays the chip rate, which is 1.2288 MHz when the spreading rate is x1 and 3.6864 MHz when the spreading rate is x3.

Channel settings

Use this screen to configure the cdma2000 link.
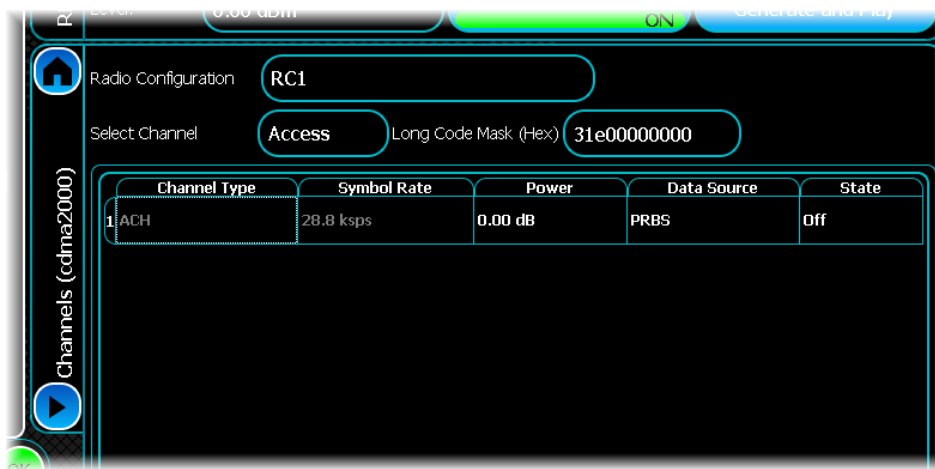
Radio Configuration

There are nine radio configurations available.

For Link Direction Up/Reverse, radio configurations 1 to 4 are allowed if the spreading rate is x1, and radio configurations 5 to 6 are allowed with a spreading rate of x3.

For Link Direction Down/Forward, radio configurations 1 to 5 are allowed if the spreading rate is x1, and radio configurations 6 to 9 are allowed with a spreading rate of x3.

When you select a radio configuration, the types of channel available are presented in the channel table.

Now set up a reverse link or a forward link.

Creating a reverse link

Once you have set the radio configuration, define the reverse channel(s) for that configuration.

Radio configurations RC1 and RC2

If you have selected either radio configuration 1 or 2 you are able to define either an Access or Traffic channel.

Select Channel

Use this to select the type of channel. The settings are the same for RC1 and RC2

An Access channel presents these settings:

A Traffic channel presents these settings:
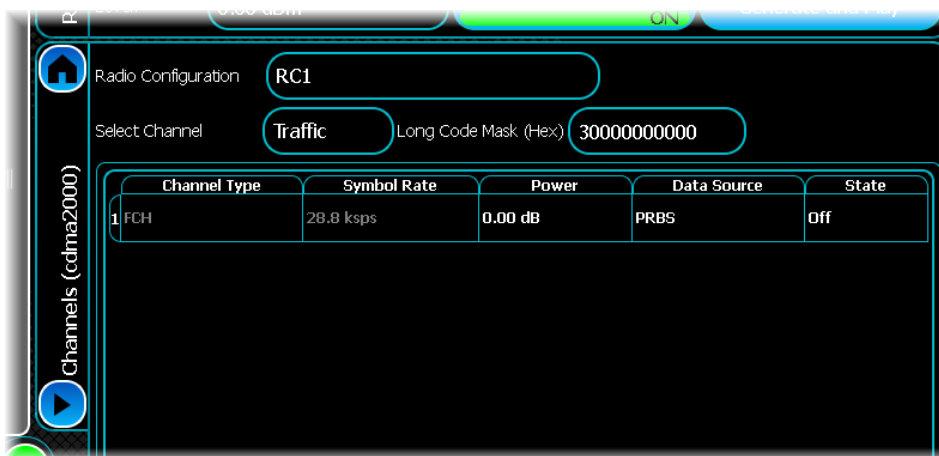
Long Code Mask

The long code mask is used to scramble the data. It is a hex number that defines 42 bits. The default value for the access channel is 31E00000000; for the forward channel it is 30000000000.

Channel Properties

Modify the properties of the channel by touching any of the editable cells in the table. The channel type and symbol rate properties are not editable, and are shown as gray characters.

Power

This controls the level of the specific channel. The range is 0 to -60 dB. The default is 0 dB.

Data Source

This shows the type of data used by the data channel. Valid data types are All Zeroes, All Ones, PRBS, User Data and Repeating Pattern. To configure the data source that is used, touch the table cell. The default is a PN9 sequence.

State

This controls whether the channel is transmitted or not. When this is Off, the data channel is not transmitted. The default is Off.

Radio configurations RC3 and RC4

If you have selected radio configuration 3 or 4 you are able to define an Enhanced Access, Common Control or Traffic channel only.

Select Channel

Use this to select the type of channel. The settings are the same for RC3 and RC4.

An Enhanced Access channel presents these settings:
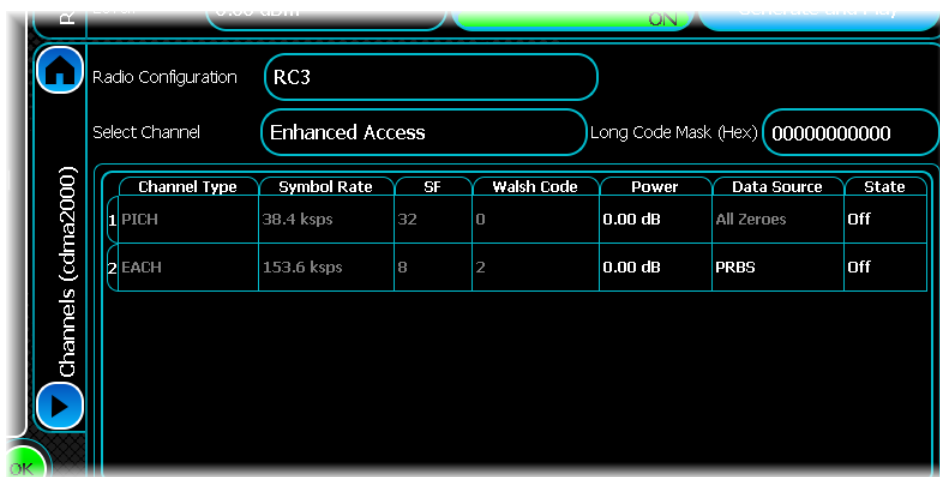
Common Control and Traffic channels present these settings:
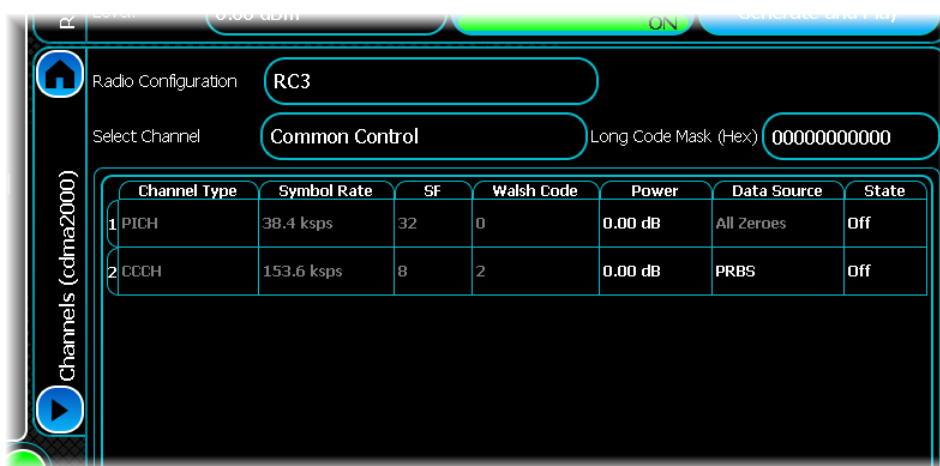
Long Code Mask

The long code mask is used to scramble the data. It is a hex number that defines 42 bits.

Configuring the Enhanced Access Channel

The enhanced access channel consists of a pilot channel (PICH) and the enhanced access channel (EACH).

Set the channel state, power level and data source as described previously for each of the channels. Note that the data source for the pilot channel is PRBS. Edit a channel by touching the cell of interest.

You are able to change the data source and power level. The Walsh Code and symbol rate are fixed and are not editable, shown with a gray text. The power level is limited to the range of 0 to –60 dB.

Configuring the Common Control Channel

The common control channel consists of a pilot channel (PICH) and the common control channel (CCCH). Set the channel state, power level and data source as described previously for each of the channels. The data source for the pilot channel is fixed to zeros. Edit any parameters of interest by touching the parameter you wish to modify.

Configuring the Traffic Channel

The traffic channel consists of a pilot channel (PICH), dedicated control channel (DCCH), fundamental channel (FCH), and supplemental channels 1 and 2 (SCH1 and SCH2).

Set the channel state, power level and data source as described previously for each of the channels. For the SCH1 and SCH2 channels you are also able to set the spreading factor, Walsh code and symbol rate. The Walsh code changes to 1 if you set a spreading factor of 2. SCH1 and SCH2 support different data rates and can have different Walsh codes. The data source for the pilot channel is fixed to zeros. As with the other described channels, you can edit any parameters of interest by touching the parameter you wish to modify.

In addition to the power and data source parameters, you are able to set the symbol rate and spreading factor. The Walsh code changes to 1 if you set a spreading factor of 2. The relationships between symbol rate, spreading factor and Walsh code are given in Appendix A.

Note that SCH1 and SCH2 support different data rates and can have different Walsh codes.

Radio configurations 5 and 6 (RC5 and RC6)

You are able to select radio configurations 5 and 6 only if the spreading rate is set to x3. Define an Enhanced Access, Common Control or Traffic channel. Select the type of channel using the Select Channel field. The settings are the same for RC5 and RC6. The method of defining and editing the channels is the same as that described for RC3 and RC4. The relationships between symbol rate, spreading factor and Walsh code are given in Appendix A.

Generating a waveform

Once you have set up the reverse channel as required, generate the waveform.

Creating a forward link

Once you have set the radio configuration, define the forward channel(s) for that configuration.

Radio configurations RC1 and RC2

Selecting either radio configuration 1 or 2 displays the link configuration setup shown here. From here, you are able to set the Pilot PN Offset and configure the forward channels. The Pilot PN Offset is used to set the offset of the scrambling codes. Typically, each base station is assigned its own offset. Valid values are 0 to 511.

Channel Properties

Modify the properties of the channel by touching any of the editable cells in the table. Parameters that are not editable are shown in gray.

The default table shows the Pilot (PICH) and Sync (SYNCH) channels. In general, you would want to turn these channels on. To do this, touch the appropriate State cell and select On.

The spreading factor (SF), Walsh code and symbol rate are fixed for the PICH and SYNCH channels. You can set the relative power level for both channels and the data source type for the SYNCH channel. Set the power level by touching the appropriate Power cell. Then enter a value between 0 and –60 dB. To select a data source, touch the appropriate Data Source cell. You are then presented with the standard data source dialog, from which you can select the data source required.

Symbol Rate

This is the symbol rate used for the particular channel. This is not editable for PICH, SYNC, PCH and QPCH. As traffic channels are split into sub channels, symbol rate is not applicable.

Spreading Factor

This is the spreading factor for the specified channel. This is derived from the symbol rate of the channel and is for display purposes only.

Walsh Code

This specifies the Walsh code of the given channel. The valid range is 0 to 63. For PICH and SYNC channels, this value not editable. The default value is 0.

Power

This changes the relative power of the channel within the signal. The allowed range is -60 dB to 0 dB. The default value is 0 dB.

Data Source

This shows the type of data used by the data channel. Valid data types are All Zeroes, All Ones, PRBS, User Data and Repeating Pattern. To configure the data source that is used, touch the table cell. The default is a PN9 sequence.

For PICH channels, the data source is fixed to All Zeroes.

State

This defines whether the channel is transmitted, and lets you add, edit and remove channel parameters. All default channels are turned off.

To edit any of the parameters; you can touch any of the items within the table.

For traffic channels, select the specific channel by touching the required channel row. On doing so, the Edit… button at the bottom of the screen is enabled. To edit the specific channel, touch the Edit… button, which presents the dialog shown below. Use this dialog to modify all the properties described above for the component channels within the traffic channel.

	Channel Type	Symbol Rate	SF	Walsh Code	Power	Data Source	State
1	FCH	19.2 ksps	64	0	0.00	PRBS	Off
2	SCCH1	19.2 ksps	64	0	0.00	PRBS	Off
3	SCCH2	19.2 ksps	64	0	0.00	PRBS	Off
4	SCCH3	19.2 ksps	64	0	0.00	PRBS	Off
5	SCCH4	19.2 ksps	64	0	0.00	PRBS	Off
6	SCCH5	19.2 ksps	64	0	0.00	PRBS	Off
7	SCCH6	19.2 ksps	64	0	0.00	PRBS	Off
8	SCCH7	19.2 ksps	64	0	0.00	PRBS	Off

Add channel

Add more channels by pressing the Add... button, which presents the Add Channel dialog box shown below. From here, you can add all the channels supported in RC1 and 2. Remove channels by selecting the channel in the table and pressing the Remove button.

The default Add Channel dialog shows the settings for adding a traffic channel. For radio configurations 1 and 2, a traffic channel can consist of one fundamental channel and up to seven supplemental channels. In all cases, the spreading factor is fixed at 64.

You are able to set the channel state, Walsh code, power level and data source type for each of the allowed channels within a traffic channel. Do this by selecting the channel of interest and touching the parameter cell as described to set the channel's state. You can set the Walsh code, power level and data source type. Note that you are unable to define long code masks, as the SGD currently does not support this in the forward link. The State field selects the state of the traffic channel, and lets you turn off a traffic channel without having to turn off channels within the traffic channel.

The Walsh code for a channel is entered into the Walsh Code field. Allowed values are 0 to 63. Note that if you choose a code that is either already in use or that is not orthogonal to another that is in use, the channels that are in conflict with each other are highlighted in red, as shown below. This warning appears only when the channel is turned on.

To add channels other than a traffic channel, touch Select Channel Type. The available channels are: BCCH, CACH, CCCH, PCH and QPCH. For the BCCH, CACH and CCCH channels you are presented with the Add Channel dialog. The parameters, and how to change them, are again straightforward. With these channels, you are able to change the symbol rate. For the PCH and QPCH channels the symbol rate is fixed and cannot be changed.

In all cases the SGD limits the number of channels that you can add. The number of available Walsh codes limits the number of traffic channels.

Remove channel

Remove a channel by selecting the channel in the table (touch the number at the far left of the row) and touch the Remove button.

Radio configurations RC3, RC4 and RC5

Selecting radio configuration 3, 4 or 5 displays the link configuration setup shown here. Use this to set the Pilot PN Offset, the Quasi-Orthogonal set, and configure the forward channels. The Pilot PN Offset is used to set the offset of the scrambling codes. Typically, each base station is assigned its own offset. Valid values are 0 to 511. The Quasi-Orthogonal set defines the Walsh Rotation bits and QOF values that are used to modify the Walsh code. Valid values are 0 to 3.

The default channel table shows the Pilot (PICH) and Sync (SYNCH) channels. In general, you would want to turn these on. The channel state and other parameters that can be changed within the table are altered as described earlier.

To add a channel press the Add… button, which displays the Add Channel dialog. The default channel is the traffic channel. For RC3, RC4 and RC5 the traffic channel consists of up to two SCHs, a DCCH and a FCH. You can edit and alter parameters as for RC1 and RC2.

To add another type of channel, touch the Select Channel Type field. The available channels are: BCCH, CACH, CCCH, PCH and QPCH. Set these channels up in the same way as for RC1 and RC2.

Generating a waveform

Once you have set up the forward channel, select the filter tab to set the channel filter. For the forward link you would generally select cdma2000 filter. Then generate the waveform.

FSK

Use this to produce a generic FSK waveform.

Touch the ▶ button, and configure FSK generation using the following screens:

RF Settings

Modulation

Filter

Data Source

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for FSK.

Modulation Type

Select the modulation required from the drop-down list of FSK modulation types.

Number of Symbols

Set the number of symbols occupied by the burst.

Symbol Rate

Set the symbol rate for the signal to be created.

Oversampling Factor

Normally, leave the Oversampling Factor Auto button On, so that the factor is adjusted automatically for the filter you choose.

Frequency Shifts

Set the required frequency shifts to represent the 0, 1 symbols (2FSK) or 00, 01, 10, 11 symbols (4FSK).

GSM/EDGE

The GSM/EDGE modulation facility lets you produce a waveform that simulates a GSM/EDGE signal as per the following GSM/EDGE specifications, based on the GMSK and 8PSK modulation.

3GPP TS 45.001: "Physical layer on the radio path; General description".

3GPP TS 45.002: "Multiplexing and multiple access on the radio path".

3GPP TS 45.003: "Channel coding".

3GPP TS 45.004: "Modulation".

3GPP TS 45.010: "Radio subsystem synchronization".

3GPP TS 45.060: "Radio Link Control/Medium Access Control (RLC/MAC) protocol".

The EDGE modulation facility lets you produce a waveform that simulates an Enhanced Data for GSM Evolution cellular mobile phone TDMA signal. You can generate test signals with EDGE bursts in any slot.

Touch the ▶ button, and configure GSM/EDGE generation using the following screens:

RF Settings
Modulation
Frame Config
Filter
Markers
IQ Impairments
Graphics

Modulation

Use this screen to set general modulation parameters for GSM/EDGE.
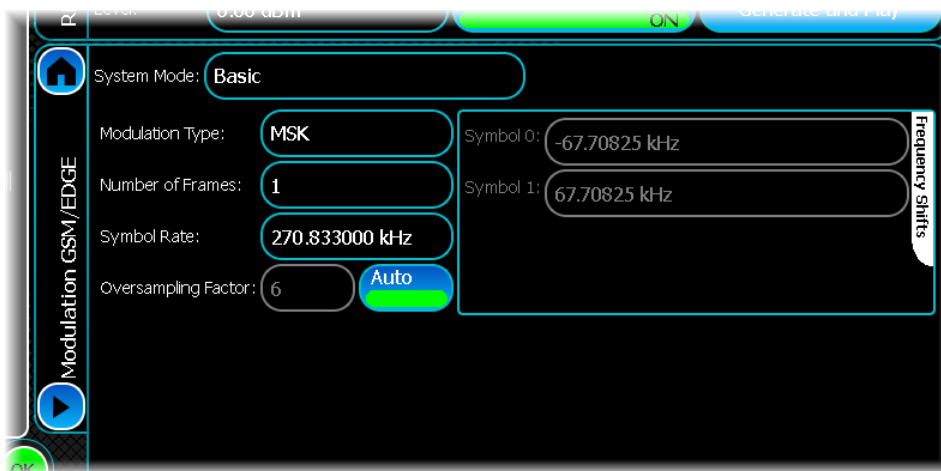
GSM/EDGE supports two modes of operation:

Basic mode lets you configure a basic signal, and allows basic slot information to be created.

Advanced mode lets signals be created that can be used by devices for receiver and more complex BER testing. The default mode for GSM/EDGE is Basic, but you can change this mode in the System Mode field.

When advanced mode is selected, the main modulation page change to reflect the new system mode:
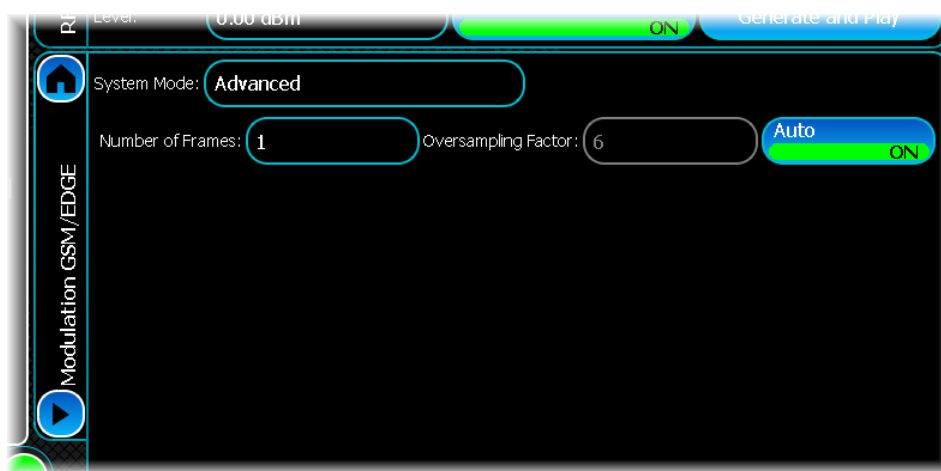
The modulation tab provides the same properties for Number of Frames and Oversampling Factor as in Basic mode.

Frame configuration (basic)

In Basic mode you can select the modulation type, set the number of frames you want to generate, adjust the symbol rate, and change the oversampling factor. All these items are set to their nominal settings for GSM on initial entry of the modulation screen (MSK modulation, one frame, 270.8333333 kHz symbol rate, and six times oversampling). In general, when using a combination of EDGE and GSM slots, it is not possible to guarantee a correct phase wrap, because the modulation type has to change between GSM and EDGE bursts. Therefore, the default number of frames is not set to eight, as it is for EDGE-only modulation.

Basic frame configuration lets you modify the GSM frame being generated. You are presented with the TDMA configuration screen shown below. This consists of eight time slots, each of which can be modified by touching the relevant item in the slot graphic.
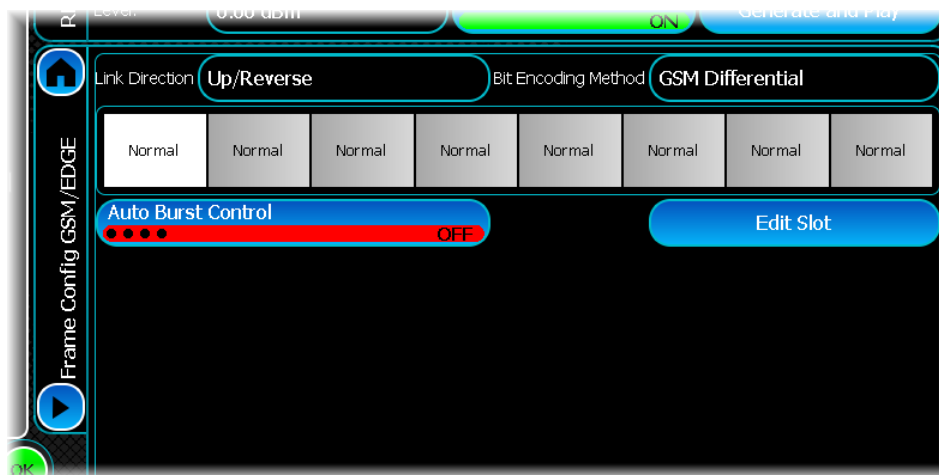
Link Direction

use this to select an uplink frame or a downlink frame. This selection determines the type of burst that can be inserted into the frame: the default in both cases is a normal burst.

Bit Encoding Method

Use this to set the bit encoding method. By default, the encoding is set to GSM Differential, and you can change it to None.

Auto Burst Control

Enabling this option causes marker 1 to be defined automatically, based upon the slots that you have turned on or off.

This figure shows the marker that is automatically defined when automatic burst control is enabled.
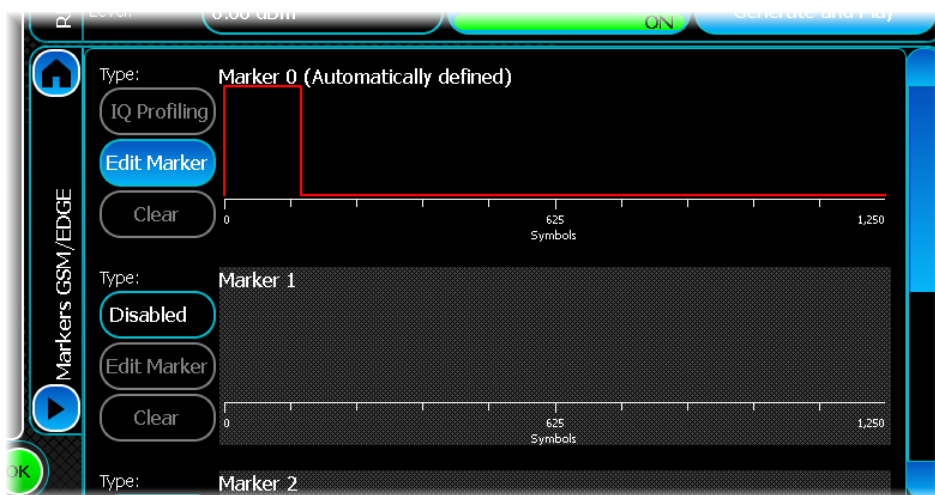
Edit Slot

Touch this button to take you to a new screen, where you edit the uplink or downlink slot.

Configuring an uplink slot

On this Frame Config tab, you can examine the fields that make up the slot, you can change the contents of the Sync and Data fields, and you can set the burst type to be Normal, Access or Edge. The Slot Enabled button allows you control if the specific slot is transmitted or not. By default, only the first slot is transmitted.
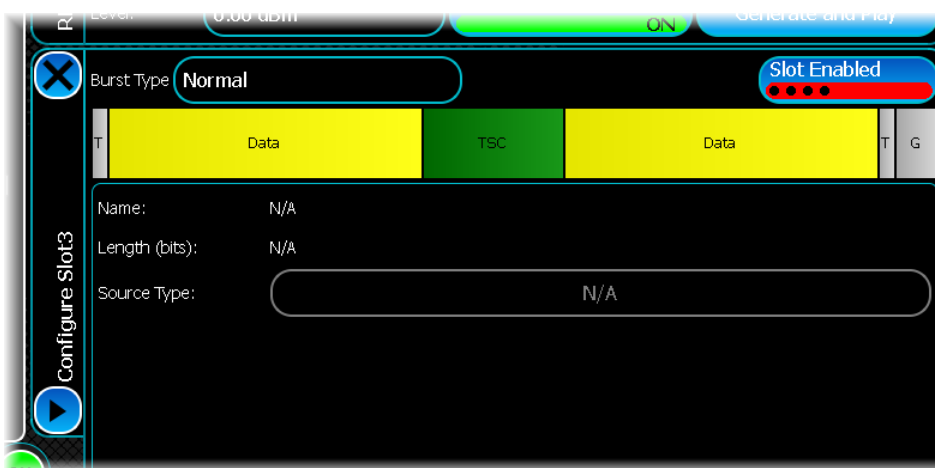
There are two data fields in a normal burst, both 58 bits long, which are treated as a contiguous block of data. The data source you select for either of these is automatically applied to the other, and, if you choose a PRBS sequence, the data at the start of the second field continues in the sequence from where the first field finished. These two fields combined therefore generate 116 data bits of the PRBS sequence, which restarts after the total number of frames you set on the modulation screen. If you want a sequence longer than 116 bits, increase the number of frames, since the PRBS sequence is continued for every frame in the set. For example, to generate a sequence of at least 5,000 bits, set the number of frames to 44, which will provide a sequence that repeats after 44 x 116 bits = 5,104 bits. The data source can be modified by touching the data portion of the slot graphic, and then selecting the data source button below.

An EDGE burst looks very similar to a normal GSM burst, except that every field has three times as many bits. The burst occupies the same number of symbols as a GSM burst, because the 8PSK modulation uses three bits per symbol.

You can change the training sequence field of a normal burst to any of the eight patterns TS0 to TS7 by selecting the sync portion of the slot graphic and then using the TSC control below. An access burst has a fixed sync field and only one data field of 36 bits.

Configuring a downlink slot

You can change to a downlink frame by selecting Down/Forward on the Link Direction control. To configure a slot within the downlink frame, touch the slot within the main slot graphic. This figure shows a frequency correction burst in a downlink frame.
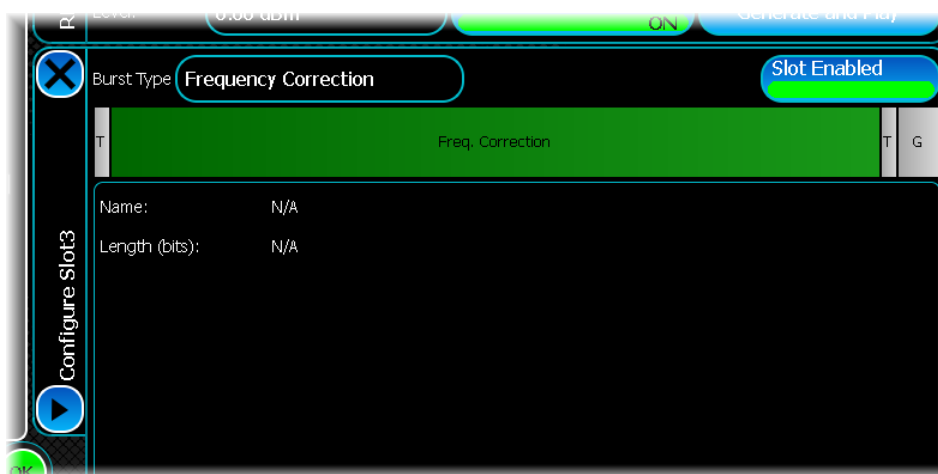
The burst types available for downlink slots are Dummy, Frequency Correction, Normal, Sync and Edge. You have two choices for the frequency correction: the fixed bits can be set to represent either +67.7 kHz or -67.7 kHz. This can be changed by selecting the Freq. Correction portion of the graphic and selecting the Correction control below. The guard period is either long or normal, depending on the slot number, the same as uplink bursts.

A dummy burst has no user options, a synchronization burst has two data fields that you can configure, and a normal burst has two data fields and a training sequence field with options.

Frame configuration (advanced)

In the advanced mode of GSM/EDGE modulation, a single carrier frequency signal can be generated with the following characteristics:

Slot 0 always configured as BCCH carrier.

Slot 1 to slot 7 configured to carry TCH/SACCH, PDTCH or Dummy burst.

You can generate the test signals for GSM/GPRS/EDGE.

The following properties can be configured:

- Network Color Code

- Base Color Code

- Channel Type

- Data Type

- Training Sequence

- Power Control Level (PCL)

- Fast Power Control (FPC)

- Modulation and Coding Scheme (MCS)

- MAC Header

- Data Source

Multiframes, superframes and hyperframes

The longest recurrent time period of the structure is called a hyperframe and has a duration of 3h 28mn 53s 760ms. The TDMA frames are numbered modulo this hyperframe (TDMA frame number, or FN, from 0 to 2,715,647). A hyperframe is subdivided into 2048 superframes, which have a duration of 6.12 seconds. The superframe is the least common multiple of the time frame structures. The superframe is itself subdivided into multiframes.

The following multiframes are supported by GSM/EDGE modulation in the advanced mode of operation:

- 51 multiframe (26 per superframe) with duration of 235.4 ms (3060/13 ms), comprising 51 TDMA frames. This multiframe is used to carry BCCH, CCCH.
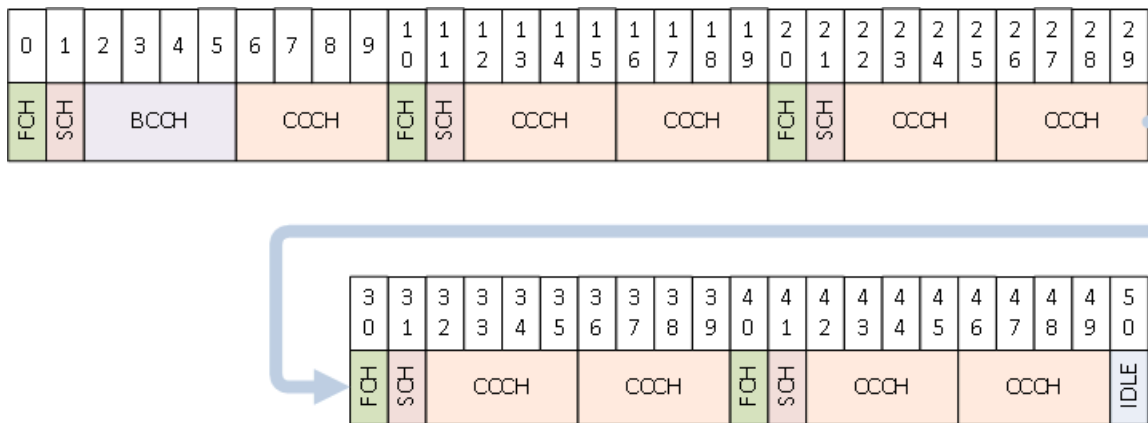
- 26 multiframe (51 per superframe) with duration of 120 ms, comprising 26 TDMA frames. This multiframe is used to carry TCH (and SACCH/T).
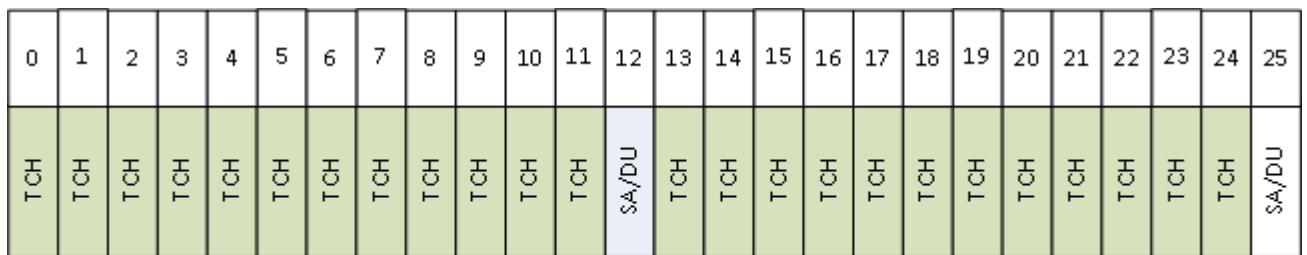
SA/DU- SACCH or Dummy burst (IDLE)

• 52 multiframe (25.5 per superframe) with duration of 240 ms, comprising 52 TDMA frames. This multiframe is used to carry PDTCH.

DU- Dummy burst (IDLE) sent instead of PTCCH
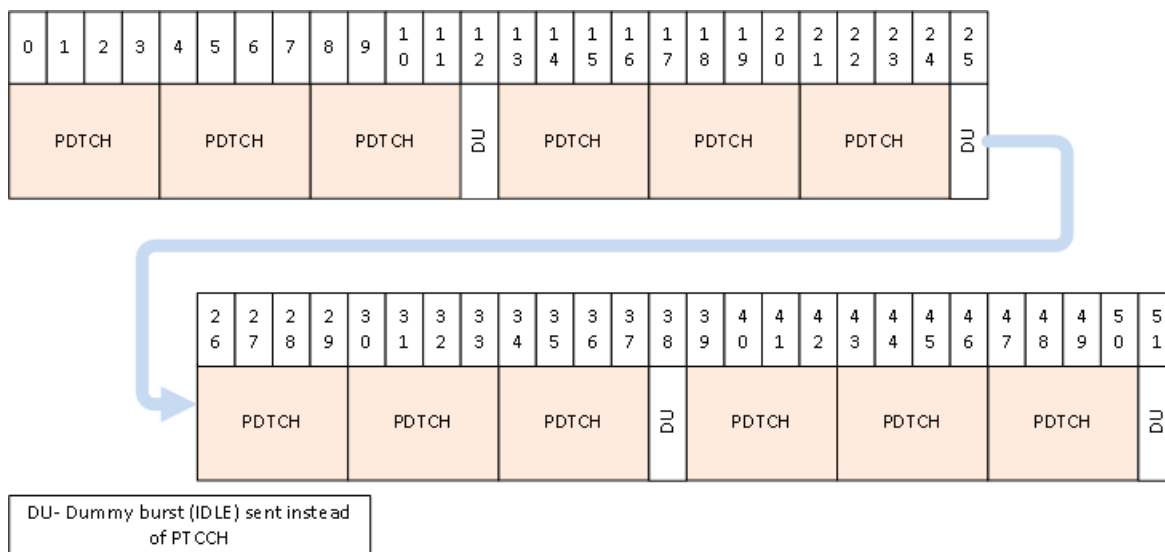
Logical channels

The following logical channels are supported by GSM/EDGE modulation in advanced mode of operation:

1. Frequency correction channels (FCCH). The frequency correction channel carries information for frequency correction of the mobile station.

2. Synchronization channel (SCH). The synchronization channel carries information for frame synchronization of the mobile station and identification of a base transceiver station.

3. Broadcast control channel (BCCH). The broadcast control channel broadcasts general information on a base transceiver station per base transceiver station basis. The contents of the BCCH channel are internally configured by GSM/EDGE Modulation.

4. Common control channel (CCCH). Intended to carry common control signaling in circuit-switched mode. The contents of the CCCH channel are internally configured by GSM/EDGE Modulation.

5. Full rate traffic channel (TCH/F). Intended to carry either encoded speech or user data in circuit switched mode.

6. Full rate packet data traffic channel (PDTCH/F). Intended to carry user data in packet switched mode.

7. Slow Associated Control Channel (SACCH/M). Provides a relatively slow signaling connection and is associated with traffic channel TCH/F. The contents of the SACCH channel are internally configured by GSM/EDGE Modulation.

The channels listed above are not exposed for configuration and are configured by the GSM/EDGE modulation based on the user settings. For example, slot 0 always carries all the BCCH information required for synchronization. The SCH Frame Numbers are internally calculated based on the number of frames to be generated and always start from 1.

For all the modulation schemes, the stealing flags as per the following table are inserted before burst mapping:

Modulation and coding scheme	Stealing flags for 4 bursts in radio block
CS-1	1 1 1 1 1 1 1 1
CS-2	1 1 0 0 1 0 0 0
CS-3	0 0 1 0 0 0 0 1

CS-4	0 0 0 1 0 1 1 0
MCS-1 to MCS-4	0 0 0 1 0 1 1 0
MCS-5, MCS-6	0 0 0 0 0 0 0 0
MCS-7 to MCS-9	1 1 1 0 0 1 1 1

This figure shows the resulting burst in the radio block after burst mapping (bit swapping is not shown in the figure):

(n) - Number of Symbols
GP – Guard Period
MH – Coded MAC Header
SF – Stealing Flags
TB – Tail Bits
TSC – Training Sequence
USF – Coded Uplink Status Flag
Note: Data bits are uncoded

Creating an advanced frame

When Advanced mode is selected on the Modulation screen, the screen below is displayed to configure an advanced GSM frame.
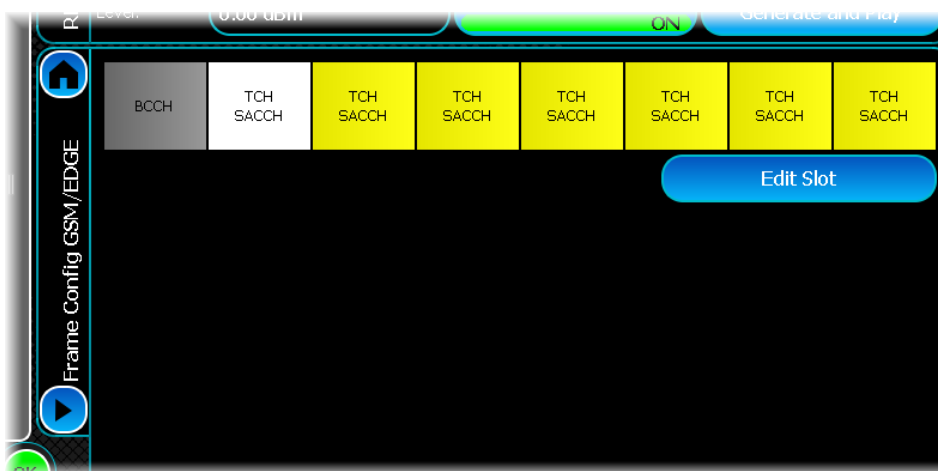
The following channel types are supported per slot.

1.   BCCH. Slot 0 is set as BCCH carrier and carries all the information required for synchronization with the DUT in non-signaling mode of operation.

2.   TCH/SACCH. This channel type can be set for slot 1 to slot 7. All the slots carry channel-coded user data for transmission. When this channel type is selected for a slot, you can further configure the mode of operation as speech or data.

3.   PDTCH. This channel type can be set for slot 1 to slot 7. This channel type lets you transmit PDTCH data. When this channel type is selected, you can configure the RLC/MAC Header based on the Modulation and Coding scheme.

The channel type can be set by selecting the appropriate value in the Channel Type box for the slot under configuration.

By default, the parameters for BCCH are displayed, allowing you to configure both the Base Color Code, and the Network Color code. The first slot within the frame is fixed to BCCH and cannot be changed. However, any of the other slots may be edited by touching the slot graphic.

This figure shows the screen that is displayed when the second slot, (a TCH-SACCH slot) is edited.

Channel Type

Use this to modify the type of channel that is present on the given slot. By default, all configurable channels are set to TCH/SACCH mode: however the following slot types are available: TCH/SACCH, PDTCH and Dummy.

Configuring a TCH/SACCH slot

The controls that become available when the Edit Slot button is pressed are as follows.

PCL

This field is enabled only if TCH/SACCH channel type is selected for transmission. The Power Control Level is 5-bit field in the SACCH message. This means that a value ranging from 0 (high power) to 31 (low power) can be set.

The PCL commands the power level to be used by the mobile station.

Training Sequence

This is the standard training sequence. The training sequence is used as a timing reference and for equalization. There are total of eight different bit sequences that may be used, each 26 symbols long.

TSC0 to TSC7 can be selected and applies to the whole slot under configuration. The default is TS0

FPC

This field is enabled only if TCH/SACCH channel type is selected for transmission. The fast power control is a 1-bit field in the SACCH message.

The PCL field indicates whether fast measurement reporting and power control mechanism is used. A disabled FPC button results in the FPC bit being set to 0 in the SACCH message, indicating that FPC is not in use.

By default, the FPC button is enabled, which results in the FPC bit being set to 1 in the SACCH message.

Class Bits

This controls the data payload of the class bits. When the Channel Bits type is set to Speech, two buttons are displayed, for Class 1 Bits and for Class 2 bits. When the Channel Bits type is set to Loop C, there is a single data payload button representing the data to be transmitted on this channel.

Configuring a PDTCH slot

The channel organization for packet data channels uses the 52-frame multiframe. Four TDMA slots constitute a radio block. It is basically a sequence of four normal bursts carrying one RLC/MAC protocol data unit.

The figure shows the radio blocks in a 52-frame multiframe:
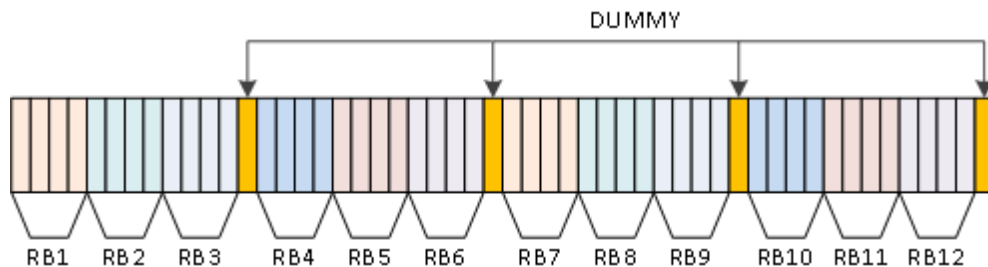
For PDTCH, the data is not coded before mapping to the bursts. The data source configured for generation terminates every radio block and restarts. This allows the data to wrap around if a multiple of 52 frames is used.

When the Channel Type of a given slot is changed to PDTCH; the main configuration area changes to that shown here:
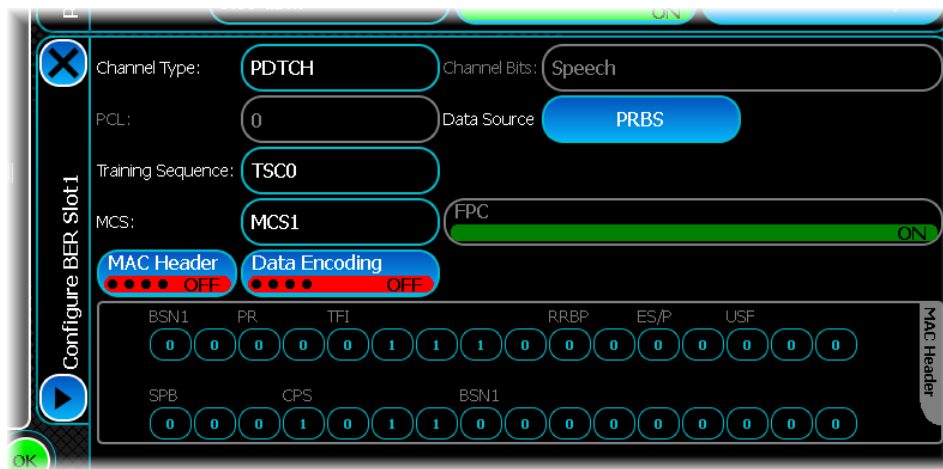
This channel type presents similar controls to those described in the TCH/SACCH channel configuration above, but also provides additional controls for MCS and MAC Header.

MCS

GSM/EDGE modulation supports GPRS and EGPRS DL modulation and coding schemes.

Four different coding schemes, CS-1 to CS-4, are defined for the GPRS radio blocks carrying RLC data blocks:

Packet service	Channel type	MCS type	Modulation type
GPRS	PDTCH	CS-1 to CS-4	GMSK
EGPRS	PDTCH	MCS-1 to MCS-4	GMSK
	PDTCH	MCS-5 to MCS-9	8PSK

The modulation and coding scheme can be set by selecting the appropriate value in the MCS box. The selected value of MCS changes the configuration of the MAC header.

RLC/MAC block

A RLC/MAC block is the protocol data unit exchanged between RLC/MAC entities. A RLC/MAC header block is the part of an RLC/MAC block carrying a control message between RLC/MAC entities.

A RLC data block is the part of a RLC/MAC block carrying user data or signaling data received from an upper layer.

RLC/MAC Header

This button sets whether the RLC/MAC header is included and coded for transmission.

There are only certain valid combinations of RLC/MAC header and data encoding that are allowed by the advanced mode of GSM/EDGE modulation. These are shown in this table:

Valid combinations for RLC/MAC Header field and Data Encoding field

Modulation and coding scheme	RLC/MAC Header button	Data Encoding button	Comments
CS-1 to CS-4 MCS-1 to MCS-4	On	On	Both the header and data are coded before transmission.
	Off	Off	The data is directly mapped to the burst without coding for transmission. The header bits are not used at all.
MCS-5 to MCS-9	On	On	Both the header and data are coded before transmission.
	Off	Off	The data is directly mapped to the burst without coding for transmission. The header bits are not used at all.
	On	Off)	The header is coded and data without coding is mapped to the bursts in the radio block for transmission.

Data Encoding

This button sets whether the data is coded for transmission.

There are only certain valid combinations of RLC/MAC Header and Data Encoding that are allowed by the advanced mode of GSM/EDGE Modulation. These are shown in the table above.

RLC/MAC header

The RLC/Mac header contains control information about the RLC/MAC block. Depending upon the MCS selected, an applicable RLC/MAC header is displayed. You are able to configure the parameters of the RLC/MAC header.

The format of RLC/MAC headers for various MCS are as follows:

For MCS-1, MCS-2, MCS-3 and MCS-4, Header type 3 as per 3GPP TS 44.060 is used. Total header size is 31 bits.

Header type 3 (MCS-1, MCS-2, MCS-3 and MCS-4)

Bit								
8	7	6	5	4	3	2	1	Octet
TFI	RRBP		ES/P		USF			1
BSN1		PR		TFI				2
BSN1								3
	SPB		CPS			BSN1		4

For MCS-5 and MCS-6, Header type 2 as per 3GPP TS 44.060 is used. Total header size is 28 bits.

Header type 2 (MCS-5 and MCS-6)

Bit								Octet
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Octet**
TFI	RRBP		ES/P		USF			1
BSN1		PR		TFI				2
BSN1								3
				CPS			BSN1	4

For MCS-7, MCS-8 and MCS-9, Header type 1 per 3GPP TS 44.060 is used. Total header size is 40 bits.

Header type 1 (MCS-5 and MCS-6)

Bit								Octet
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**Octet**
TFI	RRBP		ES/P		USF			1
BSN1		PR		TFI				2
BSN1								3
BSN2							BSN1	4
CPS				BSN2				5

For CS-1 to CS-4, only USF bits are applicable.

USF bits

Bit		
3	**2**	**1**
USF		

The Advanced mode of GSM/EDGE generation modulation does not implement all the RLC/MAC header-related functionality except for the CPS field, which affects the way the coding and puncturing scheme used for the RLC/MAC data block in case the data encoding is set. It lets you set the values within the valid range.

All the RLC/MAC header fields can be set by touching each bit in the MAC header field. The RLC/MAC header settings are constant across all the RLC/MAC header data blocks for a configured slot.

Uplink state flag (USF) field

The USF field is sent in all downlink RLC/MAC blocks and indicates the owner or use of the next uplink radio block on the same timeslot (3GPP TS 45.002). The USF field is three bits in length and eight different USF values can be assigned.

EGPRS Supplementary/Polling (ES/P) field

The ES/P field is used to indicate whether the RRBP field is valid or not valid, and what fields the next uplink control block shall contain. For more information, refer to 3GPP TS 44.060.

Relative Reserved Block Period (RRBP) field

The RRBP value specifies a single uplink block in which the mobile station shall transmit either a PACKET CONTROL ACKNOWLEDGEMENT message or a PACCH block to the network. For more information, refer to 3GPP TS 44.060.

Temporary Flow Identity (TFI) field

The TFI identifies the Temporary Block Flow (TBF) to which the RLC data block belongs. It is 5 bits in length. For more information, refer to 3GPP TS 44.060.

Power Reduction (PR) field

The Power Reduction (PR) field indicates the power level reduction of the current RLC block. If downlink power control is not used, the MS ignores the PR field.

PR field

bit 8 7	Power reduction
0 0	0 dB (included) to 3 dB (excluded) less than BCCH level - P0
0 1	3 dB (included) to 7 dB (excluded) less than BCCH level - P0
1 0	7 dB (included) to 10 dB (included) less than BCCH level - P0
1 1	Not usable

Block Sequence Number (BSN) field

The Block Sequence Number (BSN) field carries the sequence absolute Block Sequence Number (BSN) modulo Sequence Number Space (SNS) (2048 in EGPRS) of each RLC data block within the TBF. In EGPRS, the BSN is 11 bits in length and is encoded as a binary number with range 0 to 2047.

If two to four RLC data blocks are sent within a RLC/MAC block, BSN2 to BSN4 are relative to BSN1, provided the difference between the second to fourth block number and the first block modulo SNS is less than Window Size (WS).

For more information, refer to 3GPP TS 44.060.

Coding and Puncturing Scheme indicator field (CPS)

The Coding and Puncturing Scheme indicator field indicates the kind of channel coding and puncturing used for data blocks.

Refer to the tables below for possible CPS field values. For more information, refer to 3GPP TS 44.060.

Header type 1 CPS bit fields

Bits 54321	CPS
00000	(MCS-9/P1 ; MCS-9/P1)
00001	(MCS-9/P1 ; MCS-9/P2)
00010	(MCS-9/P1 ; MCS-9/P3)
00100	(MCS-9/P2 ; MCS-9/P1)
00101	(MCS-9/P2 ; MCS-9/P2)
00110	(MCS-9/P2 ; MCS-9/P3)
01000	(MCS-9/P3 ; MCS-9/P1)
01001	(MCS-9/P3 ; MCS-9/P2)
01010	(MCS-9/P3 ; MCS-9/P3)
01011	(MCS-8/P1 ; MCS-8/P1)
01100	(MCS-8/P1 ; MCS-8/P2)
01101	(MCS-8/P1 ; MCS-8/P3)
01110	(MCS-8/P2 ; MCS-8/P1)
01111	(MCS-8/P2 ; MCS-8/P2)
10000	(MCS-8/P2 ; MCS-8/P3)
10001	(MCS-8/P3 ; MCS-8/P1)
10010	(MCS-8/P3 ; MCS-8/P2)
10011	(MCS-8/P3 ; MCS-8/P3)
10100	(MCS-7/P1 ; MCS-7/P1)
10101	(MCS-7/P1 ; MCS-7/P2)
10110	(MCS-7/P1 ; MCS-7/P3)
10111	(MCS-7/P2 ; MCS-7/P1)
11000	(MCS-7/P2 ; MCS-7/P2)
11001	(MCS-7/P2 ; MCS-7/P3)
11010	(MCS-7/P3 ; MCS-7/P1)
11011	(MCS-7/P3 ; MCS-7/P2)
11100	(MCS-7/P3 ; MCS-7/P3)
Note: the bit numbering is relative to the field position.	

Header type 2 CPS bit fields

Bits 321	CPS
000	MCS-6/P1
001	MCS-6/P2
100	MCS-5/P1
101	MCS-5/P2
Note: the bit numbering is relative to the field position.	

Header type 3 CPS bit fields

Bits 4321	CPS
0000	MCS-4/P1
0001	MCS-4/P2
0010	MCS-4/P3
0011	MCS-3/P1
0100	MCS-3/P2
0101	MCS-3/P3
1001	MCS-2/P1
1010	MCS-2/P2
1011	MCS-1/P1
1100	MCS-1/P2

Split Block indicator field (SPB)

The Split Block indicator is only used in header type 3 to indicate if some user data is retransmitted using two-block re-segmentation. For more information, refer to 3GPP TS 44.060.

MAC Header Configuration

The MAC Header box allows you to modify the individual portions of the header transmitted as part of the PDTCH channel.

You can either modify individual bits by touching the particular box you wish to toggle, as shown below:
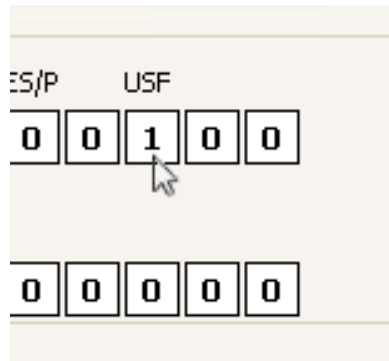
Alternatively, you can edit the values by touching the particular field you wish to edit and typing either 1 or 0; this will fill the field from right to left with the bits you type. Note that the values you type do not carry over from one field to the next.

Setting the filter

The filter has standard GSM filtering as default — Gaussian filter and BT of 0.3. You can change these values to create a non-standard GSM signal.

LR-WPAN

Use this to produce a waveform that simulates a LR-WPAN modulation conforming to IEEE IEEE 802.15.4.

Touch the ▶ button, and configure LR-WPAN generation using the following screens:

RF Settings

Modulation

Frame Control

Filter

Data Source

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for LR-WPAN.
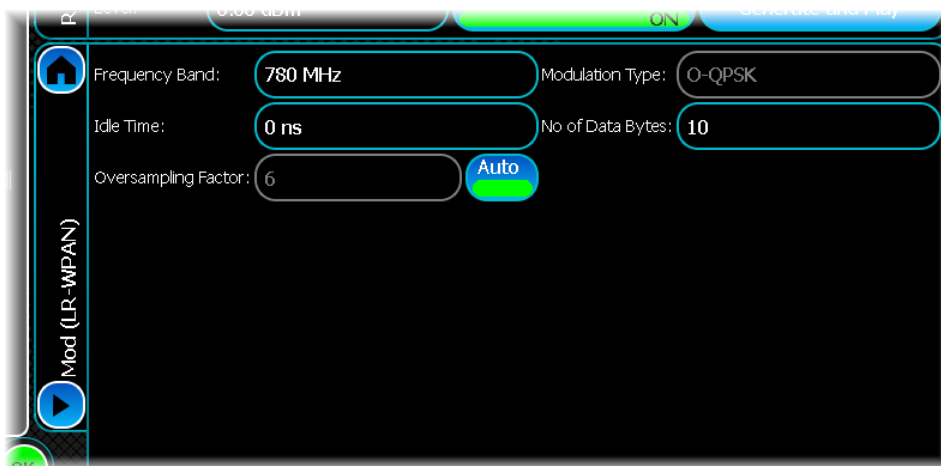
This section describes the general settings available for LR-WPAN and how you can modify them. The figure above shows the default settings that appear when you open the LR-WPAN modulation screen. The following parameters can be set:

Frequency Band

Use this to select the frequency band of the signal you require.

Idle Time

Edit this box to set the length of the idle period between PPDU packets. The value is in microseconds (µs).

Oversampling Factor

To oversample by a different amount to the default value of 4, disable auto mode by touching the Auto button, and enter the oversampling factor of your choice.

Modulation Type

Edit this box to select the modulation type to be used for the LR-WPAN signals. The choice of modulation type is restricted by the Frequency Band configured for use.

No of Data Bytes

Edit this box to set the payload bytes of the SDU to be generated.

Frame control

Use this screen to configure the frame and MAC header for LR-WPAN.
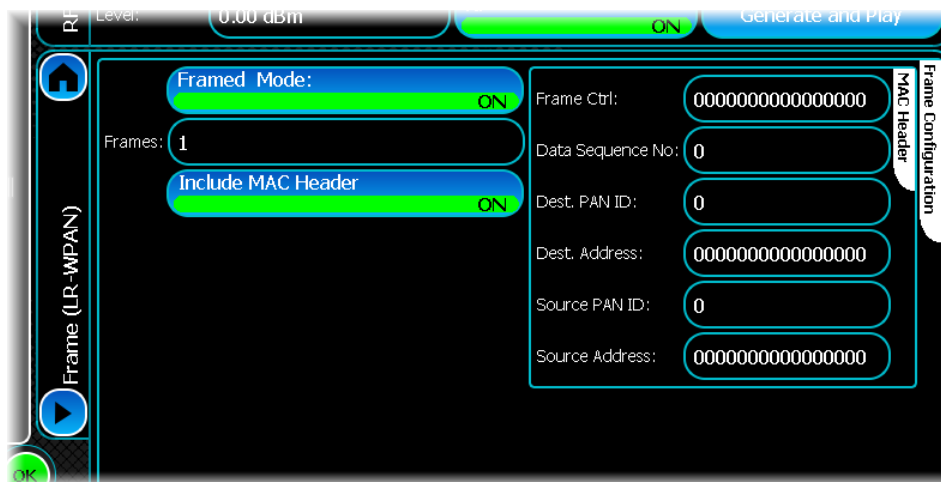
Setting the Frame Control parameters

Framed Mode

When Off, only the data part is transmitted. The MAC header and MAC FCS are not transmitted, and their respective controls become non-selectable.

Frames

This sets the number of times the PPDU and Idle Period pair is repeated in a file. The data is contiguous throughout the frames. Note that for a PRBS data source, the data is not repeated throughout the frames.

Include MAC Header

When Off, prefixes a MAC header with user-set fields to the data in the SDU. If this button is off, the MAC Header options become non-selectable.

Setting the MAC Header parameters

Frame Ctrl

Use this to set the frame control (decimal notation) in the MAC header of the frame to be generated. The frame control field is 16 bits in length and contains information defining the frame type, addressing control fields, and other control flags.

Data Sequence No.

Use this to set the Sequence Number (decimal notation) in the MAC header of the frame to be generated. The sequence number field is 8 bits in length and specifies a unique sequence identifier for the frame.

Dest. PAN ID

Use this to set the destination PAN identifier (decimal notation) in the MAC header of the frame to be generated. The destination PAN identifier field is 16 bits in length and specifies the unique PAN identifier of the intended recipient of the frame. A value of 65535 in this field represents the broadcast PAN identifier, which is accepted as a valid PAN identifier by all devices currently listening to the channel.

Dest. Address

Use this to set the destination address (decimal notation) in the MAC header of the frame to be generated. The destination address field is 64 bits in length, and specifies the address of the intended recipient of the frame.

Source PAN ID

Use this to set the source PAN identifier (decimal notation) in the MAC header of the frame to be generated. The source PAN identifier field is 16 bits in length and specifies the unique PAN identifier of the originator of the frame.

Source Address

Use this to set the source address (decimal notation) in the MAC header of the frame to be generated. The source address field is 64 bits in length, and specifies the address of the originator of the frame.

LTE FDD

Use this to produce a waveform that simulates a 3GPP Long Term Evolution (LTE) carrier. The modulation scheme is defined in 3GPP specifications TS 36.211 and TS 36.212.

Touch the ▶ button, and configure LTE-FDD generation using the following screens:

[RF Settings](#)

[Modulation](#)

[Uplink Channel Settings](#)

[Downlink Channel Settings](#)

[Frame Structure Settings](#)

[Filter](#)

[Markers](#)

[IQ Impairments](#)

[Graphics](#)

Modulation

Use this screen to set general modulation parameters for LTE-FDD.

Link Direction

Use this to specify the link direction of the signal being generated.

Channel Bandwidth

Use this to specify the system bandwidth of the LTE signal. Valid values are 3 MHz, 5 MHz, 10 MHz and 20 MHz. The default value is 20 MHz.

Oversampling Factor

Use this to define the oversampling factor to be used in the simulation. When the Auto button is active, the oversampling rate is adjusted automatically.

Number of Frames

Use this to specify the number of radio frames to be generated. The valid range is 1 to 8. The default value is 1.

Cell ID

Use this to define the physical layer cell identity. The range is 0 to 503. The default value is 0.

CP Type

This read-only value specifies the cyclic prefix type of the signal being generated.

Windowing parameters

Time domain windowing is not mandatory in the LTE standard. The window function is employed to reduce out-of-band spectrum emissions.

Time Domain Windowing

Use this to define whether the time domain windowing function is applied to the simulation. If this button is On, windowing is employed. The default is On.

Transition Time

This is the time interval of the time domain windowing. By default, it is set to 0 ns. Increasing the transition time increase the spectrum roll-off at the cost of a decreased delay spread tolerance. Note that in order to prevent rounding/truncation of the overlap samples, it is advisable to enter values multiples of 100 ns. The transition time range is 0 to 4600 ns.

Uplink channel settings

Use this screen to configure general uplink parameters for LTE-FDD.

RNTI

This specifies the radio network temporary identifier of the uplink signal. The range is 0 to 65535. The default value is 100.

Generation Mode

Use this to specify whether the uplink portion of the frame contains traffic data or a PRACH signal.

If the generation mode is set to PRACH, all traffic tabs are disabled. If the generation mode is set to Traffic, the PRACH tab is disabled.

PRACH configuration

Touch the tab (generation mode set to PRACH) to define how the PRACH channel is transmitted.

Configuration Index

The valid range is 0 to 57. The default value is 0. The configuration indexes used in LTE FDD are specified in Table 5.7.1-2 of 3GPP TS 36.211 V8.9.0 (2009-12).

Format

This is a read-only parameter that shows the current PRACH format. The PRACH format is dependent on the PRACH configuration index.

Root Sequence number

The root sequence can take any value from 0 to 837. The default value is 0. This corresponds to the logical root sequence number that is used to determine the physical root sequence numbers used in PRACH generation. See tables 5.7.2-4 and 5.7.2-5 of 3GPP TS 36.211 V8.9.0 (2009-12).

Cyclic Shift Configuration

The valid range is 0 to 15. The default value is 0. This corresponds to the N_{CS} configuration specified in tables 5.7.2-2, and 5.7.2-3 of 3GPP TS 36.211 V8.9.0 (2009-12).

Preamble Index

The default range is 0 to 63. The default value is 0. This is used to configure which of the possible 64 preambles are transited on the PRACH.

Mask Index

Use this to specify which of the possible transmission opportunities is used to transmit the PRACH. The value must be greater than 0. The default value is 0.

High Speed

This button specifies whether the cyclic shifts are taken from the restricted set, or the unrestricted set. When High Speed is set On, the unrestricted set of cyclic shifts is used; otherwise the restricted set is used.

Frequency Offset

This is the frequency offset that is applied to the PRACH. It is specified in terms of resource blocks. This value must be 6 RBs less than the total system bandwidth.

This table displays the maximum number of resource blocks that are available. This parameter is calculated based on the system bandwidth, and is updated automatically when the system bandwidth is altered.

Relationship between system bandwidth and number of RBs

System bandwidth BWChannel [MHz]	1.4	3	5	10	15	20
Number of resource blocks	6	15	25	50	75	100

Doppler Offset

This is a doppler offset that is applied to the PRACH. The valid range of values is 0 to 1340 Hz.

PUSCH configuration

Touch the tab to define how the PUSCH channel is transmitted.

N1 DMRS

This specifies the cell-specific DMRS cyclic shift. This can take a value of 0, 2, 3, 4, 6, 8, 9,10. The default is 0.

Delta Sequence Shift

This configures the Delta Shift sequence used when performing group hopping. The valid range is 0 to 29. The default value is 0.

Sub Frame Hopping

This parameter specifies whether the hopping is Inter Subframe, or Intra and Inter Subframe.

Number of Sub Bands

This specifies the number of sub bands used in PUSCH Hopping. Valid values are 0, 1, 2, 3 or 4. The default value is 0.

Hopping Offset

This is the hopping offset used in PUSCH hopping. The valid range is 0 to 98. The default value is 0.

HARQ Offset

The HARQ offset is used to determine the $\beta_{offset}^{HARQ-ACK}$ parameter (see 3GPP TS 36.213 V8.8.0 (2009-09)). The valid range is 0 to 14. The default value is 0.

Auto Calculate DAI

This button specifies the whether the downlink assignment index should be automatically calculated or not.

Data Source

This specifies the data payload of the PUSCH channel. Touch this control to show a standard data source configuration window that lets you configure what the output data will be. The available options are All Ones, All Zeroes, PRBS, Random Bits, Repeating Pattern or a User data pattern file.

PUCCH configuration

Touch the tab to define how the PUCCH channel is transmitted.

N1

This parameter is used to configure the PUCCH resource used for PUCCH format 1a/1b. The valid range is 0 to 2037. The default value is 0.

N1SRI

This is used to configure the PUCCH resource used for PUCCH format 1. The valid range is 0 to 2047. The default value is 0.

N2

This parameter is used to configure the PUCCH resource used for PUCCH format 2/2a/2b. The valid range is 0 to 1185. The default value is 0.

N2 Resource Blocks

This parameter is used to configure the CQI resource used for PUCCH format 2/2a/2b. The valid range is 0 to 98. The default value is 0.

Number of Cyclic Shifts

This defines the number of cyclic shifts used for PUCCH formats 1/1a/1b in a resource block with a mix of formats 1/1a/1b and 2/2a/2b. Valid values are 0 to 7 in integer steps. The default value is 0.

Delta Shift

This can be set to 0, 1, 2 or 3. The default value is 0.

SR Configuration Index

The valid range is 0 to 154. The default value is 0.

Simultaneous Ack, Nack and SRS

This button is used to enable the simultaneous transmission of ACK/NACK on the PUCCH channel.

Transmit Scheduling Request

This enables the transmission of a scheduling request to be enabled/ disabled. When the button is On the scheduling request is transmitted, otherwise it is not.

Auto Calculate Format

When this button is On, the PUCCH format is calculated automatically. When the button is Off the PUCCH format has to be specified for every subframe that carries PUCCH information.

DMRS configuration

Touch the tab to define configuration parameters specific to the DMRS portion of the uplink signal.

Group Hopping

This button enables/disables DMRS group hopping.

Sequence Hopping

This button enables/disables DMRS sequence hopping.

SRS configuration

Touch the tab to define configuration parameters specific to the SRS portion of the uplink signal.

State

This disables/enables the transmission of the SRS signal. When the button is Off, the SRS signal is not transmitted in any subframes.

Sub Frame Configuration

This configures the SRS subframe configuration specified in Table 5.5.3.3-1 of 3GPP TS 36.211 V8.9.0 (2009-12). This can be set to any value from 0 to 15.

Configuration Index

This sets the SRS configuration index I_{SRS}, which is used to determine SRS periodicity and SRS subframe offset. For LTE FDD the SRS periodicity and SRS subframe offset are determined using Table 8.2-1 of 3GPP TS 36.213 V8.8.0 (2009-09). The SRS configuration index can take any value from 0 to 13.

Cyclic Shift

This sets the SRS cyclic shift parameter n_{SRS}^{CS} that is used to generate the SRS sequence. This parameter must be in the range 0 to 7.

Transmission Comb

This sets the transmission comb parameter k_{TC}, which is used in mapping the SRS onto physical resources. The transmission comb parameter can be set to a value of 1 or 0.

Cell Specific B/W Config

This sets the cell-specific B/W parameter C_{SRS}, which maps the SRS onto physical resources. This parameter can take any value from 0 to 7.

U/E Specific B/W

This sets the UE-specific B/W parameter B_{SRS}, which maps the SRS onto physical resources. This parameter can take any value from 0 to 3.

Frequency Domain Position

This configures the frequency domain position value n_{RRC}. This is used in mapping the SRS onto physical resources. This value must be in the range 0 to 23.

Hopping Bandwidth

This sets the hopping bandwidth parameter b_{hop}. This parameter can take any value from 0 to 3.

HARQ configuration
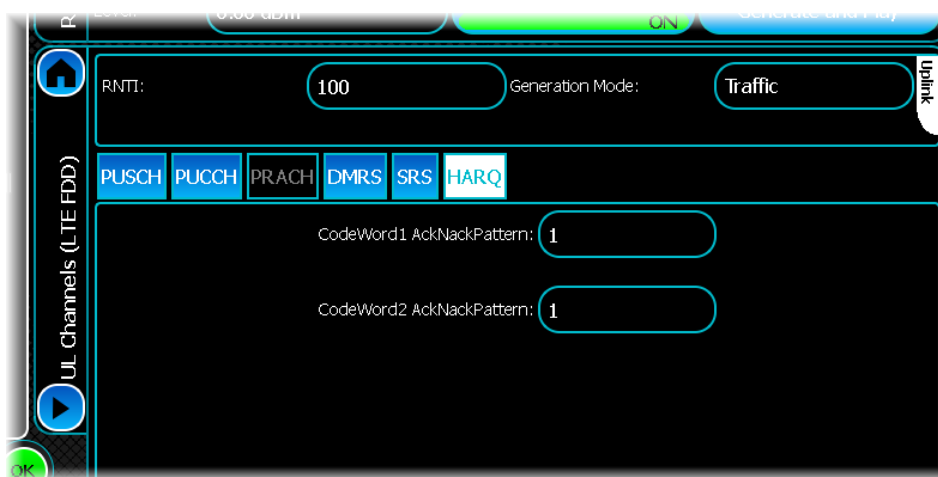
CodeWord1 AckNackPattern

Use this to specify the pattern of Ack/Nack bits used within the HARQ codeword 1. Enter 1 for on, 0 for off, or D for DTX.

Codeword2AckNackPattern

Use this to specify the pattern of Ack/Nack bits used within the HARQ codeword 2. Enter 1 for on, 0 for off, or D for DTX.

Downlink channel settings

Use this screen to configure general downlink parameters for LTE-FDD.

It consists of two parts; the downlink configuration portion and the downlink channel configuration table portion.

Downlink Configuration

Antennas

This specifies how many antennas are used in the signals. Valid values are 1 or 2.

UE Category

This specifies the UE category, which is used to determine the channel coding that is applied to the PDSCH. The valid range is 1 to 5. The default value is 5.

PHICH duration

Valid values are normal and extended.

Ng

This specifies the Ng. Ng is used to control how many PHICH groups are present. Valid values are 1/6, 1/2, 1 or 2.

UE ID

The valid range is 0 to FFFF. The default value is 3d.

Downlink Channels

This table lets you edit the downlink channels present in the LTE FDD simulation.

Power

This defines the relative power of the channel. The valid range is – 60 to 30 dB. The default value is 0 dB.

State

This defines if the signal is present (On) or absent (Off). The default state is On.

Editing a channel

You can show more parameters for the downlink channel, by selecting the desired item from the table and touching the Edit… button underneath. This then provides the parameters specific to the channel selected.

PDCCH configuration

Show this screen by selecting the PDCCH channel in the channel table and touching the Edit… button.

There are two tabs: one that contains DL Grant-specific parameters...

... the other contains UL Grant-specific parameters.

DL Grant

PDCCH DL Grant State

Use this button to turn off the DL Grant. If this is On, the grant is transmitted; otherwise, it is not included in the signal. By default, this is On.

Format

The DL grant format is used to control the number of CCEs used to transmit the DL grant. Valid values are 0, 1, 2 or 3.

Search Space

The search space controls which CCEs are used to transmit the DL grant. The common search space contains CCEs that get read by every UE, whereas the UE Specific search space contains CCEs that are only guaranteed to be read by a specific UE. Valid values are UE Specific and Common.

UL Grant

UL Grant State

Use this button to turn off the UL Grant. If this is On, the grant is transmitted; otherwise, it is not included in the signal. By default, this is On.

Search Space

The search space controls which CCEs are used to transmit the UL grant. The common search space contains CCEs that get read by every UE, whereas the UE Specific search space contains CCEs that are only guaranteed to be read by a specific UE. Valid values are UE Specific and Common.

DMRS Cycle Shift

This is used to control the DMRS cyclic shift used on the uplink transmission that is scheduled by the UL grant. The valid range is 0 to 7. The default value is 0.

CQI Request

This sends a CQI request on the UL grant. Valid values are 0 and 1.

TPC Pattern

This specifies the UL grant TPC pattern that is transmitted on the UL grant. It can accept a sequence of numbers including 0, 1, 2 or 3.

Format

The UL grant format is used to control the number of CCEs used to transmit the UL grant. Valid values are 0, 1, 2 or 3.

MCS

The MCS transmitted specifies the modulation and channel coding that should be applied to the uplink transmission that is scheduled by the UL grant. The valid range is 0 to 28. The default value is 0.

RB Start

This specifies the starting resource block to be used by the uplink transmission that is scheduled by the UL grant. Valid values are 0 to 99.

RB Length

This specifies the number of resources blocks to be used by the uplink transmission that is scheduled by the UL grant. Valid values are 0 to 99.

Hopping Flag

This button specifies whether the hopping flag is set in the UL grant. If this button is On, hopping is set to 1; otherwise it is set to 0. The default is Off.

PDSCH configuration

Show this screen by selecting the PDSCH channel in the channel table and touching the Edit… button.

PDSCH State

Use this button to turn off PDSCH. By default, this is on.

Transmission Mode

The transmission mode specifies how the signal is transmitted. The transmission mode can be Single Port (SISO), Tx Diversity (MIMO), Closed Loop (MIMO) or Open Loop (MIMO).

Starting Resource Block

This specifies the starting resource block to use in the PDSCH transmission. This control is only valid if the resource allocation type is set to Type 2. The starting RB + the RB length cannot exceed the total system bandwidth. The number of resource blocks available for specific bandwidths is shown in the table.

Rank

This control is only valid in Closed Loop transmission mode. Valid values are 0, 1 or 2.

Codeword1 DataSource

This specifies the payload data of the Codeword 1 part of the signal. If the transmission mode is close loop or open loop then two code words may be transmitted; otherwise only a signal code word is transmitted. Touch this button to display the standard data source configuration screen that lets you configure the output data. Available options are All Ones, All Zeroes, PRBS, Random Bits, Repeating Pattern or a User data pattern file.

Codebook Index

This control is only valid in Closed Loop transmission mode. Valid values are 0, 1 or 2.

Resource Allocation Type

The resource allocation type can be:

- Type 0: controlled by a resource allocation bit mask

- Type 2: controlled by starting resource block

- Full: allocates all possible RBs so the signal occupies the maximum bandwidth.

Resource Block Allocation Length

This specifies the number of resource blocks to use in the PDSCH transmission. This control is only valid if the resource allocation type is set to Type 2. The starting RB + the RB length cannot exceed the total system bandwidth. The number of resource blocks available for specific bandwidths is shown in the table.

Codeword 2 Data Source

This specifies the payload data of the Codeword 2 part of the signal. If the transmission mode is close loop or open loop then two code words may be transmitted; otherwise only a signal code word is transmitted. Touch this button to display the standard data source configuration screen that lets you configure the output data. Available options are All Ones, All Zeroes, PRBS, Random Bits, Repeating Pattern or a User data pattern file.

Resource Allocation Bit Mask

This is only available if the resource allocation type is set to Type 0. It accepts a hexadecimal value. Each bit in the bit mask corresponds to a set of resource blocks. If the bit is set, the corresponding set of resource blocks is transmitted; otherwise it is not.

PHICH configuration

Show this screen by selecting the PHICH channel in the channel table and touching the Edit… button.

PHICH State

Use this button to turn off the PHICH within the signal. If this button is On, the PHICH channel is transmitted, otherwise, it is not included in the signal. By default, this is On.

ACK/NACK Pattern

Use this to set a binary bit pattern. This pattern configures the ACK/NACK bits that are transmitted. The ACK/NACK bits are transmitted at a rate of 1 bit per downlink subframe. If the number of downlink subframes is greater than the length of the ACK/NACK pattern, the ACK/NACK pattern is repeated.

PBCH configuration

Show this screen by selecting the PBCH channel in the channel table and touching the Edit… button.

PBCH State

Use this button to turn off the PBCH within the signal. If this button is On, the PBCH channel is transmitted, otherwise, it is not included in the signal. By default, this is On.

Transmit SFN

This specifies whether the subframe number is broadcast as part of the PBCH channel. If this button is On, the SFN is transmitted. The default is Off.

Data Source

This specifies the payload data of the PBCH channel. Touch this button to display the standard data source configuration screen that lets you configure the output data. Available options are All Ones, All Zeroes, PRBS, Random Bits, Repeating Pattern or a User data pattern file.

Frame structure settings

Use this screen to control parameters that change on a subframe basis for LTE-FDD.

At the top is the subframe graphical control that provides a graphical representation of all the subframes within the signal. Touching a specific subframe lets you configure the settings that correspond to that subframe. The parameters that can be configured for each subframe differ depending whether the signal is uplink or downlink.

Configure Frame

Touch this button after selecting the frame you wish to configure.

Downlink subframe parameters

The following parameters are available for any downlink subframe being configured. These are available if the link direction is set to Downlink.

CFI

This specifies the control frame indicator (CFI) of this subframe. The CFI controls how many OFDM symbols are used to transmit control information. This can be set to 1, 2 or 3. The default value is 0.

CodeWord1 MCS Index

This specifies the codeword1 MCS index for this subframe. The MCS index defines the modulation and coding scheme used to transmit data on the PDSCH. In a SISO system, or a MIMO system that uses TX diversity, only one code word is transmitted. In open loop or closed loop MIMO two code words may be transmitted. The valid range is 0 to 28. The default value is 0.

CodeWord2 MCS Index

This specifies the codeword2 MCS index for this subframe. The valid range is 0 to 28. The default value is 0. Codeword2 is only used when open loop or closed loop MIMO is employed.

Uplink subframe parameters

The following are parameters that are available for any uplink subframe being configured. These are available if the link direction is set to Uplink.

Channel Type

This specifies the type of channel that is transmitted within this subframe. Valid values are PUSCH, PUCCH or DTX.

Modulation Type

When the channel type is set to PUSCH, this specifies the modulation type. Valid values are QPSK, 16QAM and 64QAM. When the modulation mode for the PUSCH channel is user-defined this property is settable. If the modulation mode is MCS Index, the property is read-only (and is derived from the MCS index).

N2 DMRS

When the channel type is set to PUSCH this specifies the N2 DMRS value ($n_{DMRS}^{(2)}$). This value controls the DMRS cyclic shift applied when transmitting a DMRS signal for PUSCH. The valid range is between 0 and 10. The default value is 0.

Hopping Bits

This control is available only when the channel type is set to PUSCH. The number of hopping bits is used in conjunction with hopping type to control the type of hopping that is applied, as shown in the table. This can be set to 0 (default),1, 2 or 3.

Relationship between hopping type and hopping bits
(Table 8.4-2 of 3GPP TS 36.213 V8.8.0 (2009-09))

System BW N_{RB}^{UL}	Number of hopping bits	Information in hopping bits	$\tilde{n}_{PRB}(i)$
6 − 49	1	0	$\left(\left\lfloor N_{RB}^{PUSCH}/2 \right\rfloor + \tilde{n}_{PRB}^{S1}(i)\right) \bmod N_{RB}^{PUSCH}$
		1	Type 2 PUSCH hopping
50 − 110	2	00	$\left(\left\lfloor N_{RB}^{PUSCH}/4 \right\rfloor + \tilde{n}_{PRB}^{S1}(i)\right) \bmod N_{RB}^{PUSCH}$
		01	$\left(\left\lfloor N_{RB}^{PUSCH}/4 \right\rfloor + \tilde{n}_{PRB}^{S1}(i)\right) \bmod N_{RB}^{PUSCH}$
		10	$\left(\left\lfloor N_{RB}^{PUSCH}/2 \right\rfloor + \tilde{n}_{PRB}^{S1}(i)\right) \bmod N_{RB}^{PUSCH}$
		11	Type 2 PUSCH hopping

Number Of RBs

M_{RB}^{PUSCH}

This defines the number of PUSCH resource blocks that have been scheduled for transmission in the current subframe. This control is available only when the channel type is set to PUSCH. The value of this parameter should be set according to the following rules:

- It must also be a non-zero positive value and not be divisible by any prime number other than 2, 3 and 5. The staring RB + the number of RBs cannot exceed the total system bandwidth. The number of resource blocks available for specific bandwidths is shown in the table.

- When hopping is enabled, another level of restriction is imposed. In this case, M_{RB}^{PUSCH} cannot exceed the hopping bandwidth.

Current TxNB

This sets the transmission number of data being transmitted in the selected subframe. This control is available only when the channel type is set to PUSCH. Valid values are 0, 1, 2 or 3. The default value is 0.

Power

When the channel type is set to PUSCH or PUCCH this controls the relative power of this subframe within the simulation. The valid range is -1000 to 30 dB.

Hopping Type

This control is available only when the channel type is set to PUSCH. This is used in conjunction with the hopping bits to control the type of hopping that is applied. This control can be set to 0, 1 or 2. The default value is 0.

Starting RB

This defines the starting position of the virtual resource block. This control is available only when the channel type is set to PUSCH. The value of this parameter should be set following the rules below:

- If hopping is disabled, the sum of Starting Virtual RB and M_{RB}^{PUSCH} should not go beyond the bandwidth. The number of resource blocks available for specific bandwidths is shown in the table.

- If hopping is enabled, ensure that the Starting Virtual RB lies within the hopping bandwidth.

Code Rate

This control is available only when the channel type is set to PUSCH and the modulation mode is user- defined. Valid values are 1/6, 1/5, 1/3, 1/2 , 2/3 3/4 or 5/6. The default value is 1/3.

MCS Index

This control is available only when the channel type is set to PUSCH and the modulation mode is MCS Index. The valid range is 0 to 28.

Starting CCE

This specifies the starting CCE of the PDCCH transmission that corresponds to PUCCH being transmitted in the current subframe. This control is available only when the channel type is set to PUCCH. The valid range is 0 to 87. The default value is 0.

PUCCH Format

This control is available only when the channel type is set to PUCCH, and Auto Calculate PUCCH Format is set to false. The PUCCH format can be 1/1a/1b.

LTE TDD

Use this to produce a waveform that simulates a 3GPP Long Term Evolution (LTE) carrier. The modulation scheme is defined in 3GPP specifications TS 36.211 and TS 36.212.

Touch the button, and configure LTE-TDD generation using the following screens:

RF Settings

Modulation

Uplink Channel Settings

Downlink Channel Settings

Frame Structure Settings

Filter

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for LTE-TDD.
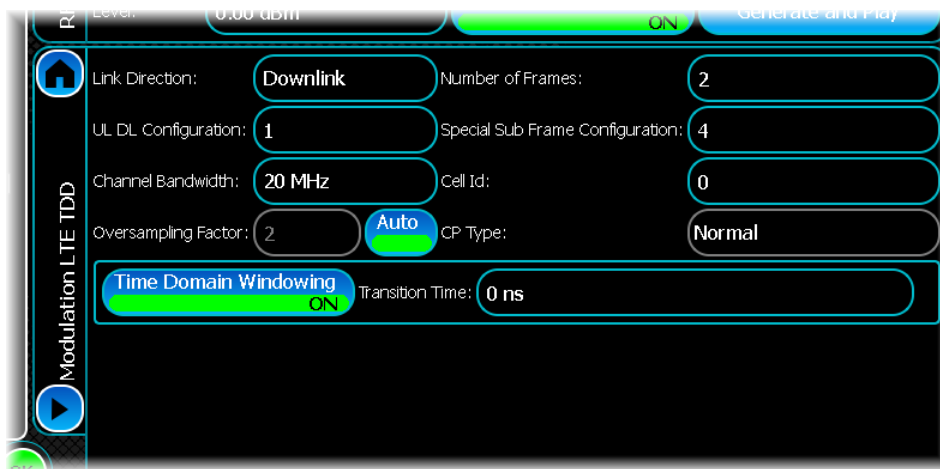
Link Direction

Use this to specify the link direction of the signal being generated.

UL DL Configuration

This specifies the UL–DL frame configuration, which controls the ratio of uplink/downlink subframes. The valid range is 0 to 6. The default value is 1.

Channel Bandwidth

Use this to specify the system bandwidth of the LTE signal. Valid values are 3 MHz, 5 MHz, 10 MHz and 20 MHz. The default value is 20 MHz.

Oversampling Factor

Use this to define the oversampling factor to be used in the simulation. When the Auto button is active, the oversampling rate is adjusted automatically.

Number of Frames

Use this to specify the number of LTE TDD frames to be generated. The valid range is 1 to 8. The default value is 1.

Special Subframe Configuration

This specifies the configuration index of special subframes generated within the LTE TDD signal. The configuration index controls the length of the DwPTS, GP and UpPTS. The range is 0 to 8. The default value is 4.

The table shows the possible special subframe configurations.

TDD uplink downlink configurations (Table 4.2-2 from 3GPP TS 36.211 V8.9.0 (2009-12))

Uplink-downlink configuration	Downlink-to-uplink switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 m s	D	S	U	U	U	D	S	U	U	U
1	5 m s	D	S	U	U	D	D	S	U	U	D
2	5 m s	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 m s	D	S	U	U	U	D	S	U	U	D

Cell ID

Use this to define the physical layer cell identity. The range is 0 to 503. The default value is 0.

CP Type

This read-only value specifies the cyclic prefix type of the signal being generated.

Windowing parameters

Time domain windowing is not mandatory in the LTE standard. The window function is employed to reduce out-of-band spectrum emissions.

Time Domain Windowing

Use this to define whether the time domain windowing function is applied to the simulation. If this button is On, windowing is employed. The default is On.

Transition Time

This is the time interval of the time domain windowing. By default, it is set to 0 ns. Increasing the transition time increase the spectrum roll-off at the cost of a decreased delay spread tolerance. Note that in order to prevent rounding/truncation of the overlap samples, it is advisable to enter values multiples of 100 ns. The transition time range is 0 to 4600 ns.

Uplink channel settings

Use this screen to configure general uplink parameters for LTE-TDD.

RNTI

This specifies the radio network temporary identifier of the uplink signal. The range is 0 to 65535. The default value is 100.

Generation Mode

Use this to specify whether the uplink portion of the frame contains traffic data or a PRACH signal.

If the generation mode is set to PRACH, all traffic tabs are disabled. If the generation mode is set to Traffic, the PRACH tab is disabled.

PRACH configuration

Touch the tab (generation mode set to PRACH) to define how the PRACH channel is transmitted.

Configuration Index

The valid range is 0 to 57. The default value is 0. The configuration indexes used in LTE TDD are specified in Table 5.7.1-3 of 3GPP TS 36.211 V8.9.0 (2009-12).

Format

This is a read-only parameter that shows the current PRACH format. The PRACH format is dependent on the PRACH configuration index.

Root Sequence number

The root sequence can take any value from 0 to 837. The default value is 0. This corresponds to the logical root sequence number that is used to determine the physical root sequence numbers used in PRACH generation. See tables 5.7.2-4 and 5.7.2-5 of 3GPP TS 36.211 V8.9.0 (2009-12).

Cyclic Shift Configuration

The valid range is 0 to 15. The default value is 0. This corresponds to the N_{CS} configuration specified in tables 5.7.2-2, and 5.7.2-3 of 3GPP TS 36.211 V8.9.0 (2009-12).

Preamble Index

The default range is 0 to 63. The default value is 0. This is used to configure which of the possible 64 preambles are transited on the PRACH.

Mask Index

Use this to specify which of the possible transmission opportunities is used to transmit the PRACH. The value must be greater than 0. The default value is 0.

High Speed

This button specifies whether the cyclic shifts are taken from the restricted set, or the unrestricted set. When High Speed is set On, the unrestricted set of cyclic shifts is used; otherwise the restricted set is used.

Frequency Offset

This is the frequency offset that is applied to the PRACH. It is specified in terms of resource blocks. This value must be 6 RBs less than the total system bandwidth.

This table displays the maximum number of resource blocks that are available. This parameter is calculated based on the system bandwidth, and is updated automatically when the system bandwidth is altered.

Relationship between system bandwidth and number of RBs

System bandwidth BWChannel [MHz]	1.4	3	5	10	15	20
Number of resource blocks	6	15	25	50	75	100

Doppler Offset

This is a frequency offset that is applied to the PRACH. The valid range of values is 0 to 1340 Hz.

PUSCH configuration

Touch the tab to define how the PUSCH channel is transmitted.

N1 DMRS

This specifies the cell-specific DMRS cyclic shift. This can take a value of 0, 2, 3, 4, 6, 8, 9,10. The default is 0.

Delta Sequence Shift

This configures the Delta Shift sequence used when performing group hopping. The valid range is 0 to 29. The default value is 0.

Subframe Hopping

This parameter specifies whether the hopping is Inter Subframe, or Intra and Inter Subframe.

Number of Sub Bands

This specifies the number of sub bands used in PUSCH Hopping. Valid values are 0, 1, 2, 3 or 4. The default value is 0.

Hopping Offset

This is the hopping offset used in PUSCH hopping. The valid range is 0 to 98. The default value is 0.

HARQ Offset

The HARQ offset is used to determine the $\beta_{offset}^{HARQ-ACK}$ parameter (see 3GPP TS 36.213 V8.8.0 (2009-09)). The valid range is 0 to 14. The default value is 0.

Auto Calculate DAI

This button specifies the whether the downlink assignment index should be automatically calculated or not.

Data Source

This specifies the data payload of the PUSCH channel. Touch this control to show a standard data source configuration window that lets you configure what the output data will be. The available options are All Ones, All Zeroes, PRBS, Random Bits, Repeating Pattern or a User data pattern file.

PUCCH configuration

Touch the tab to define how the PUCCH channel is transmitted.

N1

This parameter is used to configure the PUCCH resource used for PUCCH format 1a/1b. The valid range is 0 to 2037. The default value is 0.

N1SRI

This is used to configure the PUCCH resource used for PUCCH format 1. The valid range is 0 to 2047. The default value is 0.

N2

This parameter is used to configure the PUCCH resource used for PUCCH format 2/2a/2b. The valid range is 0 to 1185. The default value is 0.

N2 Resource Blocks

This parameter is used to configure the CQI resource used for PUCCH format 2/2a/2b. The valid range is 0 to 98. The default value is 0.

Number of Cyclic Shifts

This defines the number of cyclic shifts used for PUCCH formats 1/1a/1b in a resource block with a mix of formats 1/1a/1b and 2/2a/2b. Valid values are 0 to 7 in integer steps. The default value is 0.

Delta Shift

This can be set to 0, 1, 2 or 3. The default value is 0.

SR Configuration Index

The valid range is 0 to 154. The default value is 0.

Simultaneous Ack, Nack and SRS

This button is used to enable the simultaneous transmission of ACK/NACK on the PUCCH channel.

Transmit Scheduling Request

This enables the transmission of a scheduling request to be enabled/ disabled. When the button is On the scheduling request is transmitted, otherwise it is not.

Auto Calculate Format

When this button is On, the PUCCH format is calculated automatically. When the button is Off the PUCCH format has to be specified for every subframe that carries PUCCH information.

DMRS configuration

Touch the tab to define configuration parameters specific to the DMRS portion of the uplink signal.

Group Hopping

This button enables/disables DMRS group hopping.

Sequence Hopping

This button enables/disables DMRS sequence hopping.

SRS configuration

Touch the tab to define configuration parameters specific to the SRS portion of the uplink signal.

State

This disables/enables the transmission of the SRS signal. When the button is Off, the SRS signal is not transmitted in any subframes.

Sub Frame Configuration

This configures the SRS subframe configuration specified in Table 5.5.3.3-2 of 3GPP TS 36.211 V8.9.0 (2009-12). This can be set to any value from 0 to 13.

Configuration Index

This sets the SRS configuration index I_{SRS}, which is used to determine SRS periodicity and SRS subframe offset. For LTE TDD the SRS periodicity and SRS subframe offset are determined using Table 8.2-2 of 3GPP TS 36.213 V8.8.0 (2009-09). The SRS configuration index can take any value from 0 to 13.

Cyclic Shift

This sets the SRS cyclic shift parameter n_{SRS}^{CS} that is used to generate the SRS sequence. This parameter must be in the range 0 to 7.

Transmission Comb

This sets the transmission comb parameter k_{TC}, which is used in mapping the SRS onto physical resources. The transmission comb parameter can be set to a value of 1 or 0.

Cell Specific B/W Config

This sets the cell-specific B/W parameter C_{SRS}, which maps the SRS onto physical resources. This parameter can take any value from 0 to 7.

U/E Specific B/W

This sets the UE-specific B/W parameter B_{SRS}, which maps the SRS onto physical resources. This parameter can take any value from 0 to 3.

Frequency Domain Position

This configures the frequency domain position value n_{RRC}. This is used in mapping the SRS onto physical resources. This value must be in the range 0 to 23.

Hopping Bandwidth

This sets the hopping bandwidth parameter b_{hop}. This parameter can take any value from 0 to 3.

Max UpPts

This is used for configuring the use of the SRS in special subframes. This parameter can be set Off or On.

HARQ configuration
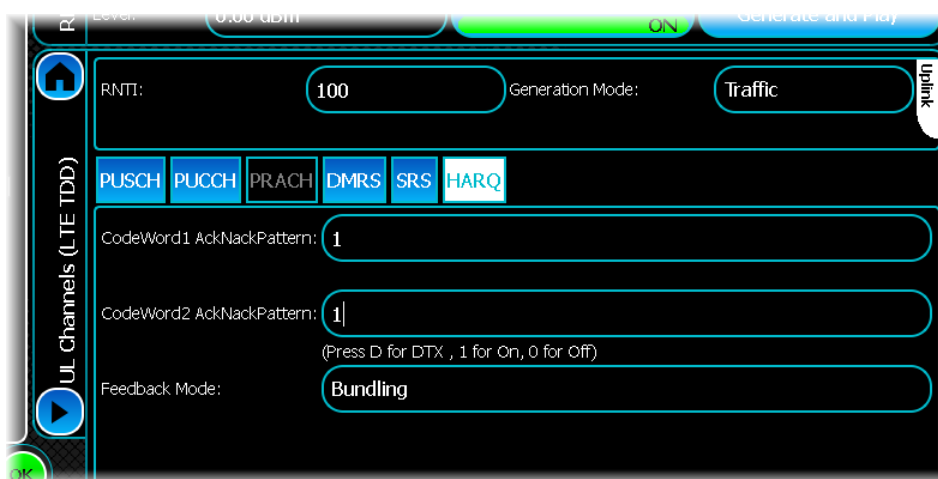
CodeWord1 AckNackPattern

Use this to specify the pattern of Ack/Nack bits used within the HARQ codeword 1. Enter 1 for on, 0 for off, or D for DTX.

Codeword2 AckNackPattern

Use this to specify the pattern of Ack/Nack bits used within the HARQ codeword 2. Enter 1 for on, 0 for off, or D for DTX.

Feedback Mode

This sets the HARQ feedback mode. The feedback mode can be set to multiplexing or bundling. In LTE TDD the number of uplink subframes is not always equal to the number of downlink subframes. HARQ multiplexing and HARQ bundling are two methods that are employed to enable the ACK/NACKs transmitted on PUCCH to acknowledge transmissions from multiple downlink subframes.

Downlink channel settings

Use this screen to configure general downlink parameters for LTE-TDD.

It consists of two parts; the downlink configuration portion and the downlink channel configuration table portion.

Downlink Configuration

Antennas

This specifies how many antennas are used in the signals. Valid values are 1 or 2.

UE Category

This specifies the UE category, which is used to determine the channel coding that is applied to the PDSCH. The valid range is 1 to 5. The default value is 5.

PHICH duration

Valid values are normal and extended.

Ng

This specifies the Ng. Ng is used to control how many PHICH groups are present. Valid values are 1/6, 1/2, 1 or 2.

UE ID

The valid range is 0 to FFFF. The default value is 3d.

Downlink Channels

This table lets you edit the downlink channels present in the LTE TDD simulation.

Power

This defines the relative power of the channel. The valid range is – 60 to 30 dB. The default value is 0 dB.

State

This defines if the signal is present (On) or absent (Off). The default state is On.

Editing a channel

You can show more parameters for the downlink channel, by selecting the desired item from the table and touching the Edit… button underneath. This then provides the parameters specific to the channel selected.

PDCCH configuration

Show this screen by selecting the PDCCH channel in the channel table and touching the Edit… button.

There are two tabs: one that contains DL Grant-specific parameters...

... the other contains UL Grant-specific parameters.

DL Grant

PDCCH DL Grant State

Use this button to turn off the DL Grant. If this is On, the grant is transmitted; otherwise, it is not included in the signal. By default, this is On.

Format

The DL grant format is used to control the number of CCEs used to transmit the DL grant. Valid values are 0, 1, 2 or 3.

Search Space

The search space controls which CCEs are used to transmit the DL grant. The common search space contains CCEs that get read by every UE, whereas the UE Specific search space contains CCEs that are only guaranteed to be read by a specific UE. Valid values are UE Specific and Common.

UL Grant

UL Grant State

Use this button to turn off the UL Grant. If this is On, the grant is transmitted; otherwise, it is not included in the signal. By default, this is On.

Search Space

The search space controls which CCEs are used to transmit the UL grant. The common search space contains CCEs that get read by every UE, whereas the UE Specific search space contains CCEs that are only guaranteed to be read by a specific UE. Valid values are UE Specific and Common.

DMRS Cycle Shift

This is used to control the DMRS cyclic shift used on the uplink transmission that is scheduled by the UL grant. The valid range is 0 to 7. The default value is 0.

CQI Request

This sends a CQI request on the UL grant. Valid values are 0 and 1.

TPC Pattern

This specifies the UL grant TPC pattern that is transmitted on the UL grant. It can accept a sequence of numbers including 0, 1, 2 or 3.

Format

The UL grant format is used to control the number of CCEs used to transmit the UL grant. Valid values are 0, 1, 2 or 3.

MCS

The MCS transmitted specifies the modulation and channel coding that should be applied to the uplink transmission that is scheduled by the UL grant. The valid range is 0 to 28. The default value is 0.

RB Start

This specifies the starting resource block to be used by the uplink transmission that is scheduled by the UL grant. Valid values are 0 to 99.

RB Length

This specifies the number of resources blocks to be used by the uplink transmission that is scheduled by the UL grant. Valid values are 0 to 99.

Hopping Flag

This button specifies whether the hopping flag is set in the UL grant. If this button is On, hopping is set to 1; otherwise it is set to 0. The default is Off.

PDSCH configuration

Show this screen by selecting the PDSCH channel in the channel table and touching the Edit… button.

PDSCH State

Use this button to turn off PDSCH. By default, this is on.

Transmission Mode

The transmission mode specifies how the signal is transmitted. The transmission mode can be Single Port (SISO), Tx Diversity (MIMO), Closed Loop (MIMO) or Open Loop (MIMO).

Starting Resource Block

This specifies the starting resource block to use in the PDSCH transmission. This control is only valid if the resource allocation type is set to Type 2. The starting RB + the RB length cannot exceed the total system bandwidth. The number of resource blocks available for specific bandwidths is shown in the table.

Rank

This control is only valid in Closed Loop transmission mode. Valid values are 0, 1 or 2.

Codeword1 DataSource

This specifies the payload data of the Codeword 1 part of the signal. If the transmission mode is close loop or open loop then two code words may be transmitted; otherwise only a signal code word is transmitted. Touch this button to display the standard data source configuration screen that lets you configure the output data. Available options are All Ones, All Zeroes, PRBS, Random Bits, Repeating Pattern or a User data pattern file.

Codebook Index

This control is only valid in Closed Loop transmission mode. Valid values are 0, 1 or 2.

Resource Allocation Type

The resource allocation type can be:

- Type 0: controlled by a resource allocation bit mask

- Type 2: controlled by starting resource block

- Full: allocates all possible RBs so the signal occupies the maximum bandwidth.

Resource Block Allocation Length

This specifies the number of resource blocks to use in the PDSCH transmission. This control is only valid if the resource allocation type is set to Type 2. The starting RB + the RB length cannot exceed the total system bandwidth. The number of resource blocks available for specific bandwidths is shown in the table.

Codeword 2 Data Source

This specifies the payload data of the Codeword 2 part of the signal. If the transmission mode is close loop or open loop then two code words may be transmitted; otherwise only a signal code word is transmitted. Touch this button to display the standard data source configuration screen that lets you configure the output data. Available options are All Ones, All Zeroes, PRBS, Random Bits, Repeating Pattern or a User data pattern file.

Resource Allocation Bit Mask

This is only available if the resource allocation type is set to Type 0. It accepts a hexadecimal value. Each bit in the bit mask corresponds to a set of resource blocks. If the bit is set, the corresponding set of resource blocks is transmitted; otherwise it is not.

PHICH configuration

Show this screen by selecting the PHICH channel in the channel table and touching the Edit… button.

PHICH State

Use this button to turn off the PHICH within the signal. If this button is On, the PHICH channel is transmitted, otherwise, it is not included in the signal. By default, this is On.

ACK/NACK Pattern

Use this to set a binary bit pattern. This pattern configures the ACK/NACK bits that are transmitted. The ACK/NACK bits are transmitted at a rate of 1 bit per downlink subframe. If the number of downlink subframes is greater than the length of the ACK/NACK pattern, the ACK/NACK pattern is repeated.

PBCH configuration

Show this screen by selecting the PBCH channel in the channel table and touching the Edit… button.

PBCH State

Use this button to turn off the PBCH within the signal. If this button is On, the PBCH channel is transmitted, otherwise, it is not included in the signal. By default, this is On.

Transmit SFN

This specifies whether the subframe number is broadcast as part of the PBCH channel. If this button is On, the SFN is transmitted. The default is Off.

Data Source

This specifies the payload data of the PBCH channel. Touch this button to display the standard data source configuration screen that lets you configure the output data. Available options are All Ones, All Zeroes, PRBS, Random Bits, Repeating Pattern or a User data pattern file.

Frame structure settings

Use this screen to control parameters that change on a subframe basis for LTE-TDD.

At the top is the subframe control that provides a graphical representation of all the subframes within the signal. Uplink subframes are shown as blue, downlink subframes are shown in gray. Special subframes are shown in yellow.

Note that you are only able to edit subframe parameters relevant for the portion of the signal being generated. For example, if you are in uplink mode, you are only able to edit uplink subframes as it is assumed that another device will be broadcasting the downlink portions of the frame.

When in uplink mode; the graphic also shows the type of uplink subframes.

Configure Frame

Touch this button after selecting the frame you wish to configure.

Downlink subframe parameters

The following parameters are available for any downlink subframe being configured. These are available if the link direction is set to Downlink.

CFI

This specifies the control frame indicator (CFI) of this subframe. The CFI controls how many OFDM symbols are used to transmit control information. This can be set to 1, 2 or 3. The default value is 0.

CodeWord1 MCS Index

This specifies the codeword1 MCS index for this subframe. The MCS index defines the modulation and coding scheme used to transmit data on the PDSCH. In a SISO system, or a MIMO system that uses TX diversity, only one code word is transmitted. In open loop or closed loop MIMO two code words may be transmitted. The valid range is 0 to 28. The default value is 0.

CodeWord2 MCS Index

This specifies the codeword2 MCS index for this subframe. The valid range is 0 to 28. The default value is 0. Codeword2 is only used when open loop or closed loop MIMO is employed.

Uplink subframe parameters

The following are parameters that are available for any uplink subframe being configured. These are available if the <u>link direction</u> is set to Uplink.

Channel Type

This specifies the type of channel that is transmitted within this subframe. Valid values are PUSCH, PUCCH or DTX.

Modulation Type

When the channel type is set to PUSCH, this specifies the modulation type. Valid values are QPSK, 16QAM and 64QAM. When the modulation mode for the PUSCH channel is user-defined this property is settable. If the modulation mode is MCS Index, the property is read-only (and is derived from the MCS index).

N2 DMRS

When the channel type is set to PUSCH this specifies the N2 DMRS value ($n_{DMRS}^{(2)}$). This value controls the DMRS cyclic shift applied when transmitting a DMRS signal for PUSCH. The valid range is between 0 and 10. The default value is 0.

Hopping Bits

This control is available only when the channel type is set to PUSCH. The number of hopping bits is used in conjunction with hopping type to control the type of hopping that is applied, as shown in the table. This can be set to 0 (default),1, 2 or 3.

Relationship between hopping type and hopping bits
(Table 8.4-2 of 3GPP TS 36.213 V8.8.0 (2009-09))

System BW N_{RB}^{UL}	Number of hopping bits	Information in hopping bits	$\tilde{n}_{PRB}(i)$
6 – 49	1	0	$\left(\left\lfloor N_{RB}^{PUSCH}/2\right\rfloor + \tilde{n}_{PRB}^{S1}(i)\right)\mathrm{mod}\,N_{RB}^{PUSCH}$
		1	Type 2 PUSCH hopping
50 – 110	2	00	$\left(\left\lfloor N_{RB}^{PUSCH}/4\right\rfloor + \tilde{n}_{PRB}^{S1}(i)\right)\mathrm{mod}\,N_{RB}^{PUSCH}$
		01	$\left(\left\lfloor N_{RB}^{PUSCH}/4\right\rfloor + \tilde{n}_{PRB}^{S1}(i)\right)\mathrm{mod}\,N_{RB}^{PUSCH}$
		10	$\left(\left\lfloor N_{RB}^{PUSCH}/2\right\rfloor + \tilde{n}_{PRB}^{S1}(i)\right)\mathrm{mod}\,N_{RB}^{PUSCH}$
		11	Type 2 PUSCH hopping

Number Of RBs

M_{RB}^{PUSCH}

This defines the number of PUSCH resource blocks that have been scheduled for transmission in the current subframe. This control is available only when the channel type is set to PUSCH. The value of this parameter should be set according to the following rules:

- It must also be a non-zero positive value and not be divisible by any prime number other than 2, 3 and 5. The staring RB + the number of RBs cannot exceed the total system bandwidth. The number of resource blocks available for specific bandwidths is shown in the table.

- When hopping is enabled, another level of restriction is imposed. In this case, M_{RB}^{PUSCH} cannot exceed the hopping bandwidth.

Current TxNB

This sets the transmission number of data being transmitted in the selected subframe. This control is available only when the channel type is set to PUSCH. Valid values are 0, 1, 2 or 3. The default value is 0.

Power

When the channel type is set to PUSCH or PUCCH this controls the relative power of this subframe within the simulation. The valid range is -1000 to 30 dB.

Hopping Type

This control is available only when the channel type is set to PUSCH. This is used in conjunction with the hopping bits to control the type of hopping that is applied. This control can be set to 0, 1 or 2. The default value is 0.

Starting RB

This defines the starting position of the virtual resource block. This control is available only when the channel type is set to PUSCH. The value of this parameter should be set following the rules below:

- If hopping is disabled, the sum of Starting Virtual RB and M_{RB}^{PUSCH} should not go beyond the bandwidth. The number of resource blocks available for specific bandwidths is shown in the table.

- If hopping is enabled, ensure that the Starting Virtual RB lies within the hopping bandwidth.

Code Rate

This control is available only when the channel type is set to PUSCH and the modulation mode is user- defined. Valid values are 1/6, 1/5, 1/3, 1/2 , 2/3 3/4 or 5/6. The default value is 1/3.

MCS Index

This control is available only when the channel type is set to PUSCH and the modulation mode is MCS Index. The valid range is 0 to 28.

Starting CCE

This specifies the starting CCE of the PDCCH transmission that corresponds to PUCCH being transmitted in the current subframe. This control is available only when the channel type is set to PUCCH. The valid range is 0 to 87. The default value is 0.

PUCCH Format

This control is available only when the channel type is set to PUCCH, and Auto calculate PUCCH format is set to false. The PUCCH format can be 1/1a/1b.

Multi-Carrier

Multi-carrier modulation lets you produce a waveform that contains multiple carriers (each with modulation), turning a single-source generator into a multi-source device. The modulation on each carrier can either be the same (to emulate a band of occupied channels) or different (representing interfering signals from a different transmission scheme). You are able to set each carrier's frequency, level, phase and time delay independently.

Touch the ▶ button, and configure multi-carrier generation using the following screens:

RF Settings

Modulation

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for Multi-carrier modulation.
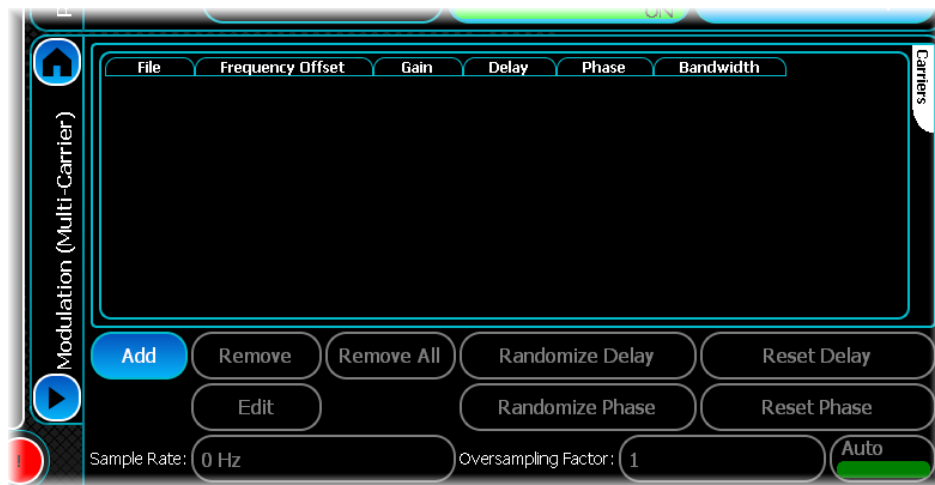
The Carriers screen displays a table (initially empty) for displaying a list of AIQ files.

You create a multi-carrier waveform by adding a number of AIQ files (already generated using the Generate AIQ button) to this table, along with details of how the signals are to be combined.

Adding a file

To add a file to the Carriers list, touch the Add button. This displays the following Parameters screen.
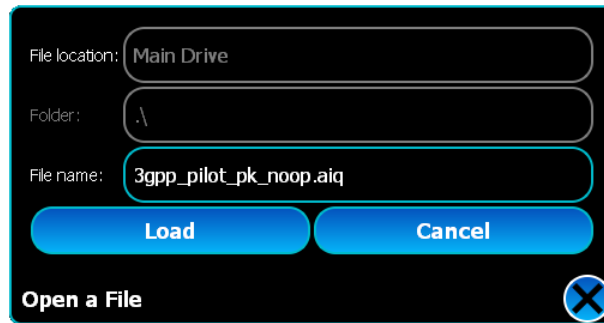
File name

Enter the file name of the AIQ file that is to become part of the multi-carrier waveform. Browse to find the folder and the file required:

Load the file, or cancel the operation.

Frequency Offset

Next, enter the frequency offset of the carrier. The value can be from -100 MHz to +100 MHz, including 0 Hz, and represents the frequency offset from the carrier by which the signal shifts when mixed.

Auto Cyclic

The Auto Cyclic button causes the instrument to calculate the closest cyclic frequency offset to the value in the Frequency Offset control, and updates the control with the new value. This value is recalculated each time any carrier is added, modified or removed.

Gain

Gain is the power level of this file relative to the other files you have added or will add later. The value can be from -60 dB to 0 dB.

Delay

Delay lets you start the mixing at any point in the file and means you can emulate similar signals with different time references up to the file length.

Random (Delay)

The Random button next to Delay puts the file into random time delay mode. In this mode, the instrument automatically generates a time delay based upon the file length. Selecting this button for each file in the list typically results in a waveform with a lower crest factor.

Carrier Phase

Carrier Phase lets you adjust the starting phase of the frequency mixer. This is of use when you have a waveform consisting of more than one file as it can help to reduce the crest factor.

Random (Carrier Phase)

The Random button next to Carrier Phase puts the file into random phase mode. In this mode, the instrument automatically generates a random phase between -180 and +180 degrees. Selecting this button for each file in the list typically results in a waveform with a lower crest factor.

Touch OK and the dialog closes, returning you to the main Multi-Carrier screen. The file is added to the other files in the Carriers list:

Editing and removing files

When a file is highlighted in the table, the Edit and Remove buttons are enabled, allowing you to make changes or remove the file. Note that when a file is in random time delay mode, the delay cannot be edited. Similarly, when a file is in random phase mode, the phase cannot be edited. The Remove All button clears all the files from the list.

Randomize Delay

Touch this button to randomize the time delay of all the files currently in random delay mode. A file can be put into random delay mode when it is added to the list using the Add button or by editing it using the Edit button.

Reset Delay

Touch this button to reset the random number generators used to randomize the time delay of each AIQ file currently in random mode. After activating this button, the time delay of these files returns to the first random delay value generated.

Randomize Phase

Touch this button to randomize the phase of all the files currently in random phase mode. A file can be put into random phase mode when it is added to the table using the Add button or by editing it using the Edit button.

Reset Phase

Touch this button to reset the random number generators used to randomize the phases of each AIQ file currently in random mode. After activating this button, the phase of these files returns to the first random phase value generated.

Sample Rate

This is the default sample rate, which is calculated internally.

Oversampling Factor

This sets the oversampling factor, which lets you increase the default sample rate. The default oversampling factor is 1. To change it manually, enable the Auto button.

Mixing different files (Multi-Carrier)

You can create a multi-carrier waveform of many similar carriers, using the same AIQ file, or similar ones created from slightly modified files. You can also mix different types of modulations, provided certain criteria are met. All of the files must have the same sampling rate or be integer multiples of each other, and have the same file length in terms of time. Note that this is not the same as each file having the same number of samples; the file length in time is the number of samples divided by the sampling rate.

As an example, mix a 3GPP carrier with a single tone representing an interfering unmodulated signal.

1. Create a default WCDMA 3GPP uplink DPCH file and call it *3gpp_reverse_dpch.aiq.* Refer to WCDMA for further details on how to do this.

2. Open *IQCreator* ® (available to download for free from the Aeroflex website).

3. Create a single tone at 0 Hz within IQCreator, using the Auto settings facility; refer to the IQCreator Arbitrary Waveform Creator and Packager User Guide for further details. Ensure that you set Destination Hardware to Aeroflex SGD/3320 Series. Generate an AIQ file called *single_tone.aiq.* Copy this file to the SGD.

4. Create a new multi-carrier waveform and add the file *3gpp_reverse_dpch.aiq* with a 0 Hz frequency offset.

5. Add the file *single_tone.aiq* with a frequency offset of -5 MHz (this adds the interfering unmodulated carrier 5 MHz below the 3GPP carrier).

Sampling rate discrepancy

When you try to generate the file of this waveform, you see this error message:
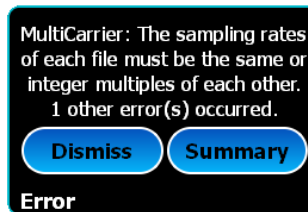
This message indicates that the sampling rates of the two files are not compatible.

It is possible to read the sampling rate directly from the file, using a text editor. The header part contains a plain text entry, as this extract shows:

[File]

Date=01/07/2014

Time=10:42:02

FileVers=

PackSWVers=01.00

Samples=614400

Title=D:/Documents and Settings/S-Series/My Documents/Aeroflex/AiqFiles/Umts/3gpp_reverse_dpch

SampleRate=15360000

In this example, the sampling rates of the two files are not integer multiples of each other. *3gpp_reverse_dpch.aiq* has a sampling rate of 15.36 MHz, which is not divisible by 50 kHz, the sampling rate of *single_tone.a*iq.

Return to the Tones settings in *IQCreator* ®, turn off Auto Settings and set the Sample Rate to 1.536 MHz. Regenerate *single_tone.aiq* with these new settings and copy this file to the SGD. The discrepancy in the sample rates is resolved.

File length discrepancy

However, when you return to the Multi-Carrier settings and try to generate the file of this multi-carrier waveform, you see a new error message:

MultiCarrier: Each file must be of the same length in terms of time.

Dismiss

Error
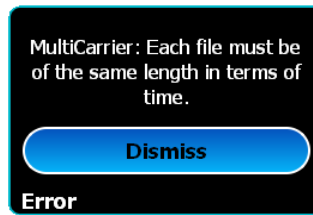
Now the two files have compatible sampling rates but the file lengths are not the same.

Correct this by regenerating *single_tone.aiq* with a different file length. *3gpp_reverse_dpch.aiq* contains 614400 samples at a sampling rate of 15.36 MHz; this equates to a file length of 40 ms. You need to set *single_tone.aiq* to the same file length. Return to the Tones settings in **IQCreator** ® and set *single_tone.aiq* to File Length = 40 ms.

The discrepancy in file lengths is now resolved, and the two files mix together correctly.

The result appears like this on an S-Series SVA:
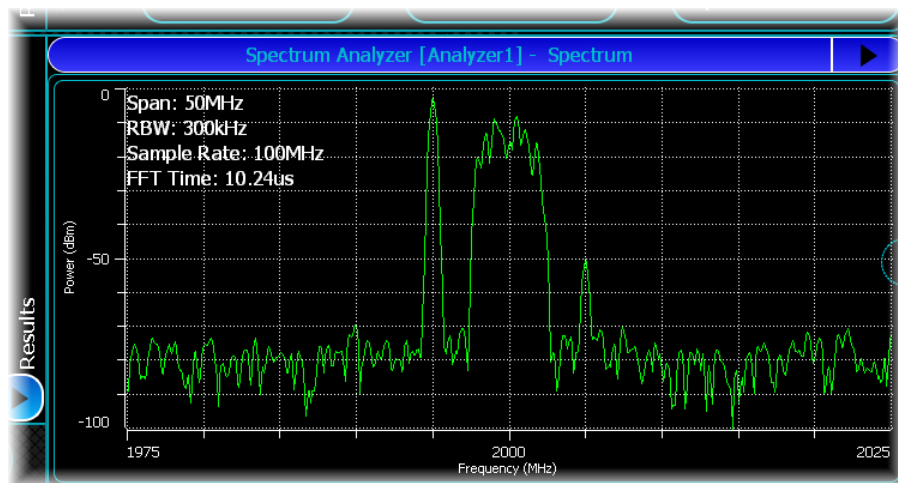
You may notice that although the two AIQ files were mixed at 0 dB each, the single tone at 5 MHz below carrier appears to be 20 dB higher than the 3GPP signal centered on the carrier. This is because the AIQ files are scaled to give an equal peak value of full scale, but the FFT plot shows the rms value of the component of the signal in each frequency bin. The single tone appears high because all the power is in one bin, whereas the 3GPP signal is spread over many bins, so each bin has only a small fraction of the signal power. You can adjust the relative amplitude of the two signals that make up this multi-carrier waveform by changing the gain factor for the signal you want to reduce in amplitude. For example, if you make the 0 Hz tone file gain parameter -32 dB, the tone appears to have a level almost equal to the top of the 3GPP signal.

PSK

Use this to produce a generic PSK waveform.

Touch the ▶ button, and configure PSK generation using the following screens:

RF Settings
Modulation
Filter
Markers
IQ Impairments
Graphics

Modulation

Use this screen to set general modulation parameters for PSK.

Modulation Type

Select the modulation required from the drop-down list of PSK modulation types.

Number of Symbols

Set the number of symbols occupied by the burst.

Symbol Rate

Set the symbol rate for the signal to be created.

Oversampling Factor

Normally, leave the Oversampling Factor Auto button On, so that the factor is adjusted automatically for the filter you choose.

Modify Mapping...

Touch this button to open a new screen where (for <u>non-differential</u> modulation schemes (for example, 8PSK)) you define your own PSK symbol map:
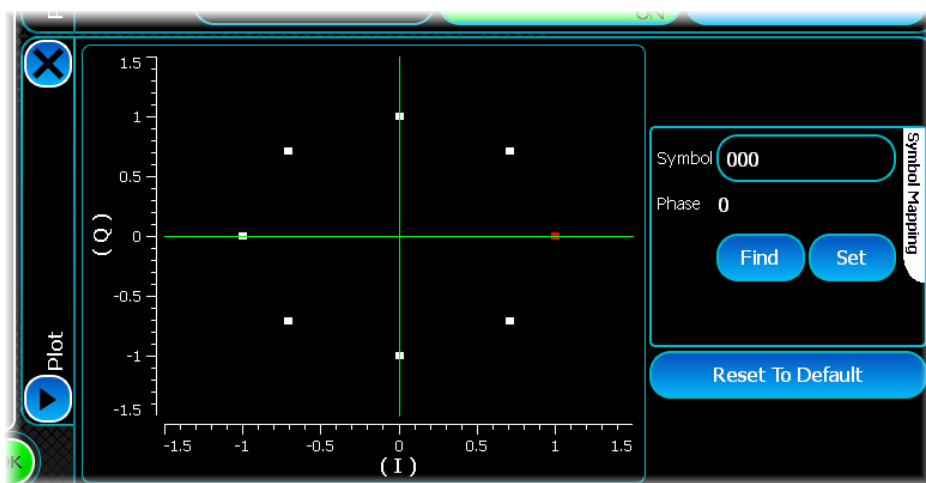
To change a symbol's value, touch the symbol on the map, which highlights it in red. Touch the Symbol control to open a binary keyboard to enter a new value for the highlighted symbol. Touch Set to assign this value to the symbol.

For <u>differential</u> modulation schemes (for example, DQPSK), a table of symbol values against phase is displayed:

Touch on a value in the Phase column to open the binary keyboard, and enter the new value. Touch Set to assign this value to the highlighted phase value. The phase value is then assigned to a different differential symbol value.

Reset to Default

Touch this to return the symbol map or table to its predefined mapping. Default symbol mapping is defined such only one bit changes in transitions between adjacent symbol points.

QAM

Use this to produce a generic QAM waveform.

Touch the ▶ button, and configure QAM generation using the following screens:

RF Settings

Modulation

Filter

Data Source

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for QAM.
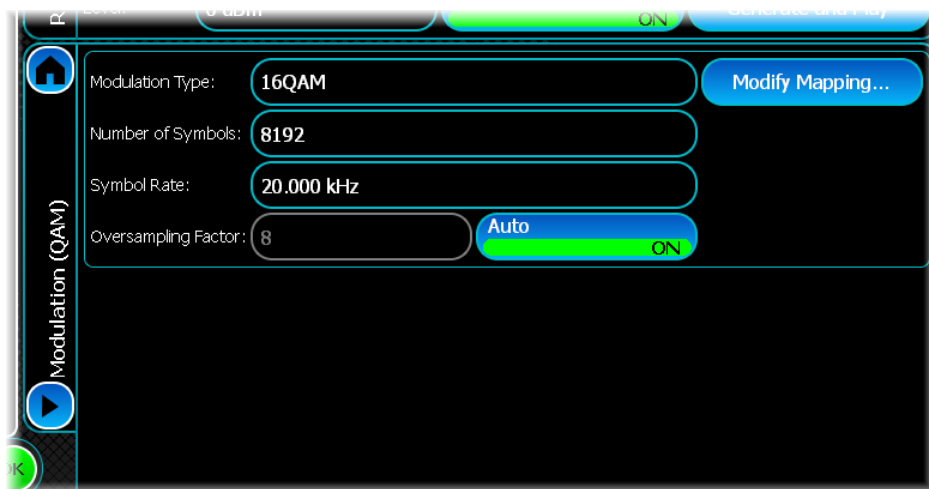
Modulation Type

Select the modulation required from the drop-down list of QAM modulation types.

Number of Symbols

Set the number of symbols occupied by the burst.

Symbol Rate

Set the symbol rate for the signal to be created.

Oversampling Factor

Normally, leave the Oversampling Factor Auto button On, so that the factor is adjusted automatically for the filter you choose.

Modify Mapping...

Touch this button to open a new screen where you define your own QAM symbol map:
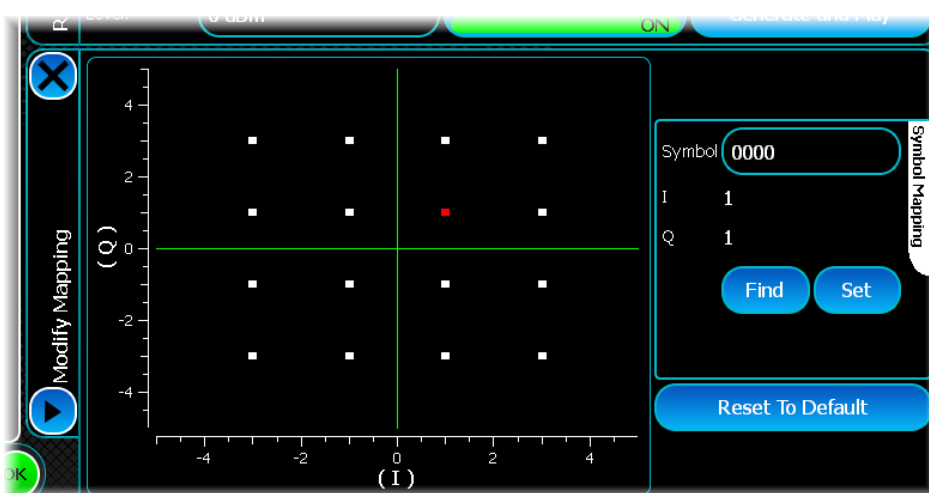
To change a symbol's value, touch the symbol on the map, which highlights it in red. Touch the Symbol control to open a binary keyboard to enter a new value for the highlighted symbol. Touch Set to assign this value to the symbol.

Reset to Default

Touch this to return the symbol map to its predefined mapping. Default symbol mapping is defined such only one bit changes in transitions between adjacent symbol points.

TD-SCDMA

Use this to produce a waveform that simulates a 3GPP TDD-LCR carrier.

Touch the ▶ button, and configure TD-SCDMA generation using the following screens:

RF Settings

Modulation

Filter

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for TD-SCDMA.
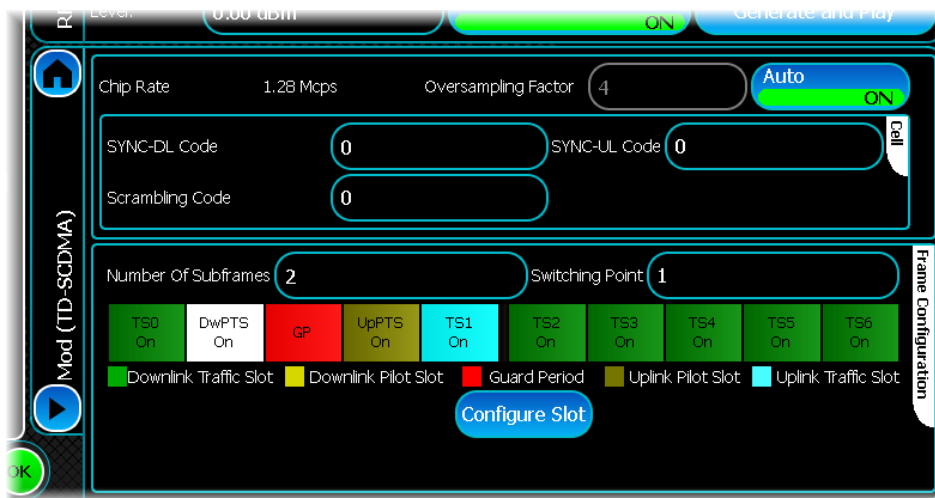
The main modulation screen consists of two parts.

The cell configuration portion at the top of the screen lets you change the top-level parameters of the TD-SCDMA cell.

The frame configuration portion lets you modify the different portions of the TD-SCDMA frame being transmitted. A graphical representation of the frame is shown, and lets you configure the individual slots within the frame.

Cell configuration

SYNC-DL code

This sets the SYNC-DL for the cell. The SYNC-DL code must be in the range 0 to 31. There is only one SYNC-DL code per code group. When the SYNC-DL is changed, the code group is set to the one corresponding to the current SYNC-DL. This means that the set of SYNC-UL and scrambling codes that can be selected changes whenever the SYNC-DL is changed.

Set the SYNC-DL code using the edit box that appears when you touch the SYNC-DL Code field, or by using the DwPTS configuration dialog: select the DwPTS cell in the slot graphic, and touch the Configure Slot button.
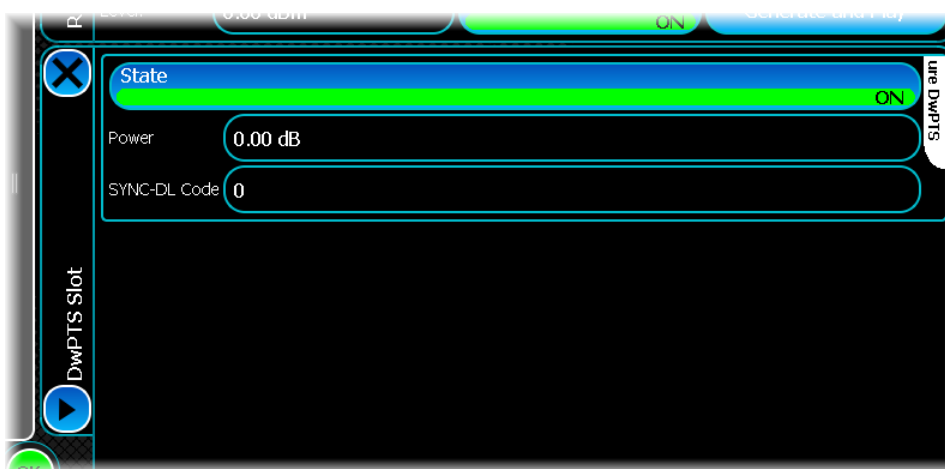
In addition to being able to set the SYNC-DL code, the DwPTS configuration dialog lets you set the following parameters.

State

This sets the state of the slot. When this button is On, the slot is transmitted; otherwise the slot is not transmitted. The default is On.

Power

This is the power/gain of the slot in dB (relative to the other slots). The value must be between 0 and –60 dB.

SYNC-UL Code

This sets SYNC-UL code for the cell. The drop-down list lets you select any of the eight SYNC-UL codes belonging to the current code group.

Set the SYNC-UL code using the edit box that appears when you touch the SYNC-UL Code field, or by using the UpPTS configuration dialog: select the UpPTS cell in the slot graphic, and touch the Configure Slot button.
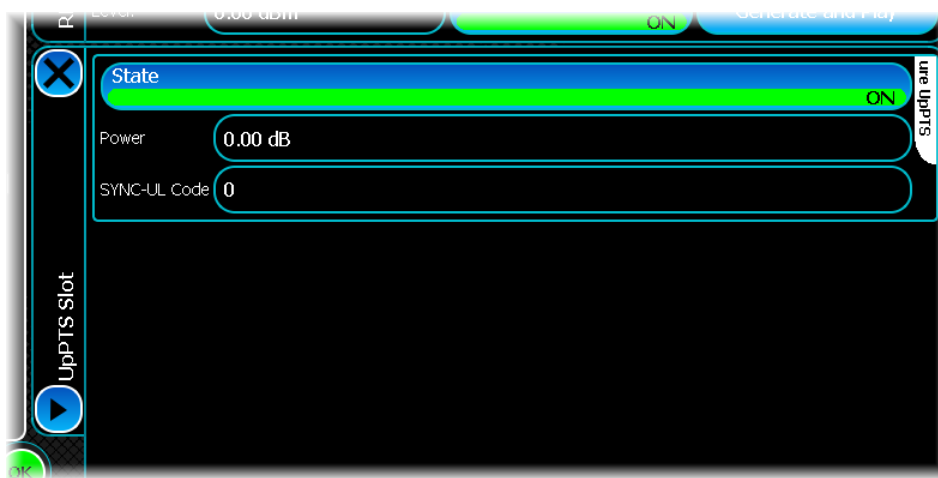
In addition to being able to set the SYNC-DL code the UpPTS configuration dialog lets you set the following parameters.

State

This sets the state of the slot. When this button is On, the slot is transmitted; otherwise the slot is not transmitted. The default is On.

Power

This is the power/gain of the slot in dB (relative to the other slots). The value must be between 0 and –60 dB.

Scrambling Code

This sets the scrambling code for the cell. The scrambling can be any of the four scrambling codes belonging to the current code group. As the basic midamble and scrambling code must be the same, the midamble code is also changed whenever the scrambling code is changed.

Frame configuration

Number of Subframes

This sets the number of sub-frames to be generated. The valid range is 1 to 1000.

Switching Point

This sets the switching point position in the frame. There are five different positions. The valid switching point range is 1 to 5. When you change the switching point, the slot graphic updates to highlight the new value.

Configuring a traffic slot

Configure a traffic slot (Ts0 to Ts6) by touching the timeslot graphic, or by selecting the slot and touching the Configure Slot button.

When configuring a traffic slot you are presented with a dialog similar to the one shown here. The following settings can be configured:

Traffic Slot State

This sets the state of the slot. When this button is On, the slot is transmitted; otherwise the slot is not transmitted. The default is On.

Maximum Number of Users (k)

This sets the maximum user ID that can be used in the slot. If you change the user ID to a value that is less than the user ID used by one of the channels, then you are asked if you want to set the user ID of the channel to 1 before continuing.

Power

This is the power/gain of the slot in dB (relative to the other slots). The value must be between 0 and –60 dB.

Channel Settings

Each traffic slot has a set of uplink channels and a set of downlink channels that are represented within the main table of the traffic slot configuration dialog. The set of channels that can be configured is dependent on the slot's link direction.

You can add, edit or remove a channel from a traffic slot using the Add..., Edit... or Remove buttons at the bottom of the Channel Settings dialog. When you add a new channel to the traffic slot, a new row is added automatically within the table. While you can edit most of the channel parameters by touching the parameter of interest within the table, you are also able to get a more detailed view of the individual channel parameters by highlighting the desired channel and touching the Edit.. button. This displays the following screen:
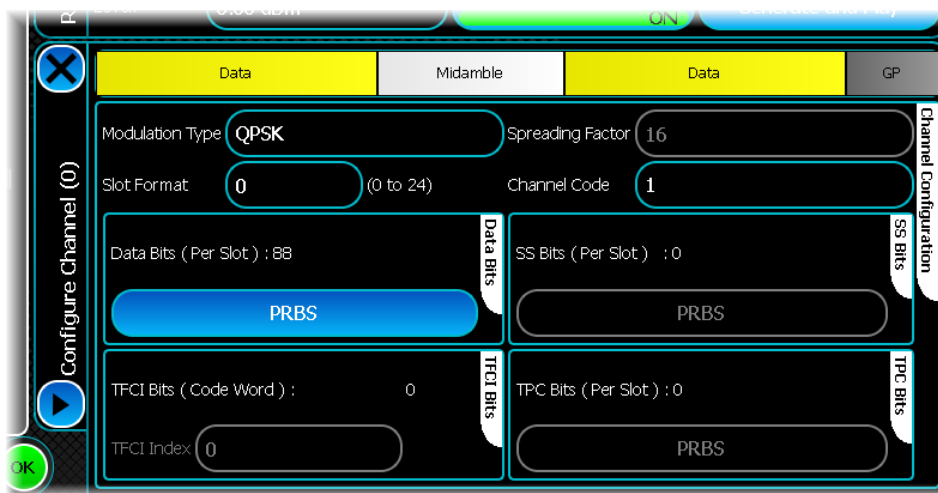
Modulation Type

This sets the type of modulation to be used when transmitting the data bursts. The modulation can be set to QPSK or 8PSK.

Slot Format

This sets the slot format used by the channel. The slot format determines the spreading factor, and the number of Data, TFCI, SS, and TPC bits transmitted by the channel. The range of slot format values is displayed to the right of the slot format field. The range of slot formats is dependent on link direction and modulation type. When the channel's slot format is changed, the channel graphic is updated to show the number of Data, TFCI, SS, and TPC bits used with the new slot format.

Channel Code

This sets the channelization code used by the channel. The range of selectable values is dependent on the spreading factor currently in use. If the chosen channelization code conflicts with channels currently transmitted in the slot, the specific channels that are in conflict are highlighted in red:

Data Bits

This lets you select the type of data used to produce the channel's data bits. Allowed data source types are PRBS, All Zeroes, All Ones, User Data and Repeating Pattern.

TFCI Bits

This lets you set the TFCI index. The TFCI index is used to produce the TFCI code word. The TFCI index should be between 0 and the maximum TFCI value displayed to the right of the TFCI edit box.

SS Bits

This lets you select the type of data used to produce the channel's SS bits. Allowed data source types are PRBS, All Zeroes, All Ones, User Data and Repeating Pattern.

TPC Bits

This lets you select the type of data used to produce the channel's TPC bits. Allowed data source types are PRBS, All Zeroes, All Ones, User Data and Repeating Pattern.

WCDMA

Use this to produce a waveform that simulates a 3GPP FDD carrier. The modulation scheme is defined in 3GPP specifications TS 25.213 V6.5.0 and TS 25.211 V6.7.0.

The terms 'UMTS' and 'WCDMA' are often used interchangeably. WCDMA Uplink is an air interface that forms part of the radio transmission standard for UMTS.

Touch the ▶ button, and configure WCDMA generation using the following screens:

RF Settings

Modulation

Downlink Parameters

Downlink Channels

Uplink Parameters

Filter

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for WCDMA.
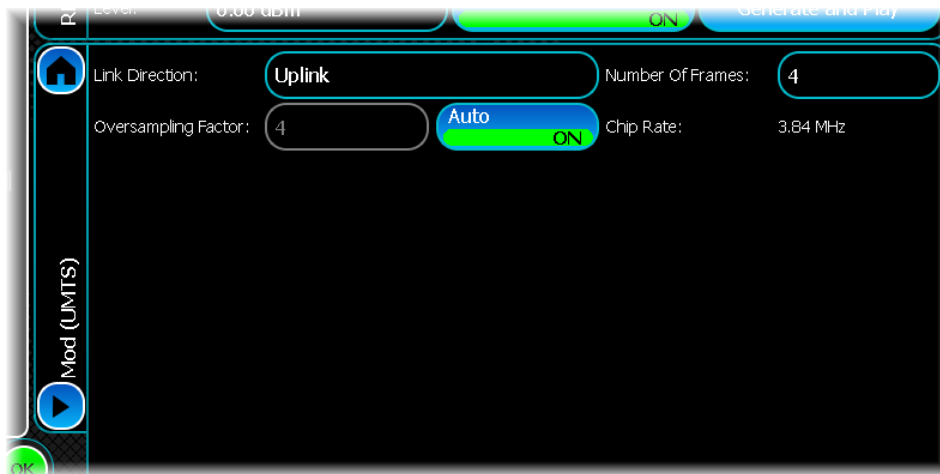
Link Direction

Use this to specify the link direction of the signal being generated.

Oversampling Factor

Use this to define the oversampling factor to be used in the simulation. When the Auto button is On, the oversampling rate is adjusted automatically.

Number of Frames

Use this to specify the number of radio frames to be generated. The valid range is 1 to 400. The default value is 4. One frame is 10 ms (34800 chips) long.

Chip Rate

The chip rate of 3GPP FDD systems is 3.84 Mchips per second.

Downlink parameters

Use this screen to configure general downlink parameters for WCDMA.
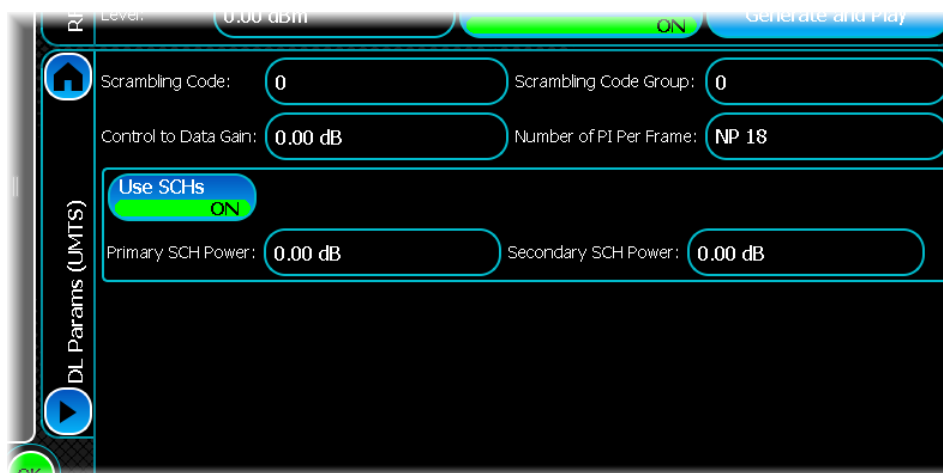
Scrambling Code

To set the scrambling code, enter the required code value in the Scrambling Code edit field. Valid values are 0 to 8191. The SGD automatically calculates the scrambling code group and places it in the Scrambling Code Group field. Current values are overridden. You can edit this value to override the automatic selection.

Control to Data Gain

Use this to set the relative power level in dB between the data and control parts of a channel. The allowed range is 0 to 60 dB.

Scrambling Group Code

The set of primary codes is divided into 64 scrambling code groups, each consisting of eight primary scrambling codes.

Number of PI Per Frame

You can set the number of paging indicators per frame by choosing a value from the drop-down list. Available values are 18, 36, 72 and 144.

Use SCHs

To use synchronization channels set the Use SCHs button On. This lets you enter the relative powers of primary and secondary channels. Valid values are between 0 and -60 dB.

Downlink channels

Use this screen to set up the individual downlink channels for WCDMA.
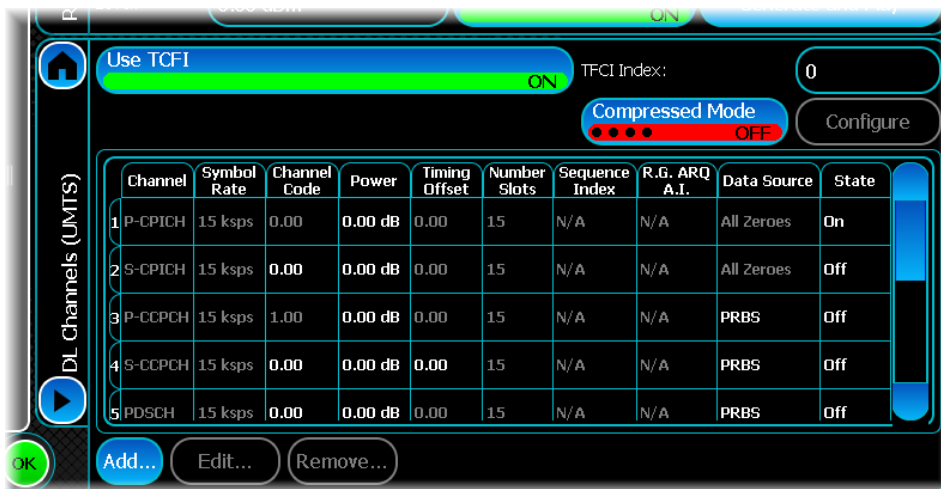
Use TFCI

If you wish to generate TFCI bits, set the Use TFCI button On.

TFCI Index

The TFI index is used to determine the TFCI bits. Valid values are 0 to 1023.

Compressed Mode

To set up compressed mode, turn the Compressed Mode button On. This enables the Configure… button. Touch this button to configure the mode.
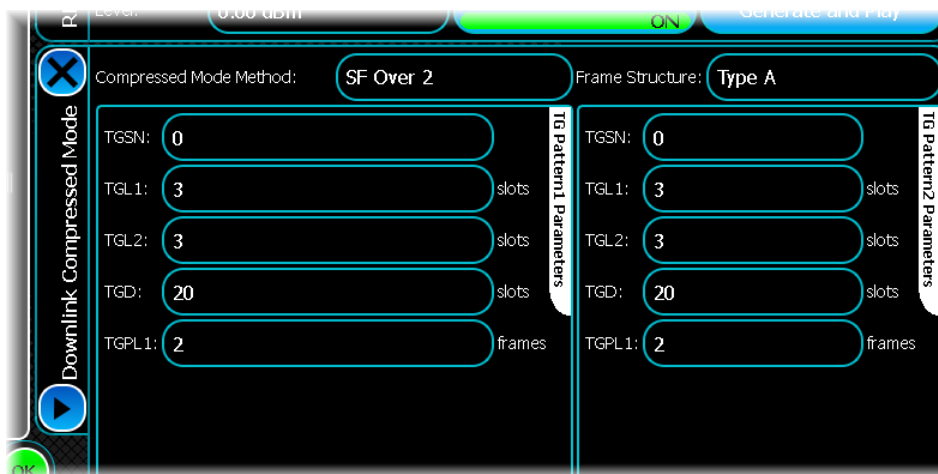
You can set up most aspects of compressed mode. This document assumes familiarity with compressed mode. The above figure includes all the parameters necessary to define the transmission gaps in the signal, which are characterized as follows:

TGSN (Transmission Gap Starting slot Number) — the slot number of the first missing (idle) slot in the transmission gap.

TGL1 (Transmission Gap Length 1) — the duration of the first transmission gap, expressed in number of slots.

TGL2 (Transmission Gap Length 2) — the duration of the second transmission gap, expressed in number of slots.

TGD (Transmission Gap start Distance) — the duration (in slots) between the two transmission gaps within a transmission gap pattern.

TGPL1 (Transmission Gap Pattern Length) — the duration of the 1st transmission gap pattern, expressed in number of frames.

Downlink channel configuration

You can add, delete and edit channels to your downlink simulation. The table always shows the primary and secondary common pilot channels (P-CPICH, S-CPICH), primary and secondary common control channels (P-CCPCH, S-CCPCH), the PDSCH, the PICH, the E-AGCH, the E-RGCH and the E-HICH.

The following parameters can be altered:

Power

Use this to set the power level for the channel. Touch the cell linking the channel and power level and enter the value. Valid values are –60 to 0 dB.

Timing Offset

Use this to set the timing offset for the channel. Touch the cell linking the channel and timing offset and enter the value. Valid values are 0 to 149. The timing offset for P-CPICH, S-CPICH, P-CCPCH, PDSCH and E-AGCH is constant and cannot be changed. For the four first channels, the timing offset is set to 0, while for the latter channel it is set to 20.

Number Slots

Use this to set the number of slots for E-AGHC, E-RGCH and E-HICH. Touch the cell linking the channel and number of slots. Select the number of slots required from the drop-down list. The allowed numbers of slots are 3, 12 and 15 (E-RGCH), 3 and 15 (E-AGHC) and 3 and 12 (E-HICH).

Sequence Index

Use this to set the sequence index for E-RGCH and E-HICH. Touch the cell linking the channel and sequence index and enter the value. The valid range is 0 to 39.

RG ARQ AI

Use this to set the relative grant (RG) and ARQ acknowledgment indicator (ARQ AI) for the E_RGCH and E-HICH, respectively. Touch the cell linking the channel and RG ARQ AI and enter the value. Valid values are +1 and –1. Note that the 0 selection is not supported, as for a 10 ms frame this results in a frame(s) with no data. A 0 selection is equivalent to switching the channel off.

Data Source

The data source can be changed for the P-CCPCH, S-CCPCH, PICH and E-AGCH. Touch the cell linking the channel and data source. This displays the standard data source dialog that lets you modify the current data source configuration.

State

The channel state can be set on or off for all channels. Touch the cell linking the channel and channel state and select On or Off from the drop-down list.

In some situations, it is possible to configure two channels such that the channel code and spreading factor (determined by the current slot format) can overlap leading to a conflict. When such a conflict occurs, an error graphic is shown, indicating that the channels are in conflict, and each overlapping channel is highlighted in red in the channel table.

Adding a channel

To add a channel into the downlink simulation, touch the Add... button.

Touching the Add... button displays this screen:

The default channel is a dedicated physical channel. Select the slot format by touching the appropriate row. Enter each parameter as required. If the channel is a multicode channel, select the Multicode Channel button. If this is On you cannot define TPC bits. Touch Ok to accept the current selection, and the channel is permanently added to the table. Touch Cancel to automatically remove the channel from the table.

In addition to the DPCH channel, you can also add an HS-SCCH channel, an HS-PDSCH channel and an OCNS channel. The OCNS channel is an orthogonal noise source. Furthermore, you can set the power level and channel code for all channel types. The slot format is used to set the symbol rate for all the available channels. No control bits are present in the HS-SCCH, HS-PDSCH and OCNS channels.

Editing a channel

To edit a channel, select the channel of interest and touch the Edit... button.

Touching the Edit... button displays this screen:

Edit the parameters of interest. Press Ok when complete. Note that you cannot alter the type of channel.

Removing a channel

To remove a channel, select the channel of interest and press the Remove... button.
The slot format that you are presented with in the Edit and Add channel dialogs depends on whether the TFCI bits are to be used or not.

Uplink parameters

Use this screen to configure the uplink channels for WCDMA.
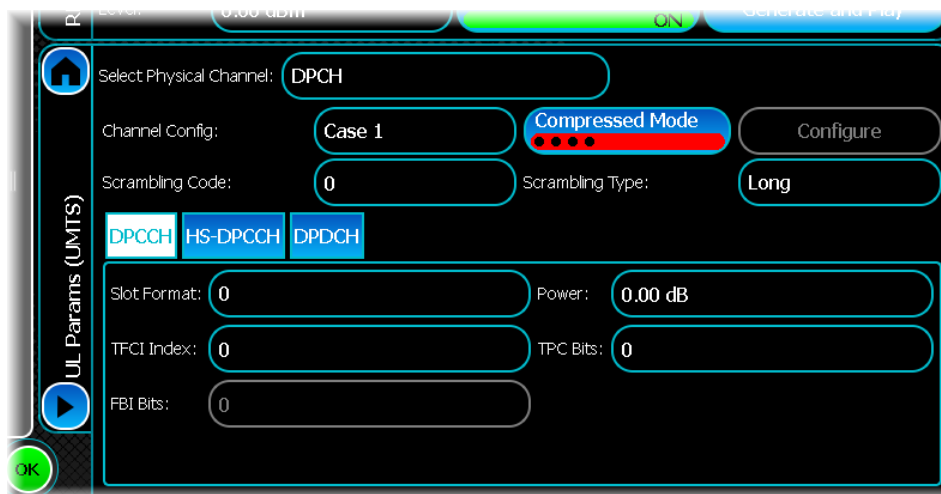
Select Physical Channel

In the uplink, the SGD supports two physical channels: the Dedicated Physical Channel and the Physical Random Access Channel. The default channel is the Dedicated Physical Channel.

Select the channel type from the Select Physical Channel field.

Channel Config

Use this to select the type of DPCH configuration. There are three different channel configuration cases: Case 1, Case 2 and Case 3.

Scrambling Code

This is the scrambling code number. It is used to define the seed of the scrambling code generators. The valid range for this number is 0 to 224-1.

Compressed Mode

The SGD supports compressed mode for channel configuration Case 1 only.

To set up compressed mode for Case 1, turn the Compressed Mode button on. This enables the Configure… button. Touch this button to configure the mode.

Scrambling Type

In the uplink, it is possible to use either a long or short scrambling code. Select the code type required.

DPCCH parameters

Slot Format

Select the required uplink DPCCH slot format. The TFCI and FBI edit boxes are enabled or disabled, depending on the slot format.

Uplink DPCCH slot formats

Slot format	Channel bit rate (kbps)	Channel symbol rate (ksps)	SF	Bits/ frame	Bits/slot	Npilot	NTPC	NTFCI	NFBI	Transmitted slots per radio frame
0	15	15	256	150	10	6	2	2	0	15
1	15	15	256	150	10	8	2	0	0	8□15
2	15	15	256	150	10	5	2	2	1	15
3	15	15	256	150	10	7	2	0	1	8□15
4	15	15	256	150	10	6	2	0	2	8-15
5	15	15	256	150	10	5	1	2	2	15

TFCI Index

The TFI index is used to determine the TFCI bits. You can set the TFCI index. Valid values are 0 to 1023.

FBI Bits

The FBI bit pattern supports feedback from the mobile to the base station. Enter the bits using the pop-up dialog.

Power

Set the relative DPCCH power level. The valid power range is -60 to 0 dB.

TPC Bits

The TPC bit pattern controls transmitter power. Enter the bits using the pop-up dialog.

HS-DPCCH parameters

Channel State

You can include or exclude the HS-DPCCH channel in the uplink DPCH by selecting the channel state. If the HS-DPCCH state is On it is possible to set the HARQ-ACK value, the CQI index, the power, number of slots and timing offset.

CQI

Channel quality indication is HS-DSCH-related feedback signaling. Enter a value in the range 0 to 31.

Timing Offset

To reduce the crest factor, some channels are offset in time with respect to others. The offset is given as number of 256 chips. All the channels are phase-referenced to the primary common control channel. Enter a value for timing offset in the range 0 to 149.

HARQ-ACK

Hybrid-ARQ acknowledgement is HS-DSCH-related feedback signaling. Enter a value in the range 0 to 31.

Power

Set the relative HS-DPCCH power level. The valid power range is -60 to 0 dB.

Number of Slots

Enter the number of slots transmitted in each frame, either 30 r 15.

DPDCH parameters

Symbol Rate

The number of DPDCH channels is dependent upon the symbol rate. For example, a symbol rate of 1920 ksps results in two DPDCH channels. Valid symbol rates are: 0, 15, 30, 60, 120, 240, 480, 960, 1920, 2880, 3840, 4800, 5760 ksps. When the symbol rate is set to 0, no data channel is displayed on the table, nor transmitted.

Channel table

The spreading factor (SF) and channel code are fixed and cannot be edited.

Set the channel power by touching the cell of interest. The valid power level range is -60 to 0 dB.

Set the data source by touching the cell of interest.

E-DPDCH parameters

As for DPDCH, but available only for Case 2 and Case 3 channel configurations.

E-DPCCH parameters

Available only for Case 2 and Case 3 channel configurations.

Power

Set the relative E-DPCCH power level. The valid power range is -60 to 0 dB.

WLAN

Use this to produce a waveform that simulates an IEEE 802.11a, b, g, n, p or ac carrier. The modulation schemes are defined in IEEE Std 802.11a-1999, IEEE Std 802.11b-1999, IEEE Std 802.11g-2003, IEEE Std 802.11n-2009, IEEE Std 802.11p-2010 and IEEE P802.11ac/D1.0.

Touch the ▶ button, and configure WLAN generation using the following screens:

RF Settings

Modulation

Data field configuration

MIMO configuration

Frame settings

MAC header configuration

Filter

Markers

IQ Impairments

Graphics

Modulation

Use this screen to set general modulation parameters for WLAN.
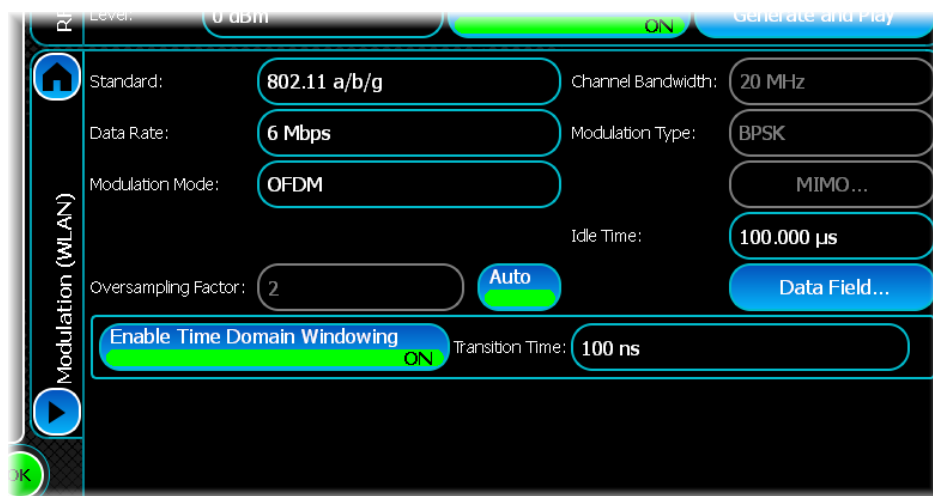
Standard

This controls the type of signal to be transmitted. The default is 802.11a/b/g, which lets you define a signal matching any of these three standards. The 802.11a/b/g setting also supports 802.11p.

802.11n and 802.11ac are provided on the drop-down menu.

Data Rate

Set the PDSU modulation rate by selecting the appropriate value in the data rate box.

The available rates are 1, 2, 5.5, 6, 9, 11, 12, 18, 22, 24, 33, 36, 48 and 54 Mbps.

This control is not available for 802.11n HT and 802.11ac HT/VHT frame formats.

Modulation Mode

For data rates of 6, 9, 12, 18, 24, 36, 48 and 54 Mbps, the modulation modes available are OFDM and DSSS-OFDM. DSSS-OFDM is an 802.11g-specific mode that includes a DSSS header in conjunction with OFDM symbols. The Modulation Mode control is not available for 802.11n HT and 802.11ac HT/VHT frame formats.

Channel Bandwidth

This controls the channel bandwidth of the signal that is transmitted. It is applicable to 802.11n/ac and 802.11p signals only.

Allowed values are:

> 20 MHz for 802.11a/b/g signals (default setting)
> 5 MHz and 10 MHz for 802.11p signals
> 20 MHz and 40 MHz for 802.11n signals
> 20 MHz, 40 MHz, 80 MHz, 160 MHz and 80 + 80 MHz for 802.11ac signals.

For the 802.11ac 80 + 80 MHz channel bandwidth, you must also select the frequency segment of the signal, either Primary or Secondary. This configures which 80 MHz frequency segment is transmitted.

Frame Format

This control is visible only when Standard is 802.11n or 802.11ac.

This controls the frame format of the signal that is transmitted. It is applicable to 802.11n/ac signals only.

For 802.11n signals, the allowed values are Non HT, HT MM (HT Mixed Mode) and HT GF (HT Greenfield).

For 802.11ac signals, the allowed values are Non HT, HT MM and HT GF and VHT (Very High Throughput).

The default is Non HT.

Modulation Type

For 802.11a/b/g and 802.11n/ac non-HT, this field displays information on the type of modulation used to modulate the sub-carriers of the PSDU. The field is read-only for all data rates except for 5.5 and 11 Mbps. For these data rates, you can select CCK or PBCC modulation types. For all other data rates, the modulation and types supported are shown in the table below.

This field is not available for 802.11n HT and 802.11ac HT/VHT frame formats.

Data rates for the different IEEE 802.11g modulation modes and types

DSSS		OFDM or DSSS-OFDM	
Data Rate (Mbps)	Modulation Type	Data Rate (Mbps)	Modulation Type
1	DBPSK	6 & 9	BPSK
2	DQPSK	12 & 18	QPSK
22 & 33	PBCC	24 & 36	16QAM
		48 & 54	64QAM

MIMO...

Grayed out unless Standard is 802.11n or 802.11ac.

This button takes you to the configuration screen for MIMO.

Idle Time

This sets the length of the idle period between PPDU packets. The value is in microseconds (μs).

Oversampling Factor

This sets the oversampling factor used in the filtering process. To oversample by a different amount, disable auto mode by touching the Auto button and entering the new oversampling factor.

Note that the appearance of the window depends on the selected data rate (DSSS or OFDM).

Data Field

This button takes you to the configuration screen for the data field.

Enable Time Domain Windowing

This is selected by default. Time domain windowing is not mandatory in the IEEE 802.11a/g/n/ac standard; however, it is advisable to apply this function. The window function is employed to reduce out-of-band spectrum.

Transition Time

This is the time interval of the time domain windowing, which corresponds to a number of samples overlap on either side of an OFDM symbol. The default is 100 ns. A longer transition time increases the spectrum roll-off at the cost of a decreased delay spread tolerance. To prevent rounding or truncation of the number of samples overlap, enter values in multiples of 100 ns. The transition time range is 0 to the duration of the guard interval defined by the Short GI property.

MCS Index

For 802.11n HT and for 802.11ac HT/VHT frame formats, the MCS (Modulation and Coding Scheme) index defines how the PSDU data is modulated on to the sub-carriers. For HT frame formats, the valid range is 0 to 76 where MCS 0 to 31 support equal modulation on all spatial streams and MCS 33 to 76 support unequal modulation on all spatial streams. For the VHT frame format, the valid range is 0 – 9.

The table below shows the possible modulation and coding index that are applicable for given frame format, channel bandwidth and number of spatial streams.

MCS as a function of Frame Format, Channel Bandwidth and Spatial Streams

MCS Index	Frame Format	Channel Bandwidth (MHz)	Number of Spatial Streams
0 – 7	HT	20 or 40	1
8 – 15 and 33 – 38	HT	20 or 40	2
16 – 23 and 39 – 52	HT	20 or 40	3
24 – 31 and 53 – 76	HT	20 or 40	4
32	HT	40	1
0 – 9	VHT	20, 40, 80, 160 or 80 + 80	1 – 8

Number of Spatial Streams

For the 802.11ac VHT frame format, this control sets the number of spatial streams that are used to transmit the signal. The range is 1 to 8. The default value is 1.

For 802.11n HT frame formats, the number of spatial streams is specified by the MCS index and this control is for information only. This control is not available for 802.11a/b/g signals.

For more information, refer to the Use STBC control.

Data field configuration
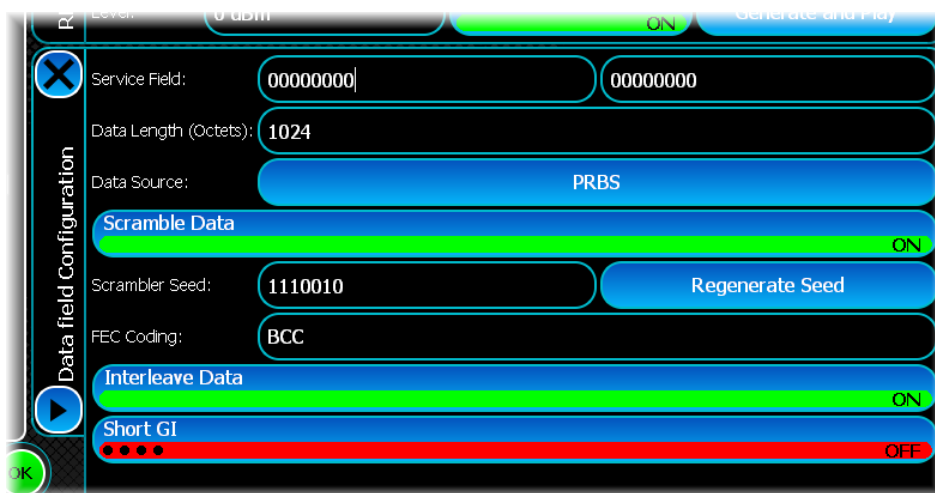
Service Field

This sets the service field to values, in binary, different to that specified in the standard, namely 0. The implementation of the service field is for specialized testing purposes. Note that the service field is disabled for 802.11b/g and 802.11n/ac non-HT data rates that use DSSS modulation. For the 802.11ac VHT frame format, the user-configurable part of the Service Field is restricted to eight bits (instead of 16 bits) because the VHT-SIG-B field CRC is inserted into the second eight bits.

Data Length (Octets)

This sets the number of octets of data to be generated per frame. This excludes the MAC header and FCS. The table shows the range for each framed and unframed 802.11 signal.

Note that with the MAC header and MAC FCS included, the ranges given in the table are reduced by the number of octets in these fields. The ranges defined for HT MM and VHT frame formats may be further reduced due to the constraints of the specification on the L-SIG Length field.

Data Length Range for framed/unframed IEEE 802.11 signals

IEEE 802.11 Signal	Framed Mode				Unframed Mode	
	MAC Header not included		MAC Header included		Minimum	Maximum
	Minimum	Maximum	Minimum	Maximum		
802.11b/g 802.11n Non HT (DSSS mode)	0	2312	0	2312	1	100000
802.11a/g 802.11n/ac Non HT (OFDM mode)	0	4095	0	4095	0	100000
802.11n/ac HT (MM or GF)	0	65535	0	7995 (4095 for A-MPDUs)	0	100000
802.11ac VHT	0	1048574	0	11454	0	100000

Data Source

This sets the data type. Allowed data types are PRBS, All Zeroes, All Ones, User Data and Repeating Pattern. Depending on the data type selected, the data source can be configured by touching the button.

Scramble Data

By default, this is ON. Turn it OFF for waveform generation without scrambling.

Scrambler Seed

This binary edit field sets the seed to be used in the scrambling process.

Regenerate Seed

Click on this button to generate a random scrambling seed.

FEC Coding

This control lets you select either BCC or LDPC data encoding and is only valid for 802.11n/ac HT and 802.11ac VHT frame formats. For 802.11a/b/g and 802.11n/ac non-HT frame formats, this control is disabled and the coding is fixed to BCC.

Interleave Data

By default, this is ON. Turn it OFF for waveform generation without interleaving. For 802.11a/b/g, interleaving is only applicable for data rates that support OFDM or DSSS-OFDM modulation.

For 802.11n/ac HT and 802.11ac VHT frame formats, interleaving is only applicable if the FEC coding is BCC.

Short GI

For 802.11n/ac HT and 802.11ac VHT frame formats, this controls whether the PSDU symbols are generated with the optional short guard interval of 400 ns rather than the standard 800 ns. For 802.11a/b/g and 802.11n/ac non-HT frame formats, this control is disabled and the guard interval is 800 ns.

Touch ✖ to return to the WLAN Modulation screen.

MIMO configuration
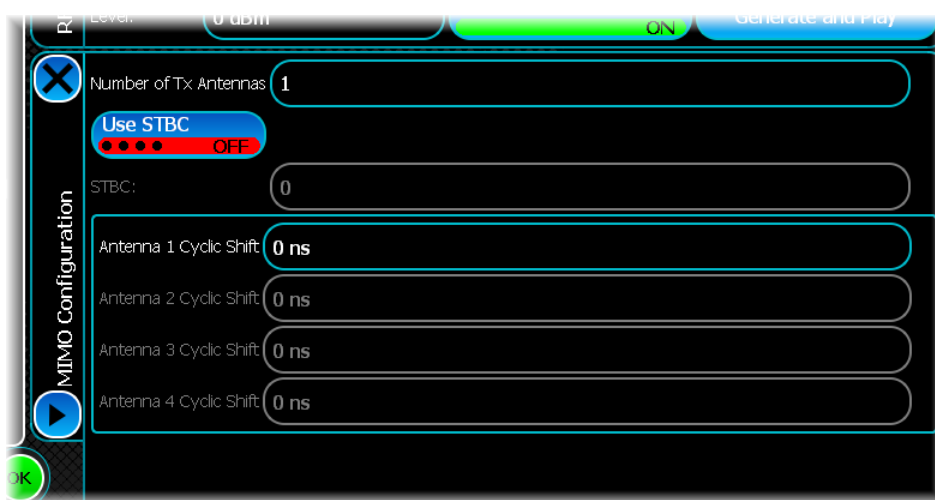
Number of Tx Antennas

For 802.11n HT and 802.11ac VHT frame formats, this controls the number of antennas used to transmit the signal. The range is 1 to 8. The maximum number of antennas that can be used for transmission in 802.11n is four; for 802.11ac, a maximum of eight antennas can be used. The default value is 1.

Use STBC

For 802.11n/ac HT and 802.11ac VHT frame formats, Use STBC defines whether STBC is used or not. By default, the Use STBC button is OFF (STBC not used).

For 802.11n HT frame formats, if Use STBC is ON (STBC used), the STBC control is enabled and can be set as described in STBC.

For the 802.11ac VHT frame format, if Use STBC is ON then NSTS = 2 × NSS and the number of Tx Antennas NTX = NSTS.

STBC

For 802.11n HT frame formats, STBC defines the difference between the number of spatial streams NSS, as defined by the MCS Index, and the number of space-time streams NSTS that are input to the spatial mapper. The valid range is 0 to 2. The default value is 0.

The STBC control is disabled for 802.11ac VHT frame formats.

Antenna Cyclic Shift

Each Antenna Cyclic Shift control lets you define a cyclic shift on the given antenna in the range 0 to 1000 nanoseconds. The default is 0.

The number of enabled Antenna Cyclic Shift controls depends upon the number of Tx Antennas.

Touch ✕ to return to the WLAN Modulation screen.

Frame settings

Use this screen to configure general frame parameters for WLAN.
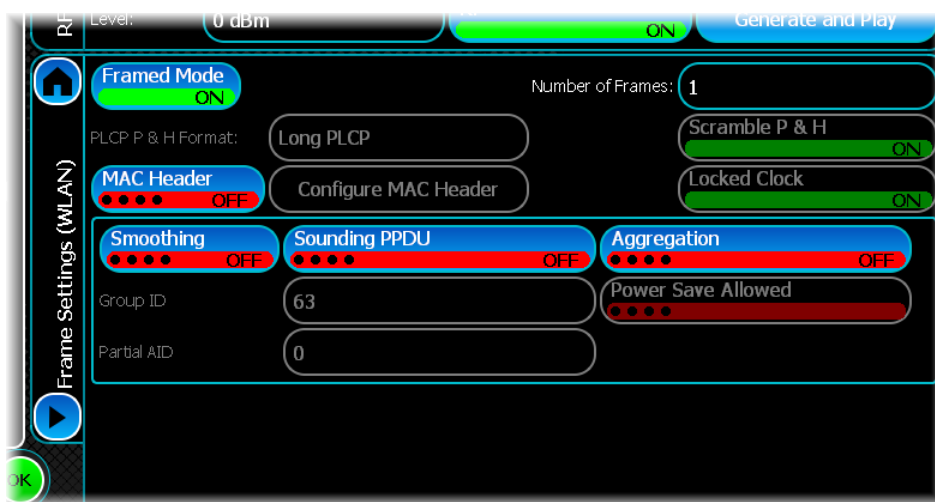
Framed Mode

When this is OFF, only the data part is transmitted. The preamble, signal, the MAC header and MAC FCS are not transmitted, and their respective controls become non-selectable.

Note that in OFDM mode the Service field is still transmitted since it is required for detecting the scrambler initial value.

Number of Frames

This sets the number of times the PPDU and Idle Period pair are repeated in a file. The data is contiguous throughout the frames. Note that for a PRBS data source, the data is not repeated throughout the frames.

PLCP P+H Format

This sets the PLCP Preamble and Header Format. There are two available formats, long and short.

The long format is composed of 144 preamble bits and 48 header bits (both modulated with 1 Mbps DBPSK), and is available for all data rates. The short format is available to all data rates, apart from the 1 Mbps data rate. It is composed of 72 preamble bits modulated with 1 Mbps DBPSK, and 48 header bits modulated with 2 Mbps DQPSK.

Note that the PLCP P+H Format is only available for 802.11a/b/g and 802.11n/ac non-HT data rates that support DSSS and DSSS-OFDM modulation.

Locked Clock

When ON, this indicates in the frame header that the transmit frequency and the symbol clocks are derived from the same oscillator.

This control is only applicable for non-HT data rates that support DSSS or DSSS-OFDM modulation. However, the IEEE 802.11g standard requires this to be fixed and the control is disabled for the 802.11g-specific modes and data rates. These data rates are 22 and 33 Mbps and 6, 9, 12, 18, 24, 35, 48 and 54 Mbps when the modulation mode is DSSS-OFDM.

Scramble P&H

When this button is ON, the PLCP Preamble and Header are scrambled before modulation as specified in the standard.

Note that this button is only available for 802.11a/b/g and 802.11n/ac non-HT data rates that support DSSS and DSSS-OFDM modulation.

MAC Header

When ON, prefixes a MAC header with user-selected fields to the data in the PSDU. The Configure MAC Header button is also enabled.

For the 802.11ac VHT frame format, if MAC Header is included, an A-MPDU is configured for generation.

Configure MAC Header

This button takes you to the configuration screen for the MAC header.

Smoothing

This control sets the smoothing bit in the HT-SIG field and is therefore only valid for 802.11n/ac HT frame formats. It is disabled for 802.11a/b/g and 802.11n/ac non-HT and 802.11ac VHT frame formats.

Sounding PPDU

This control sets the sounding bit in the HT-SIG field and is therefore only valid for 802.11n/ac HT frame formats. It is disabled for 802.11a/b/g and 802.11n/ac non-HT and 802.11ac VHT frame formats.

Aggregation

This control sets the aggregation bit in the HT-SIG field and is therefore only valid for 802.11n/ac HT frame formats. It is disabled for 802.11a/b/g and 802.11n/ac non-HT and 802.11ac VHT frame formats.

For the 802.11n/ac HT frame formats, when Include MAC Header and Aggregation field are both checked, an A-MPDU shall be configured for generation.

Group ID

This control sets the group ID field in the VHT-SIG-A field and is therefore only valid for 802.11ac VHT frame formats. It is disabled for 802.11a/b/g/n and 802.11ac non-HT/HT frame formats. The range is 0 to 63 and the default value is 63.

Partial AID

This control sets the partial AID field in the VHT-SIG-A field and is therefore only valid for 802.11ac VHT frame formats. It is disabled for 802.11a/b/g/n and 802.11ac non-HT/HT frame formats. The range is 0 to 511 and the default value is 0.

Power Save Allowed

This control sets the TXOP_PS_NOT_ALLOWED bit field in the VHT-SIG-A field and is therefore only valid for 802.11ac VHT frame formats. It is disabled for 802.11a/b/g/n and 802.11ac non-HT/HT frame formats. When not selected, the VHT-SIG-A bit field is set to 1 to indicate that power saving is not allowed.

MAC header configuration

This shows the MAC Header settings dialog.
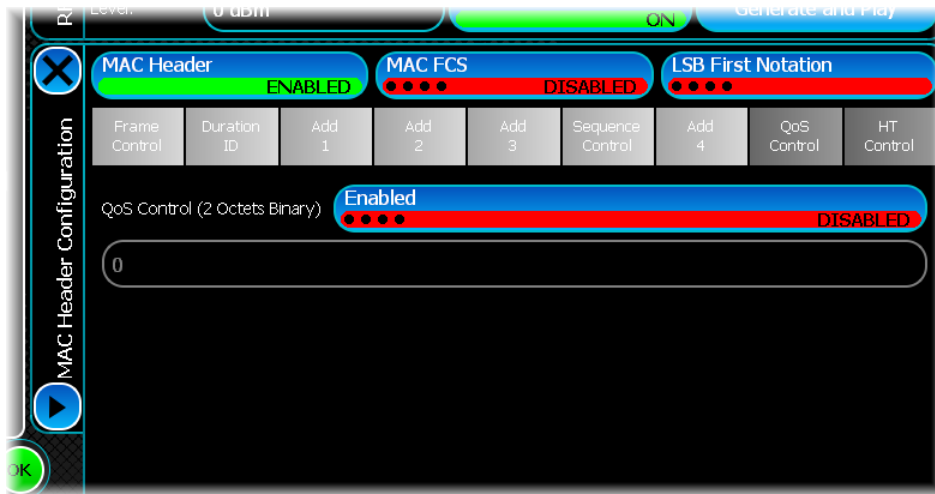
The screen displays the layout of the MAC header fields in MSB-first notation. You can override this notation to comply with the LSB-first notation described in the IEEE 802.11 standard by turning ON the LSB First Notation button.

Note that in LSB First Notation, the Fragment part corresponds to the lower four bits while the Sequence part corresponds to the upper 12 bits.

Selecting a field

To select a field, click on the item in the graphical control. The control contents below the graphic change depending on the selected item.

Optional fields

Depending on the type of MAC message being transmitted, you may want to disable one or more of the Address fields or the Sequence Control field. You can toggle the state of an optional field using the button. The default is ON, indicating that the field is transmitted.

Edit Mode

Some fields can only take in binary input and some can take hexadecimal input as indicated by the field label in the edit control. The edit boxes also have a limit on the number of characters that you can enter.

Touch to return to the Frame settings screen.

Filter

To set up the filter for WLAN, select the Filter tab.
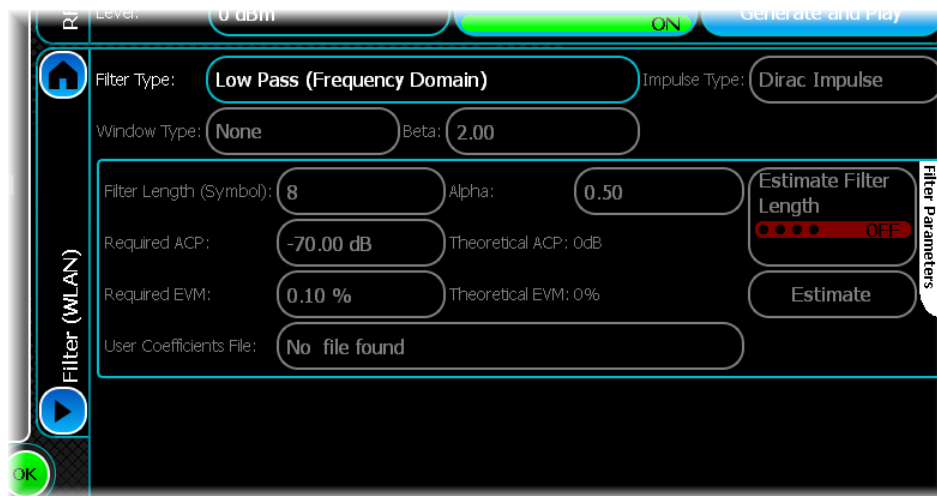
For OFDM, DSSS-OFDM non-HT, HT and VHT signals there are two filter types: ideal low pass and low pass (frequency domain). There is also the choice of no filtering. The default filter is Low Pass (Frequency Domain).

In this instance, the filtering and oversampling factor is carried out in the frequency domain. This is the preferred approach, as it tends to give better EVM performance. If you would prefer to filter in the time domain, select Ideal Low Pass. This method provides a better out-of-band spectrum.

For DSSS non-HT signals, you can choose from the standard list of filters.

Remaining standard filtering options are explained in the common Filter section.

Markers

To set up the markers for WLAN, select the Markers tab.
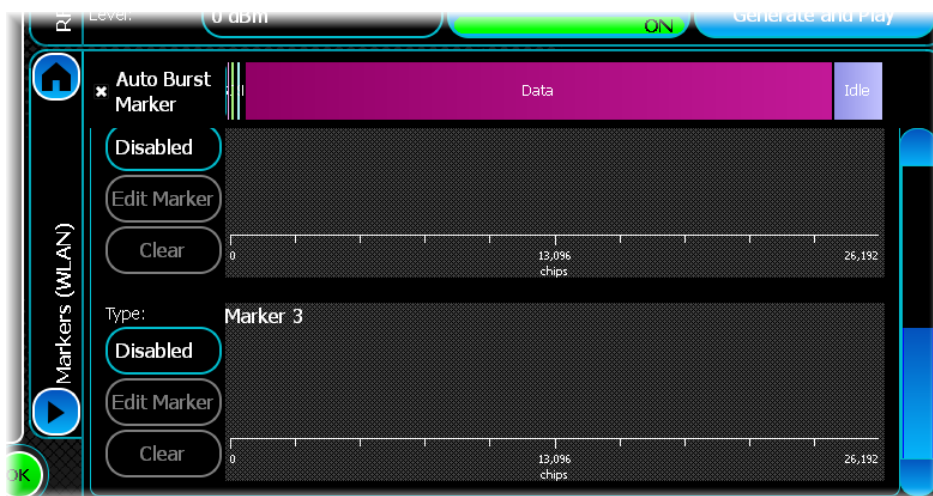
Markers can be set up for a single frame and repeated for all the frames.

Auto Burst Marker

This control lets you select whether a Burst Marker definition is defined automatically, based upon the configuration of the signal. When this control is selected, the first marker is turned on and configured as a burst marker. The on and off times of this marker are updated automatically if any properties of the signal are changed.

PPDU Graphic

The PPDU graphic, located at the top of the screen, provides a graphical representation of the different parts of the signal you are generating in relation to the size of the frame.

To view exact details about the contents of the signal being generated, touch the PPDU graphic, and a more detailed table of PPDU contents is shown:

Marker on/off times are defined in chips. For 802.11b/g DSSS signals, chips are defined as per IEEE Std 802.11b-1999. For all other frame formats, chips are defined as the number of samples at the sampling rate prior to oversampling.

The table shows how the marker unit definition changes with signal type and channel bandwidth.

Definition of the marker units for each IEEE 802.11 signal

IEEE 802.11 Signal	Modulation Mode	Channel Bandwidth	Sampling Rate	Duration of 1 marker chip
802.11b/g, 11n/ac non-HT	DSSS	N/A	11 Mcps	0.0909 µs
802.11a/g, 11n/ac non-HT	OFDM DSSS-OFDM	20 MHz	20 Msps	0.05 µs
802.11n/ac non-HT, HT, VHT	OFDM	20 MHz	20 Msps	0.05 µs
802.11n/ac non-HT, HT, VHT	OFDM	40 MHz	40 Msps	0.025 µs
802.11ac non-HT, VHT	OFDM	80 MHz 80 + 80 MHz	80 Msps	0.0125 µs
802.11ac non-HT, VHT	OFDM	160 MHz	160 Msps	0.00625 µs

Remaining standard marker options are explained in the common Markers section.

Controlling another S-Series instrument

You can attach S-Series instruments together physically (using Aerolock™) and electrically (via USB plug & play) to form a combined instrument with multiple functions. After you connect a module to the SGD via USB, its presence is recognized automatically, and the features and applications relevant to that module become available in the on-screen menu of the controlling SGD, whose menu bar shows 'SCO/SPA Front Panel'.

Many applications are being supported, including tests for power amplifiers, receiver selectivity, intermodulation, adjacent channel power and mixer testing, with further developments all the time: check the current data sheet at http://www.aeroflex.com/ats/products/category/Signal_Sources/S-Series.html.

Storing and recalling instrument settings

You can save the setup of the instrument using a file name, and then recall the setting later. This lets you return easily to a preferred measurement configuration.
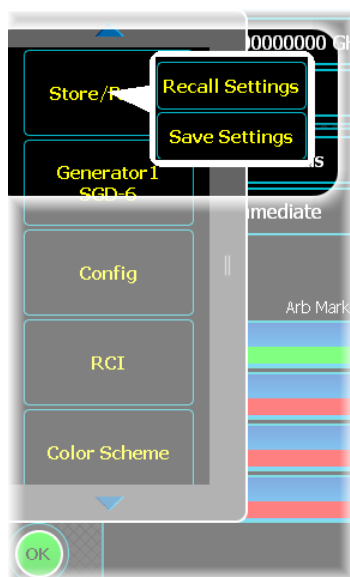
Store

Touch Store/Recall, Save Settings. The popup shows the current file location.

Enter a file name using the virtual keyboard that pops up when you touch the File Name field.

When you touch Save, the instrument stores the current configuration and settings to the non-volatile memory or to the optional removable hard drive.

Copying settings between instruments

Instrument settings are stored in XML format files that can be copied from one S-Series instrument to another (the instruments must be the same model type, SGA, SGD or SVA) to facilitate quick setup of a particular configuration.

The files are located at *Documents and Settings\S-Series\My Documents\Aeroflex\SaveFile* and have a *.pxs* suffix.

Recall

Touch Store/Recall, Recall Settings. A popup lets you browse for currently stored files.

Touch the file you want to recall, and the instrument is configured with the stored settings.

Note: when using the Store and Recall functionality, only the configuration of the active or foreground modulation or measurement type is saved or restored. If you have opened more than one modulation or measurement type then it is still active, but in the background, and so is not affected.

If you wish to save/recall configurations of background modulation or measurement type, reselect each one in turn and store or recall it individually.

Remote control interface (RCI)

You can operate the instrument remotely over an internet link or via GPIB.

Select RCI from the menu tab.
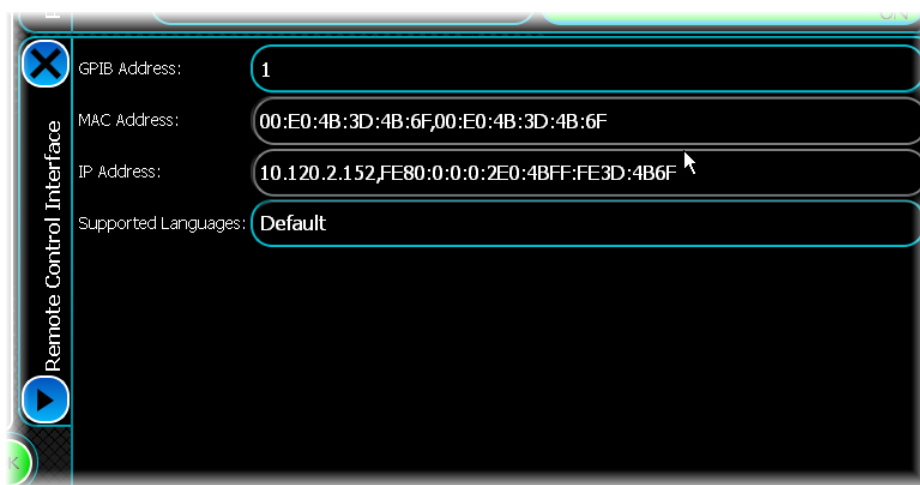
GPIB Address

This shows the instrument's GPIB address.

MAC Address

When the instrument is connected to a network, this shows the instrument's MAC address.

IP Address

When the instrument is connected to a network, this shows the instrument's IP address, which can be used to control it remotely over the internet. An alternative method of finding this is shown below.

Supported Languages

Use this to select from either the default SCPI-based programming language, or from a number of instrument emulation modes that allow the SGD to respond to the remote commands for other instruments.

Remote operation via GPIB

You can operate the instrument remotely via the GPIB (General Purpose Interface Bus) interface. The GPIB interface provides instrument control with full talk and listen capability. The command syntax conforms to IEEE 488.2.

Background to GPIB

GPIB is a high-performance bus that allows instruments and computers to be combined into integrated test systems.

The bus and its associated interface operations are defined by the IEEE 488.1 standard. The later IEEE 488.2 standard defines the interface capabilities of instruments and controllers in a measurement system. This standard also defines a set of commands that a device must accept, and programming errors that a device must recognize and report. The cables that link the devices on the bus consist of 16 signal lines that are divided into three groups:

- Data bus: eight signal lines that are used to send data from one device to another.

- Handshake lines: the transfer of each byte of information over the data bus is controlled by a three-wire handshake process between the source of the data (talker) and the destination device (listener). This forces data transfers to occur at the speed of the slowest device, and ensures data integrity in multiple listener transfers. The handshake cycle is usually performed automatically and is transparent to the GPIB programmer.

- Control lines: five control lines (or interface management lines) are used to both send bus commands and to address devices.

Devices that send data over the data lines are called talkers; devices that receive data over the same lines are called listeners. Controllers are devices that use the control lines to specify the talker and listener in a data exchange. A GPIB system can contain more than one device with controller capabilities, but only one is allowed to control data exchanges at any given time.

The device currently controlling data exchanges is called the active controller. One of the controller-capable devices can be designated as the system controller, which can take control of the bus even if it is not the active controller. Up to 15 instruments can be connected to a GPIB system. GPIB addresses are used to identify devices on the bus. The active controller uses these addresses to specify which device talks (via a Talk Address) and which device listens (via a Listen Address) during a data exchange. Each device must therefore have a unique address, and is set on the instrument itself, using either a front-panel key sequence or a rear-panel switch. Any given device address can specify two corresponding address codes, a Talk Address and a Listen Address. The decimal equivalent of the allowable address range is 0 to 30 inclusive.

SCPI compatibility

This instrument may be operated remotely via an interface that conforms to:

- IEEE Std 488.1-1987, which defines the electrical, mechanical and low-level protocol characteristics of the bus structure, the GPIB (General Purpose Interface Bus)

- IEEE Std 488.2-1987, which defines standard codes, formats, protocols and common commands for use with IEEE Std 488.1.

The instrument is not fully compliant with SCPI (Standard Commands for Programmable Instruments) because many product features are not covered by that standard, and modern software trends favor the use of instrument drivers as a means of achieving interchangeability. However, we recognize that SCPI is in common use by system developers and a number of SCPI features that make system integration easier have been implemented. These include the extended status reporting structure, the error-numbering scheme, the command mnemonic derivation rules (long and short form), and many of the most frequently used commands themselves. Refer to SCPI 1999 (standard available from the IVI Foundation) for details.

Command Reference Manual

All available GPIB commands, together with an introduction to the conventions used for GPIB programming, are listed in the SGD Remote Command Reference Manual, part no. 47090/133.

Remote operation over the internet

To do this, you need the instrument's IP address (10.120.2.152 in the example above), and some remote control software (such as VNC®) that lets you view and interact with the SGD from another computer on the internet. The SGD is supplied with VNC® remote control software installed.

On the SGD…

1. Exit the SGD application by touching Exit Application on the menu tab to access the Windows screen.
2. Log in as administrator using the administrator password *sseries.*
3. In Control Panel, select Windows Firewall.
4. Select the <Exceptions> tab.
5. Select [Add Port].
6. Select Name: and enter `VNC_5800`.
7. Select Port Number: and enter `5800`.
8. Ensure TCP is checked.
9. Go back to the <Exceptions> tab and ensure VNC_5800 is checked.
10. Close Control Panel.
11. Close Control Panel and restart the SGD application from the desktop. Note that it is not necessary to restart the instrument.

On your PC…

12. Go to your web browser on your PC and enter the IP address for the SGD in the form `http://<ipaddress>:5800`.
13. The VNC window appears: click OK. The SGD's desktop now appears on the laptop/PC web browser.
14. Open the SGD application from the desktop and operate the instrument normally.

Note: remote control is useful for monitoring and making measurements, but due to the inherent delays, it is unsuitable for taking instantaneous readings.

Alternative method of ascertaining IP address
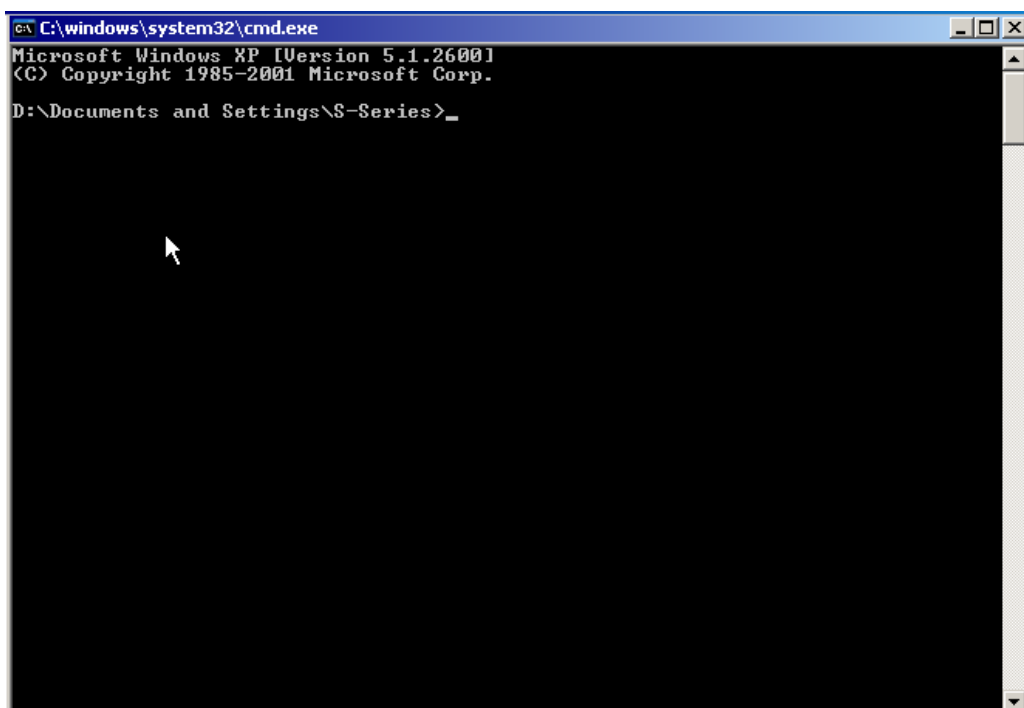
1. Exit the SGD application by touching Exit Application on the menu tab to access the Windows screen.
2. Note the IP address of the SGD by touching Start\Run and entering cmd in the Run screen:
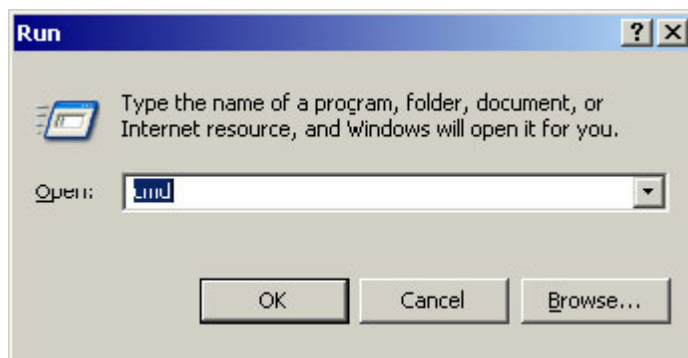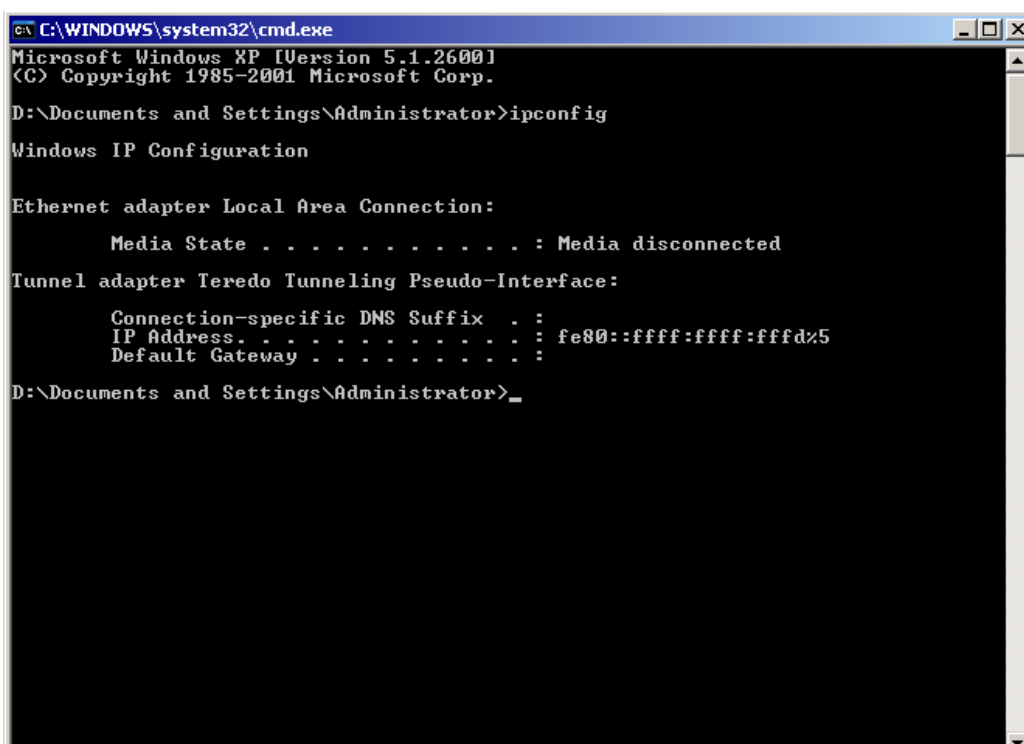
3.   Touch OK. The command line appears:

4.   Type `ipconfig`, and press Enter. The Windows IP Configuration screen appears, which shows the instrument's IP address. Make a note of this.

Accessing Windows

You can return to the Windows desktop by two methods:

Accessing Windows and closing the SGD application

Touch the Exit Application button (on the menu tab) to close the SGD application:
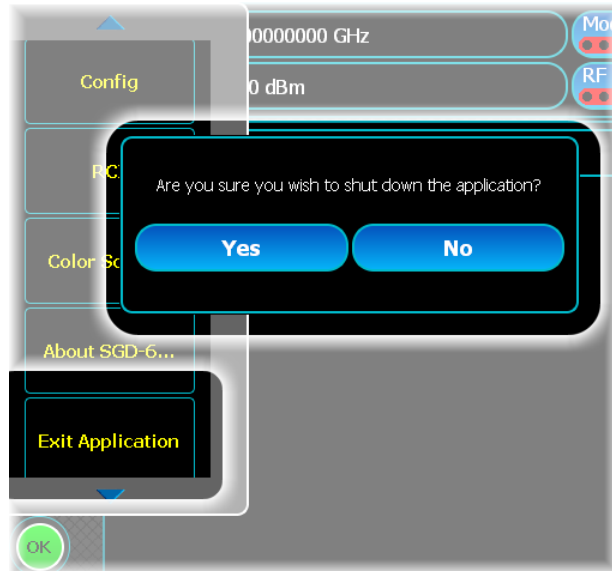
Touch Yes. The SGD application closes and you now see the Windows desktop.

Accessing Windows while keeping the SGD application open

If you do not want to close down the SGD application, plug in a USB keyboard and press ⊞ + E to display the Windows desktop. The SGD application remains active.

Key ALT + TAB to move between the open applications.

Powering down

Press the on/off switch on the front panel.

The instrument takes a few seconds to power down, first closing the SGD application, then Windows®. There is no need to exit Windows separately.

Removing power

Note: the on/off switch does not isolate the instrument from the line power. To remove all power from the instrument, disconnect the power cord.

CAUTION

Do not disconnect the power cord until the instrument has finished powering down, as you may corrupt data.

About the instrument

Touch the About... button (on the menu tab) to see information about the instrument, such as software version:
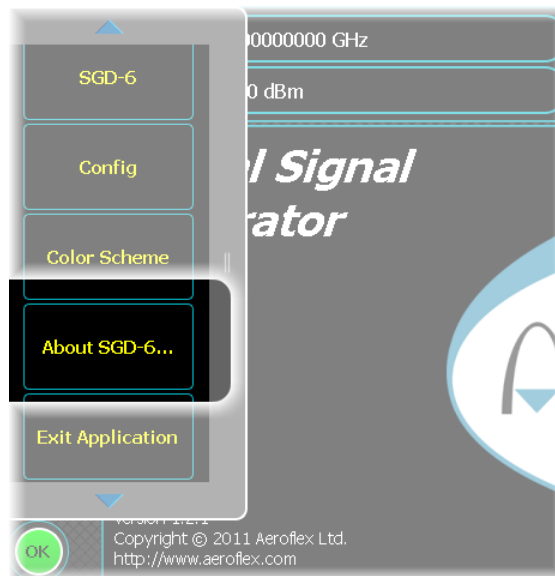
Hardware information

You can view information about the SGD and also other S-Series instruments connected to it by Aerolock™.

Touch the Config button (on the menu tab)...
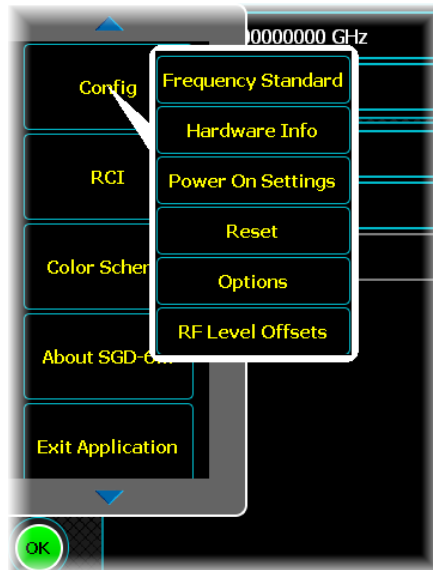
...and select Hardware Info from the drop-down menu.

The Hardware Info screen shows:

Instrument: the items that form the SGD (not the SGD itself). Touch the Instrument button for a drop-down list of items.

Resource: the Aeroflex hardware modules that are fitted within the instrument. Touch the Resource bar for a drop-down list of all hardware modules fitted.

Serial No: the Aeroflex serial numbers of these hardware modules.
Note: these are not serial numbers of the SGD instrument itself. Find the instrument's serial number on the rear panel, on the Options screen, or through the remote *IDN? command.
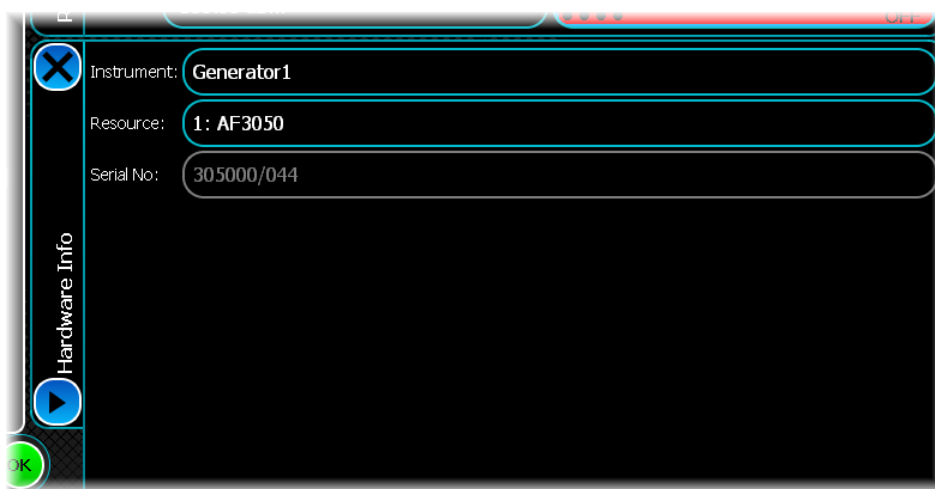
Manufacturer

This instrument is manufactured by:

Aeroflex Ltd.
Longacres House
Six Hills Way
Stevenage SG1 2AN
UK

Patent information

This instrument is protected by the following:

UK patent GB2484299B

UK patent application GB2475514A

Color scheme

Touch the *Color Scheme* button (on the menu tab) to change the appearance of the SGD screen:
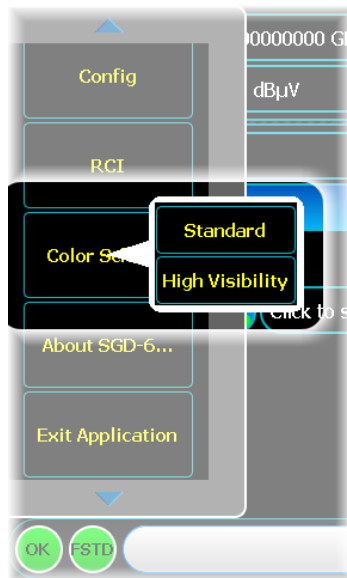
Standard displays white text on a black background, with colored buttons.

High Visibility displays black text on a white background, with minimal color on the screen.

Aerolock

Aerolock™ is a simple, strong interlocking mechanism...
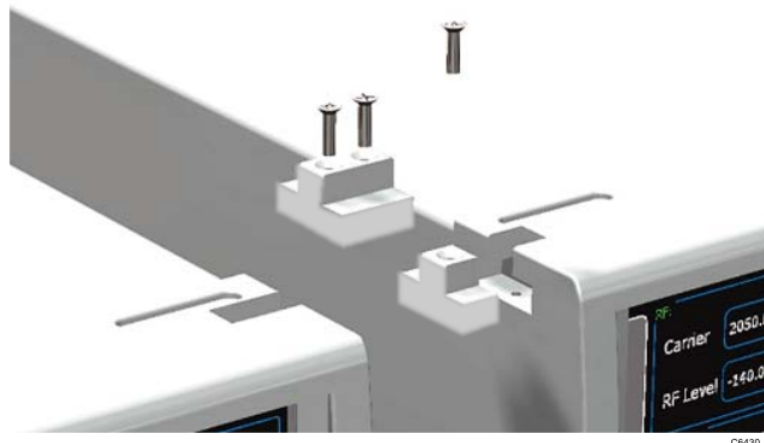
...that allows S-Series instruments to be joined together.

How it works

Each S-Series instrument is supplied with short and long T-bars that are located in the cut-outs at the top and bottom of the screen surround. When joining instruments together, you swap these T-bars over to allow the long T-bar to form a bridging link, and also screw the rear bumpers together.

Procedure: front

For example, to join two instruments side-by-side, remove the long T-bar from the left-hand instrument...
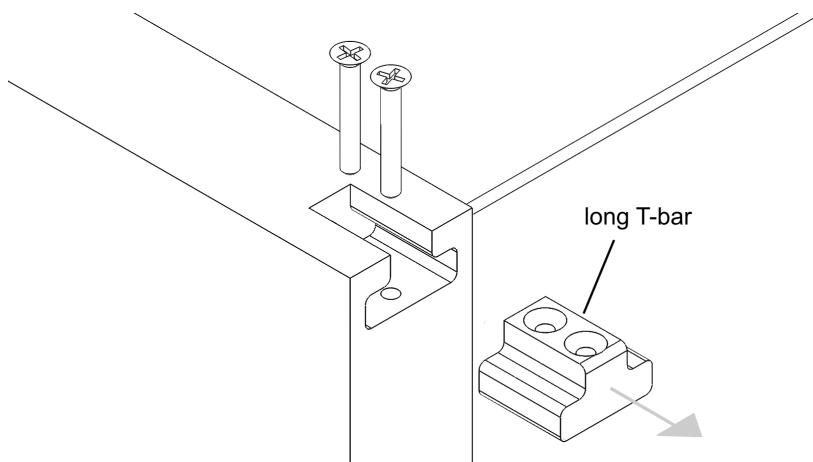
long T-bar

...move the short T-bar from the right-hand instrument into the vacated space on the left-hand instrument...

short T-bar
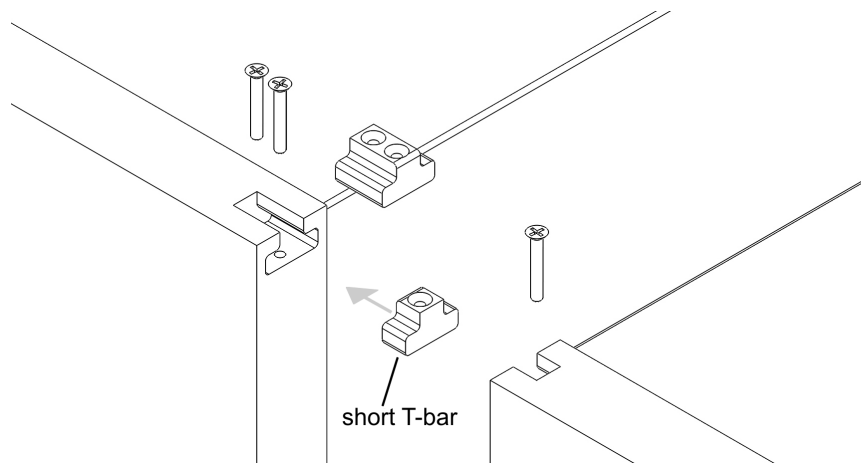
...replace the long T-bar in the left-hand instrument...
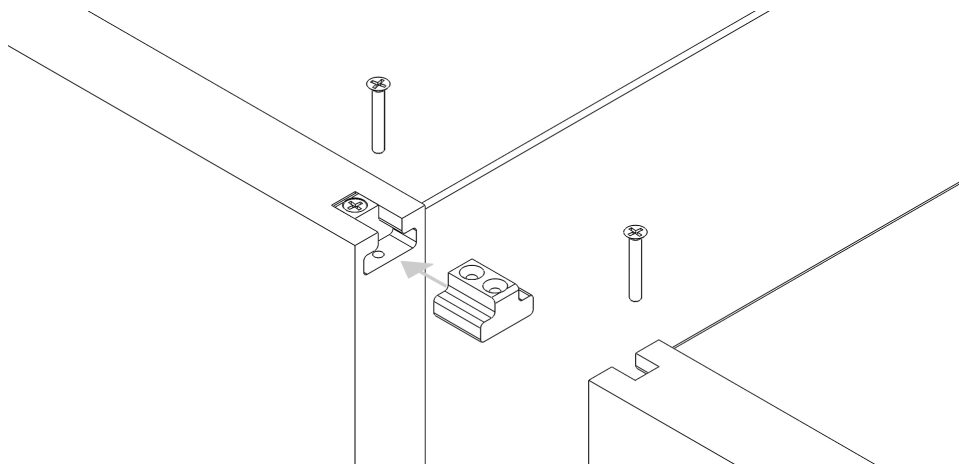
...and join the two instruments using the long T-bar as the bridging piece...
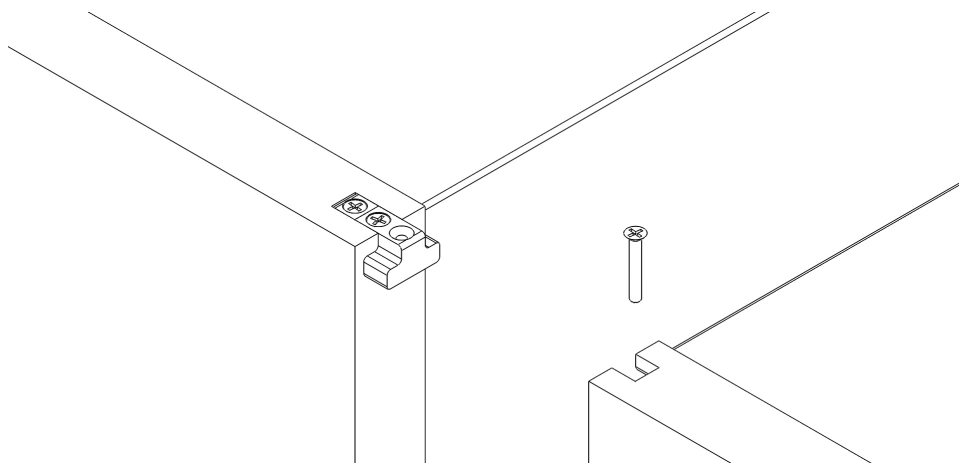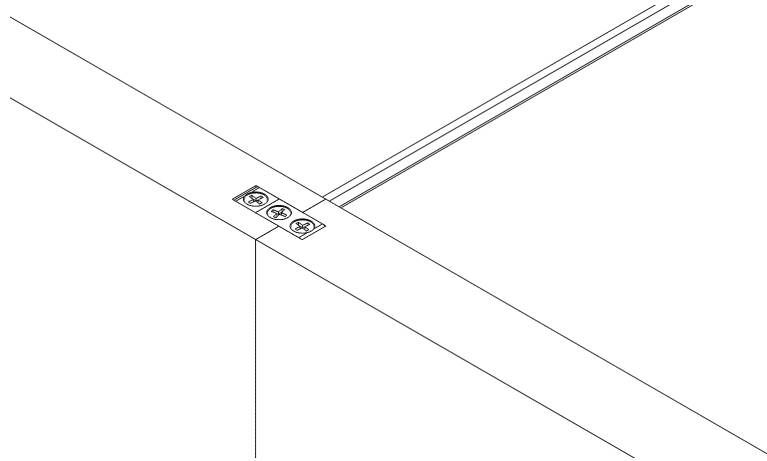
Do this at both the top and bottom of the screen surrounds.

Procedure: rear

At the rear of the instruments, screw the rear bumpers together, using the screws and tapped inserts provided in the adjacent bumpers, top and bottom.
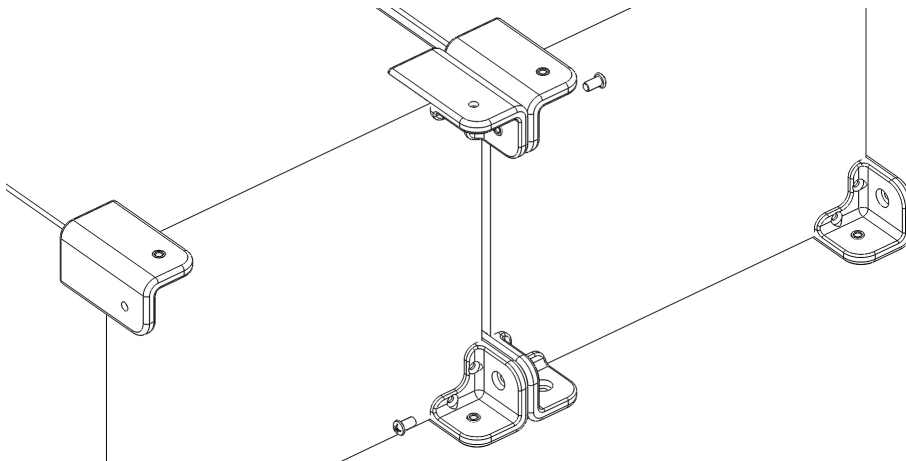
The two instruments are now joined firmly together:

Adding a full-width module

A full-width module, such as an SCO combiner, fits underneath two half-rack-width instruments using I-bars (supplied with the module) in exactly the same way as T-bars (remove the feet from the instruments first). Again, rear bumpers are screwed together also to provide stability.
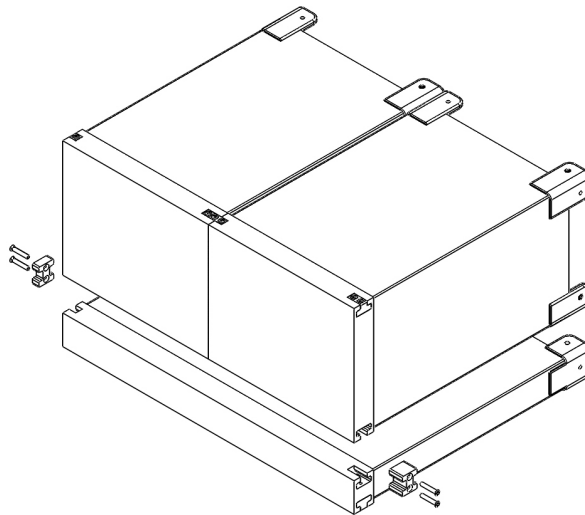
Electrical connections

Signal and control connections are created by USB cables that link the master instrument (for example, the SGD) and further modules such as signal generators, analyzers, and combiner.

Technical support

Aeroflex products are designed and manufactured to provide a high level of trouble-free performance. However, instruments typically require routine maintenance and calibration and installation of new software. If you require help or have a question, you can contact a service facility in your area. In the first instance, contact the Aeroflex help desk at www.aeroflex.com/ats/contact.cfm.

Installing software

From time to time, Aeroflex releases new versions of the SGD application software. You can download the new software at http://www.aeroflex.com/ats/products/category/Signal_Sources/S-Series.html..

Contact the Aeroflex help desk if you need assistance.

Installation procedure

To install a new version of the SGD application:

1. Connect a USB keyboard to the instrument

2. Exit the SGD application (touch Exit Application on the menu tab or press Alt+F4 on the keyboard).

3. Log off Windows. The logon screen appears:
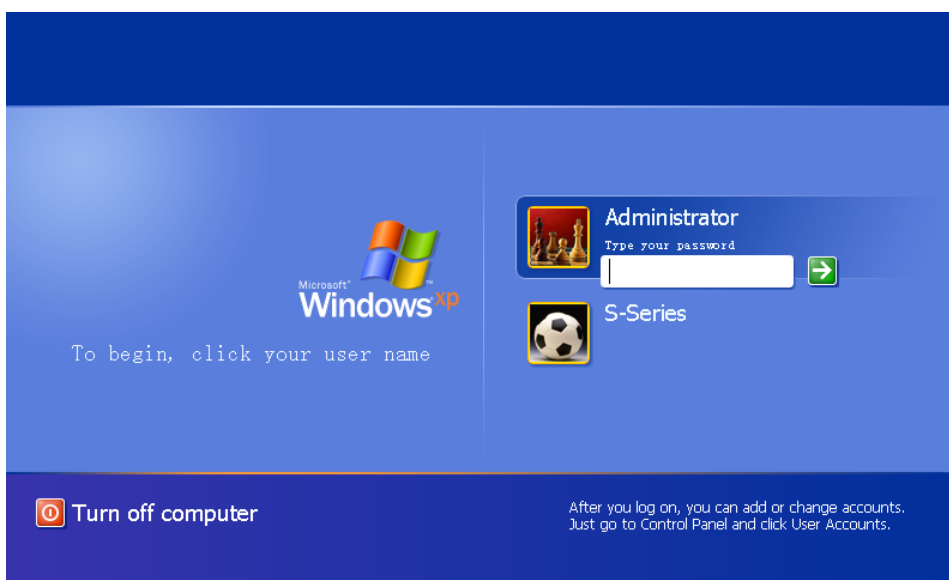
4. Log on again as Administrator.
   The password is **sseries**.

5. Open Windows Explorer (click *Start\All Programs\Accessories\Windows Explorer*).

6. Browse to the location of the installer file (if necessary, download the file from the Aeroflex website).

7. Open the installer, double-click the setup.exe file and follow the on-screen instructions. The file loads, replacing the current SGD application.

8. Restart the instrument (follow *Start\All Programs\Aeroflex\SGD Digital Signal Generator),* or log off Windows and log in again as System).

9. Confirm that the updated application is running by checking the version number on the About... screen.

Installing a license

You may need to add a new software license, for example, to permit analysis of a modulation scheme that is not currently enabled on your instrument. The software license 'unlocks' software options that are installed together with the instrument's application software.

A license file may provide one or more options.

The current data sheet shows which options are available for your instrument.

Some options require hardware changes, and may not be available to retrofit.

Contact the Aeroflex help desk if you need assistance.

Installation procedure

To install a new license:

1. Connect a USB keyboard to the instrument

2. Exit the SGD application (touch Exit Application on the menu tab or press Alt+F4 on the keyboard).

3. Log off Windows. The logon screen appears:
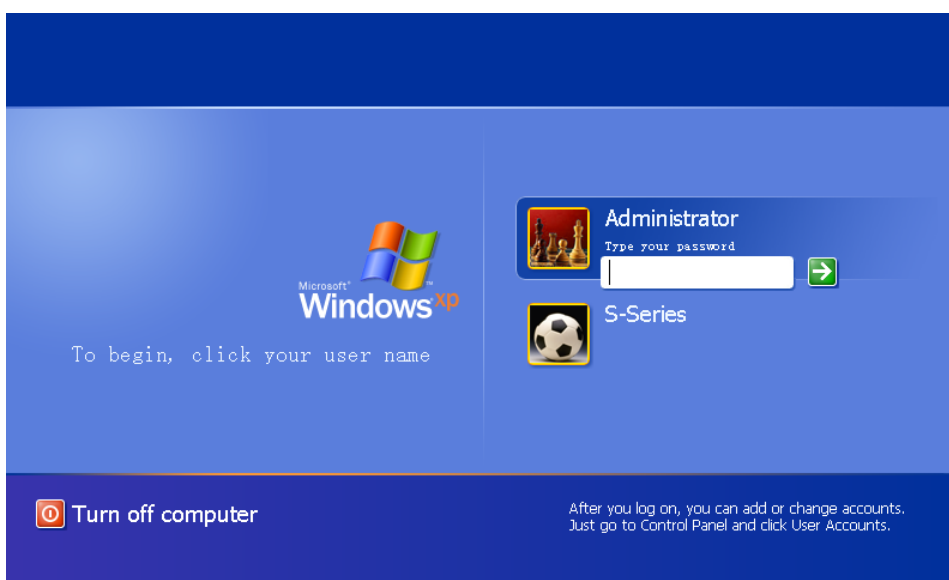
4. Log on again as Administrator.
   The password is **sseries**

5. Open Windows Explorer (right-click *Start*).

6. Browse to the location of the license file (this may have been sent to you).

7. Copy the file to *My Documents\Aeroflex\Options* and note its name.

8. Restart the SGD application from the desktop icon

9. Touch Config\Options on the <u>menu tab</u>.
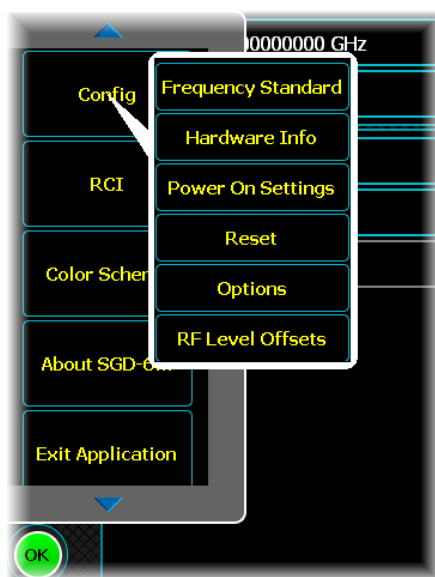
10. The Options screen appears:
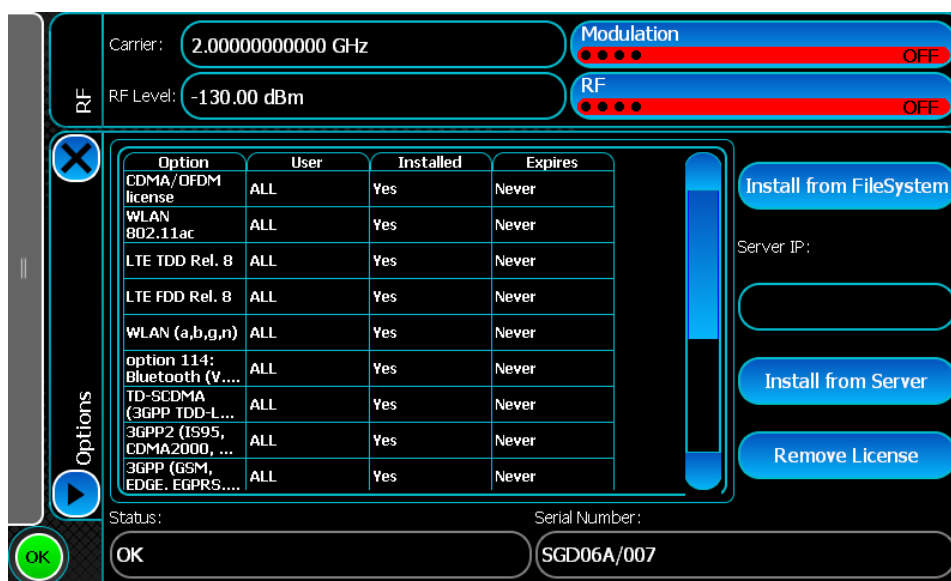
11. Touch Install from FileSystem. You are prompted for File location (this is Main Drive) and File name. Select the correct license file from the drop-down list.

12. Touch Load. The license is updated.

13. <u>Power down</u> the instrument and <u>power it up</u> again.

14. Confirm that the new option(s) appear on the Options screen.

Install a license from a server

You can install a license from a server: enter the server's IP address in the Server IP control and touch Install from Server.

Removing a license

Touch this to remove the highlighted license. You will be asked to confirm this choice. Once a license is deleted, it must be reinstalled before it becomes available again.

Serial number

This displays the instrument's serial number.

Maintenance

In the UK the 'Electricity at Work Regulations' (1989) section 4(2) places a requirement on the users of equipment to maintain it in a safe condition. The explanatory notes call for regular inspections and tests together with a need to keep records.

The following electrical tests and inspection information is provided for guidance purposes and involves the use of voltages and currents that can cause injury. It is important that these tests are only performed by competent personnel.

Calibration

The recommended calibration interval is two years. If the instrument is due for calibration, or you suspect that it is not performing correctly, contact the Aeroflex help desk at www.aeroflex.com/ats/contact.cfm.

Routine

Safety testing and inspection

Prior to carrying out any inspection and tests, you must disconnect the instrument from the power supply, and remove all external signal connections. All tests should include the instrument's own power cord, all covers must be fitted and the power switch must be in the ON position.

The recommended inspection and tests fall into three categories and should be carried out in the following sequence:

1. Visual inspection

Carry out a visual inspection on a periodic basis. This interval is dependent on the operating environment, maintenance and use, and should be assessed in accordance with guidelines issued by the Health and Safety Executive (HSE) or national or local regulations. As a guide, this equipment, when used indoors in a relatively clean environment, would be classified as 'low risk' equipment and hence should be subject to safety inspections on an annual basis. If the use of the equipment is contrary to the conditions specified, you should review the safety retest interval.

As a guide, the visual inspection should include the following where appropriate:

- Check that the equipment has been installed in accordance with the instructions provided (for example, that ventilation is adequate, supply isolators are accessible, supply wiring is adequate and properly routed).

- Check the condition of the power cord and supply connector(s).

- Check that the disconnecting device or isolator is easily accessible.

- Check the correct rating and type of supply fuses.

- Check the security and condition of covers and handles.

- Check the presence and condition of all warning labels and markings, and supplied safety information.

- Check the wiring in rewireable plugs and appliance connectors.

- Check the cleanliness and condition of any ventilation fan filters.

- Check the supply indicator functions (if fitted).

If any defects are noted, rectify them before proceeding with the following electrical tests (unless local instructions apply).

2. Ground bonding tests

Ground bonding tests should be carried out using a 25 A (12 V maximum open circuit voltage) DC source. Limit tests to a maximum duration of 5 seconds. The pass limit should be 0.1 Ω after allowing for the resistance of the power cord. Do not exceed the test duration, as this may cause damage to the equipment. Carry out the tests between the supply ground and exposed case metalwork. Make no attempt to perform the tests on functional grounded areas (for example, signal-carrying connector shells or screen connections), as this will result in damage to the equipment.

3. Insulation resistance tests

Apply a 500 V DC test between the protective ground connection and combined live and neutral supply connections, with the equipment supply switch in the ON position. It is advisable to make the live/neutral link on the appliance tester or its connector to avoid the possibility of returning the equipment to the user with the live and neutral poles linked with a temporary strap. Apply the test voltage for 5 seconds before taking the measurement.

Aeroflex employs reinforced insulation in the construction of its products, so a minimum pass limit of 7 MΩ should be achieved during this test.

Where a DC power adapter is provided with the equipment, the adapter must pass the 7 MΩ test limit.

We do not recommend dielectric flash testing during routine safety tests. Most portable appliance testers use AC for the dielectric strength test, which can cause damage to the supply input filter capacitors.

Rectification

We recommend that the results of the above tests are recorded and checked during each repeat test. Investigate significant differences between the previous readings and measured values.

If any failure is detected during the above visual inspection or tests, disable the equipment. The fault should be rectified by an experienced service engineer who is familiar with the hazards involved in carrying out such repairs.

Replace safety-critical components with equivalent parts only, using techniques and procedures recommended by Aeroflex.

The above information is provided for guidance only. Aeroflex designs and constructs its products in accordance with international safety standards such that in normal use the products represent no hazard to the operator. Aeroflex reserves the right to amend the above information in the course of its continuing commitment to product safety.

Cleaning

Before starting any cleaning, switch off the instrument and disconnect it from the supply by removing the power cord.

Case exterior: use a soft cloth moistened with water to clean the case; do not use aerosol or liquid solvent cleaners.

Touch screen: take care not to scratch the touch screen during use or when cleaning. Clean the touch screen by wiping a slightly damp, soft, lint-free cloth gently over the surface. If this does not remove finger marks, dampen the cloth sparingly with isopropyl alcohol.

WARNING *Isopropyl alcohol is flammable.*

Air inlet remove dust and any other impediments to airflow from the air inlet holes on the sides and underside of the instrument

Putting into storage

If you are putting the instrument into storage, ensure that the following conditions are maintained:

Temperature range: -40 to +71°C

Humidity: up to 95% at +40°C

Removing the hard drive

Note: this procedure applies only to instruments fitted with Option 005.

1. Shut down the instrument.

2. Undo the two captive thumbscrews retaining the hard drive unit to the rear panel.

3. Slide out the hard drive unit.

4. Protect the connectors on the hard drive unit. Seal it in an antistatic bag, enclose it in bubble wrap, and protect it from mechanical shocks.

Rack mounting

S-Series products can be mounted in a standard 19-inch rack, using the appropriate Aeroflex rack-mounting kit:

46885/005	Rack-mounting kit, single
46885/006	Rack-mounting kit, double

The figure shows:

on top: a single SGA Signal Generator, fitted into the rack using a single rack-mounting kit (SGA is identical, mechanically, to SGD)

underneath: two SGAs and a combiner, fitted into the rack using a double rack-mounting kit.
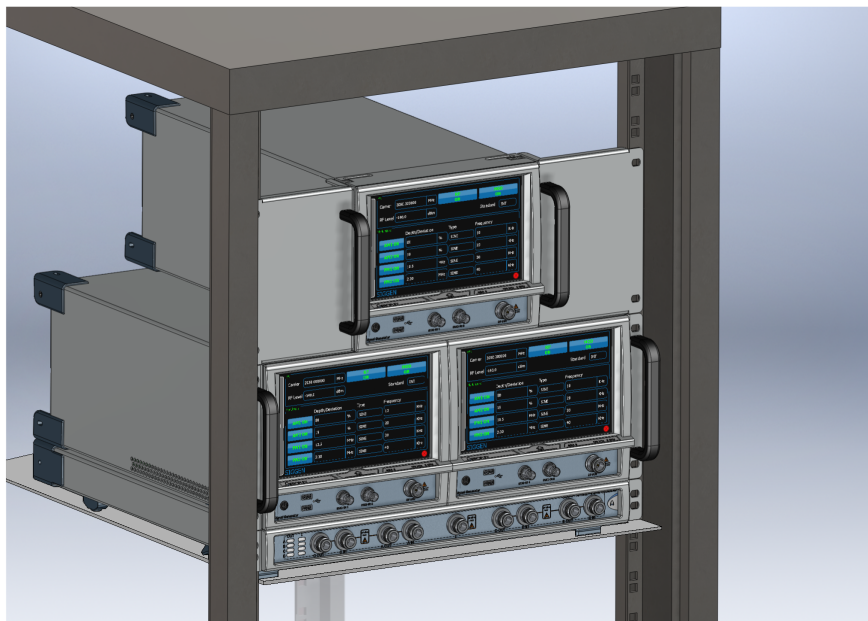
Fitting a rack-mounting kit

WARNING

The brackets supplied with the rack-mounting kits are not strong enough on their own to support the weight of single or multiple S-Series products. You *must* fit a suitable supporting tray (as shown in the figure) to the rack before installing the S-Series product(s). The tray must be capable of supporting the weight of the instrument(s): for example, 8 kg for a single SGD, and a minimum of 45 kg for the instruments shown in the figure.

WARNING

Take care when moving multiple S-Series products as they may exceed the weight that may be lifted by a single person: see Heavy instrument.

CAUTION

Use a perforated tray only. Ensure that no air intakes and outlets are obstructed whilst the instrument is in use. Make sure that the inlet grille underneath the instrument is not obscured by the tray and that there is adequate airflow.

Brackets

1. For both single and double rack-mounting kits, attach each rack mounting bracket to the instrument with three M3 x 10 countersunk Pozidriv screws on each side of the instrument.

2. Locate the instrument(s) in the rack, with the tray supporting the weight of the instrument(s). Attach the rack mounting brackets to the rack using two M5 x 10 countersunk Pozidriv screws, washers and cage nuts on each side.

Repackaging and returning

Repackaging

If you need to return an instrument to us, please observe the following:

Tagging

Tag the returned instrument with:

- your name and address

- a full description of the symptoms of the fault

- the type, model number and serial number.

Shipping containers

Repackage the instrument in its original container and packing material. If the original shipping containers and materials are not available, contact Customer Service/Support for shipping instructions.

Freight costs

Contact Customer Service/Support for our freight charge policy on warranty claims. Freight costs on shipments out of warranty are borne by the customer.

Repacking procedure

If the original container or materials are not available, use a strong double-walled carton packed with a 7 to 10 cm (3 to 4 inch) layer of shock-absorbing material around all sides of the instrument to hold it firmly. Protect the front panel with a plywood or cardboard load-spreader. A rear load-spreader is also advisable.

Your labels

It may be necessary for us to cut or remove labels that you have attached to the instrument if they impede access to its interior.

Appendix A cdma2000 data rate to symbol rate mappings

Introduction

This appendix provides mappings between frame length, data rate, symbol rate, Walsh length and Walsh repeats for all channels and radio configurations supported by the SGD. Note that the SGD currently supports frames of 20 ms duration, thus grayed-out rows in the tables below are not implemented.

Reverse/uplink channels

R-ACH

This is only available in spreading rate 1 for RC1 and 2.

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	4.8	28.8	-	-

R-EACH

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	38.4	153.6	8	See below
10	38.4	153.6	8	See below
10	19.2	153.6	8	See below
20	38.4	153.6	8	See below
20	19.2	153.6	8	See below
20	9.6	153.6	8	See below

The only differences between spreading rate 1 and 3 are the number of Walsh repeats; 1 for SR1 and 3 for SR3.

R-CCCH

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	38.4	153.6	8	See below
10	38.4	153.6	8	See below
10	19.2	153.6	8	See below
20	38.4	153.6	8	See below
20	19.2	153.6	8	See below
20	9.6	153.6	8	See below

The only differences between spreading rate 1 and 3 are the number of Walsh repeats; 1 for SR1 and 3 for SR3.

R-DCCH

RC3 and RC5

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	76.8	16	See below
20	9.6	76.8	16	See below

The only differences between RC3 and RC5 are the number of Walsh repeats; 1 for RC3 and 3 for RC5.

RC4 and RC6

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	76.8	16	See below
20	14.4	76.8	16	See below

The only differences between RC4 and RC6 are the number of Walsh repeats; 1 for RC4 and 3 for RC6.

R-FCH

RC1

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.2	28.8	-	-
20	2.4	28.8	-	-
20	4.8	28.8	-	-
20	9.6	28.8	-	-

RC2

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.8	28.8	-	-
20	3.6	28.8	-	-
20	7.2	28.8	-	-
20	14.4	28.8	-	-

RC3 and RC5

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	76.8	16	See below
20	1.5	76.8	16	See below
20	2.7	76.8	16	See below
20	4.8	76.8	16	See below
20	9.6	76.8	16	See below

The only differences between RC3 and RC5 are the number of Walsh repeats; 1 for RC3 and 3 for RC5.

RC4 and RC6

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	76.8	16	See below
20	1.8	76.8	16	See below
20	3.6	76.8	16	See below
20	7.2	76.8	16	See below
20	14.4	76.8	16	See below

The only differences between RC4 and RC6 are the number of Walsh repeats; 1 for RC4 and 3 for RC6.

R-SCCH

RC1

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.2	28.8	-	-
20	2.4	28.8	-	-
20	4.8	28.8	-	-
20	9.6	28.8	-	-

RC2

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.8	28.8	-	-

20	3.6	28.8	-	-
20	7.2	28.8	-	-
20	14.4	28.8	-	-

R-SCH

RC3

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.5	76.8	8, 4 or 2	2, 4 or 8
20	2.7	76.8	8, 4 or 2	2, 4 or 8
20	4.8	76.8	8, 4 or 2	2, 4 or 8
20	9.6	76.8	8, 4 or 2	2, 4 or 8
20	19.2	76.8	8, 4 or 2	2, 4 or 8
20	38.4	153.6	8, 4 or 2	1, 2 or 4
20	76.8	307.2	4 or 2	1 or 2
20	153.6	614.4	2	1
20	307.2	614.4	2	1
40	1.35	38.4	8, 4 or 2	4, 8 or 16
40	2.4	38.4	8, 4 or 2	4, 8 or 16
40	4.8	38.4	8, 4 or 2	4, 8 or 16
40	9.6	38.4	8, 4 or 2	4, 8 or 16
40	19.2	76.8	8, 4 or 2	2, 4 or 8
40	38.4	153.6	8, 4 or 2	1, 2 or 4
40	76.8	307.2	4 or 2	1 or 2
40	153.6	307.2	4 or 2	1 or 2
80	1.2	19.2	8, 4 or 2	8, 16 or 32
80	2.4	19.2	8, 4 or 2	8, 16 or 32
80	4.8	19.2	8, 4 or 2	8, 16 or 32
80	9.6	38.4	8, 4 or 2	4, 8 or 16
80	19.2	76.8	8, 4 or 2	2, 4 or 8

80	38.4	153.6	8, 4 or 2	1, 2 or 4
80	76.8	153.6	8, 4 or 2	1, 2 or 4

RC4

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.8	76.8	8, 4 or 2	2, 4 or 8
20	3.6	76.8	8, 4 or 2	2, 4 or 8
20	7.2	76.8	8, 4 or 2	2, 4 or 8
20	14.4	76.8	8, 4 or 2	2, 4 or 8
20	28.8	76.8	8, 4 or 2	2, 4 or 8
20	57.6	153.6	8, 4 or 2	1, 2 or 4
20	115.2	307.2	4 or 2	1 or 2
20	230.4	614.4	2	1
40	1.8	38.4	8, 4 or 2	4, 8 or 16
40	3.6	38.4	8, 4 or 2	4, 8 or 16
40	7.2	38.4	8, 4 or 2	4, 8 or 16
40	14.4	38.4	8, 4 or 2	4, 8 or 16
40	28.8	76.8	8, 4 or 2	2, 4 or 8
40	57.6	153.6	8, 4 or 2	1, 2 or 4
40	115.2	307.2	4 or 2	1 or 2
80	1.8	19.2	8, 4 or 2	8, 16 or 32
80	3.6	19.2	8, 4 or 2	8, 16 or 32
80	7.2	19.2	8, 4 or 2	8, 16 or 32
80	14.4	38.4	8, 4 or 2	4, 8 or 16
80	28.8	76.8	8, 4 or 2	2, 4 or 8
80	57.6	153.6	8, 4 or 2	1, 2 or 4

RC5

Frame length	Data rate(kbps)	Symbol rate	Walsh length	Walsh repeats

Appendix A cdma2000 data rate to symbol rate mappings

(ms)		(ksps)		
20	1.5	76.8	8, 4 or 2	6, 12 or 24
20	2.7	76.8	8, 4 or 2	6, 12 or 24
20	4.8	76.8	8, 4 or 2	6, 12 or 24
20	9.6	76.8	8, 4 or 2	6, 12 or 24
20	19.2	76.8	8, 4 or 2	6, 12 or 24
20	38.4	153.6	8,4 or 2	3, 6 or 12
20	76.8	307.2	4 or 2	3 or 6
20	153.6	614.4	2	3
20	307.2	921.6	4 or 2	1 or 2
20	614.4	1843.2	2	1
40	1.35	38.4	8, 4 or 2	12, 24 or 48
40	2.4	38.4	8, 4 or 2	12, 24 or 48
40	4.8	38.4	8, 4 or 2	12, 24 or 48
40	9.6	38.4	8, 4 or 2	12, 24 or 48
40	19.2	76.8	8, 4 or 2	6, 12 or 24
40	38.4	153.6	8, 4 or 2	3, 6 or 12
40	76.8	307.2	4 or 2	3 or 6
40	153.6	460.8	8, 4 or 2	1,2 or 4
40	307.2	921.6	4 or 2	1 or 2
80	1.2	19.2	8, 4 or 2	24, 48 or 96
80	2.4	19.2	8, 4 or 2	24, 48 or 96
80	4.8	19.2	8, 4 or 2	24, 48 or 96
80	9.6	38.4	8, 4 or 2	12, 24 or 48
80	19.2	76.8	8, 4 or 2	6, 12 or 24
80	38.4	153.6	8, 4 or 2	3, 6 or 12
80	76.8	230.4	8, 4 or 2	2, 4 or 8
80	153.6	460.8	8, 4 or 2	1, 2 or 4

RC6

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.8	76.8	8, 4 or 2	6, 12 or 24
20	3.6	76.8	8, 4 or 2	6, 12 or 24
20	7.2	76.8	8, 4 or 2	6, 12 or 24
20	14.4	76.8	8, 4 or 2	6, 12 or 24
20	28.8	115.2	8, 4 or 2	4, 8 or 16
20	57.6	230.4	8, 4 or 2	2, 4 or 8
20	115.2	460.8	8, 4 or 2	1, 2 or 4
20	230.4	921.6	4 or 2	1 or 2
20	460.8	1843.2	2	1
20	1036.8	1843.2	2	1
40	1.8	38.4	8, 4 or 2	12, 24 or 48
40	3.6	38.4	8, 4 or 2	12, 24 or 48
40	7.2	38.4	8, 4 or 2	12, 24 or 48
40	14.4	57.6	8, 4 or 2	8, 16 or 32
40	28.8	115.2	8, 4 or 2	4, 8 or 16
40	57.6	230.4	8, 4 or 2	2, 4 or 8
40	115.2	460.8	8, 4 or 2	1, 2 or 4
40	230.4	921.6	4 or 2	1 or 2
40	518.4	921.6	4 or 2	1 or 2
80	1.8	19.2	8, 4 or 2	24, 48 or 96
80	3.6	19.2	8, 4 or 2	24, 48 or 96
80	7.2	28.8	8, 4 or 2	16, 32 or 64
80	14.4	57.6	8, 4 or 2	8, 16 or 32
80	28.8	115.2	8, 4 or 2	4, 8 or 16
80	57.6	230.4	8, 4 or 2	2, 4 or 8
80	115.2	460.8	8, 4 or 2	1, 2 or 4

| 80 | 259.2 | 460.8 | 8, 4 or 2 | 1, 2 or 4 |

Forward/downlink channels

F-SYNCH

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
26.666	1.2	4.8	64	See below

For Spreading rate 1, the number of Walsh repeats is 4; for spreading rate 3, the number of Walsh repeats is 12.

F-PCH

This is only available in Spreading rate 1.

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	4.8	19.2	64	1
20	9.6	19.2	64	1

F-BCCH

Spreading rate 1

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
40	19.2	76.8	32	1
40	19.2	38.4	64	1
80	9.6	76.8	32	1
80	9.6	38.4	64	1
160	4.8	76.8	32	1
160	4.8	38.4	64	1

Spreading rate 3

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
40	19.2	57.6	128	1
80	9.6	57.6	128	1
160	4.8	57.6	128	1

F-QPCH

Spreading rate 1

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	2.4	19.2	128	1
20	4.8	19.2	128	1

Spreading rate 3

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	2.4	28.8	256	1
20	4.8	28.8	256	1

F-CACH

Spreading rate 1

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	38.4	64	1
5	9.6	19.2	128	1

Spreading rate 3

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	28.8	256	1

F-CCCH

Spreading rate 1

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	38.4	153.6	16	1
5	38.4	76.8	32	1
10	19.2	76.8	32	1
10	19.2	38.4	64	1

10	38.4	153.6	16	1
10	38.4	76.8	32	1
20	9.6	38.4	64	1
20	9.6	19.2	128	1
20	19.2	76.8	32	1
20	19.2	38.4	64	1
20	38.4	153.6	16	1
20	38.4	76.8	32	1

Spreading rate 3

Frame length(ms)	Data rate (kbps)	Convolutional Encoder	Symbol rate (ksps)	Walsh length	Walsh repeats
5	38.4	R = 1/3, K =9	115.2	64	1
10	19.2	R = 1/3, K =9	57.6	128	1
10	38.4	R = 1/3, K =9	115.2	64	1
20	9.6	R = 1/3, K =9	28.8	256	1
20	19.2	R = 1/3, K =9	57.6	128	1
20	38.4	R = 1/3, K =9	115.2	64	1

F-DCCH

RC3

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	38.4	64	1
20	9.6	38.4	64	1

RC4

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	19.2	128	1
20	9.6	19.2	128	1

RC5

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	38.4	64	1
20	14.4	38.4	64	1

F-FCH

RC1

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.2	19.2	64	1
20	2.4	19.2	64	1
20	4.8	19.2	64	1
20	9.6	19.2	64	1

RC2

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.8	19.2	64	1
20	3.6	19.2	64	1
20	7.2	19.2	64	1
20	14.4	19.2	64	1

RC3

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	38.4	64	1
20	1.5	38.4	64	1
20	2.7	38.4	64	1
20	4.8	38.4	64	1
20	9.6	38.4	64	1

RC4

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	19.2	128	1
20	1.5	19.2	128	1
20	2.7	19.2	128	1
20	4.8	19.2	128	1
20	9.6	19.2	128	1

RC5

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
5	9.6	38.4	64	1
20	1.8	38.4	64	1
20	3.6	38.4	64	1
20	7.2	38.4	64	1
20	14.4	38.4	64	1

F-SCCH

RC1

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.2	19.2	64	1
20	2.4	19.2	64	1
20	4.8	19.2	64	1
20	9.6	19.2	64	1

RC2

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.8	19.2	64	1
20	3.6	19.2	64	1

20	7.2	19.2	64	1
20	14.4	19.2	64	1

F-SCH

RC3

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.5	38.4	64	1
20	2.7	38.4	64	1
20	4.8	38.4	64	1
20	9.6	38.4	64	1
20	19.2	76.8	32	1
20	38.4	153.6	16	1
20	76.8	307.2	8	1
20	153.6	614.4	4	1
40	1.35	19.2	64	2
40	2.4	19.2	64	2
40	4.8	19.2	64	2
40	9.6	38.4	64	1
40	19.2	76.8	32	1
40	38.4	153.6	16	1
40	76.8	307.2	8	1
80	1.2	9.6	64	4
80	2.4	9.6	64	4
80	4.8	19.2	64	2
80	9.6	38.4	64	1
80	19.2	76.8	32	1
80	38.4	153.6	16	1

RC4

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.5	19.2	128	1
20	2.7	19.2	128	1
20	4.8	19.2	128	1
20	9.6	19.2	128	1
20	19.2	38.4	64	1
20	38.4	76.8	32	1
20	76.8	153.6	16	1
20	153.6	307.2	8	1
20	307.2	614.4	4	1
40	1.35	9.6	128	2
40	2.4	9.6	128	2
40	4.8	9.6	128	2
40	9.6	19.2	128	1
40	19.2	38.4	64	1
40	38.4	76.8	32	1
40	76.8	153.6	16	1
40	153.6	307.2	8	1
80	1.2	4.8	128	4
80	2.4	4.8	128	4
80	4.8	9.6	128	2
80	9.6	19.2	128	1
80	19.2	38.4	64	1
80	38.4	76.8	32	1
80	76.8	153.6	16	1

Appendix A cdma2000 data rate to symbol rate mappings

RC5

Frame length (ms)	Data rate(kbps)	Symbol rate (ksps)	Walsh length	Walsh repeats
20	1.8	38.4	64	1
20	3.6	38.4	64	1
20	7.2	38.4	64	1
20	14.4	38.4	64	1
20	28.8	76.8	32	1
20	57.6	153.6	16	1
20	115.2	307.2	8	1
20	230.4	614.4	4	1
40	1.8	19.2	64	2
40	3.6	19.2	64	2
40	7.2	19.2	64	2
40	14.4	38.4	64	1
40	28.8	76.8	32	1
40	57.6	153.6	16	1
40	115.2	307.2	8	1
80	1.8	9.6	64	4
80	3.6	9.6	64	4
80	7.2	19.2	64	2
80	14.4	38.4	64	1
80	28.8	76.8	32	1
80	57.6	153.6	16	1

Appendix B Using the instrument with an SPS power sensor

Introduction

The Aeroflex SPS USB Power Sensor is a compact self-contained device that connects directly to an S-Series instrument using the instrument's USB port and a standard USB cable. The SPS-8 covers the frequency range from 10 MHz to 8 GHz and RF levels from -60 to +20 dBm. For full details of the power sensor's performance, refer to its data sheet at aeroflex.com.

Software pre-installed on the standard S-Series instrument provides a measurement screen that turns the instrument and power sensor into a power measurement system. The power sensor converts RF and microwave power into digital data at the point of measurement. No other connections are needed as the sensor is powered via the USB cable.

S-Series instruments currently support average power measurements when used with the SPS power sensor. A full suite of measurement options, including pulse power measurements, is available when using the PC-based soft front panel provided on the USB flash drive supplied with the power sensor.

No Zero, No Cal™

A key feature of the SPS is that is does not require any zeroing or reference calibrations to compensate for temperature changes. The power sensor contains cal. data of level vs. frequency vs. temperature. As the sensed temperature changes, the cal. factor automatically adjusts.

SPS Series documentation

This section explains the features available and how to use the power sensor with an S-Series instrument. Refer to the documentation supplied on the USB flash drive for full details of the product's capabilities.

Warm-up time

Little, if any, warm-up time is required for measurements above -40.0 dBm. However, to make accurate measurements below -40 dBm, allow the power sensor to stabilize thermally for one hour.

Installation

CAUTION

Ensure that the power level at the signal source does not exceed the maximum allowable input level of the SPS power sensor, which is +20 dBm (100 mW).

Assuming the power level is less than +20 dBm, you can connect the sensor directly to the signal source without fear of damage. If the signal source produces power levels greater than +20 dBm, you must add an attenuator pad between the power sensor and the signal source. You may find it useful to enter offset or response correction (using the RF level offset facility) if you add an attenuator.

- You can plug the power sensor into a powered or unpowered S-Series instrument. If the instrument is powered up, you need to restart it so that it recognizes the power sensor and displays the power sensor menu.

- Plug the 2-meter high speed USB cable supplied with the power sensor into the back of the sensor (USB-B connector). Plug the other end into a USB port on the front or rear panel of the S-Series instrument. Switch the instrument on or restart it. The green LED on the power sensor lights to show that it is active.

- Connect the N-type connector on the power sensor to the port at which you want to measure the power.

Menu tab

The menu tab now displays a Power Meter button, showing that the instrument has recognized the power sensor.
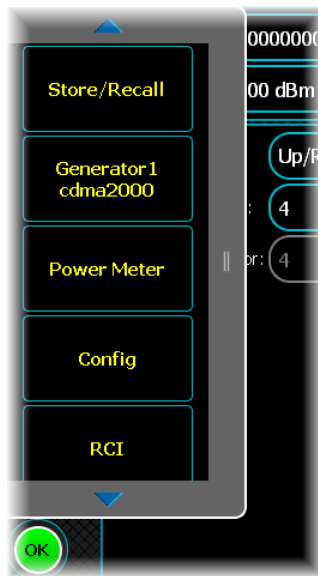
Touch the Power Meter button to display the power meter's Measurement screen.
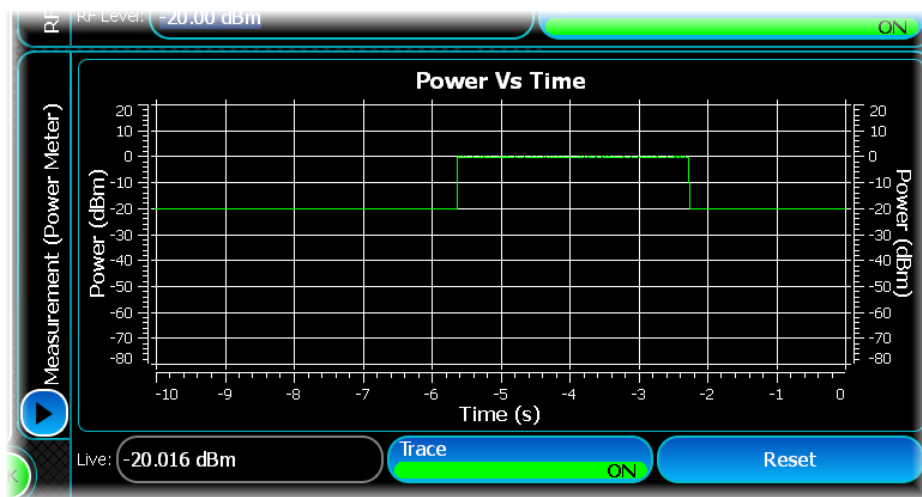
This displays the power recorded by the power sensor in real time.

Trace settings

Turn the trace off and touch the Settings... button...
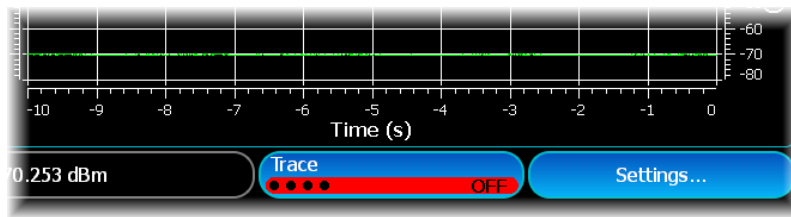
...to see the Trace Settings screen:

Unit

Use this to set the measurement units.

Frequency

Use this to set the power sensor's calibration frequency to that of the frequency being measured. The power sensor is calibrated at specific frequencies over its operating range, which corrects for amplitude flatness and temperature variation. It is important therefore to set the frequency at which the power sensor makes its measurements, as not doing so can be a significant source of error.

Averages

Use this to select an averaging factor from 1 to 30000 measurements. The number of averages depends on signal stability and power level. More averaging may be required for low-level signals. Increasing the number of averages also increases the measurement time. Each measurement takes about 250 µs.

Capture Length

Use this to set the length of time over which measurement results are displayed. The capture length is a rotating buffer that retains only the measurements within the window defined by the capture length; measurements outside this window are discarded. The range is from 10 s to 86.4 ks (that is, 24 h).

Period

Use this to set the time intervals at which a reading is taken. Shorter Period settings may affect the general speed of response of the instrument as more processing power is allocated to power meter measurements.

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6.5.2 Third party produced proprietary software ('Third Party Software') which Aeroflex may deliver with its products (where such Third Party Software carries a more limited warranty than the above warranty). In such case Aeroflex will provide a remedy for any non-conformance of the Third Party Software commensurate with the third party's warranty to Aeroflex (if any).

6.6 The remedies offered above are sole and exclusive remedies and to the extent permitted by applicable law are in lieu of any implied conditions, guarantees or warranties whatsoever and whether statutory or otherwise as to the Licensed Software all of which are hereby expressly excluded.

7. INDEMNITY

7.1 Aeroflex shall defend, at its expense, any action brought against the Licensee alleging that the Licensed Software infringes any patent, registered design, trademark or copyright, and shall pay all Licensee's costs and damages finally awarded up to an aggregate equivalent to the Licence Fee provided the Licensee shall not have done or permitted to be done anything which may have been or become any such infringement and shall have exercised reasonable care in protecting the same failing which the Licensee shall indemnify Aeroflex against all claims costs and damages incurred and that Aeroflex is given prompt written notice of such claim and given information, reasonable assistance and sole authority to defend or settle such claim on behalf of the Licensee. In the defense or settlement of any such claim, Aeroflex may obtain for the Licensee the right to continue using the Licensed Software or replace it or modify it so that it becomes non-infringing.

7.2 Aeroflex shall not be liable if the alleged infringement:

7.2.1 is based upon the use of the Licensed Software in combination with other software not furnished by Aeroflex, or

7.2.2 is based upon the use of the Licensed Software alone or in combination with other software in equipment not functionally identical to the Designated Equipment, or

7.2.3 arises as a result of Aeroflex having followed a properly authorized design or instruction of the Licensee, or

7.2.4 arises out of the use of the Licensed Software in a country other than the one disclosed to Aeroflex as the intended country of use of the Licensed Software at the commencement of this Agreement.

7.3 Aeroflex shall not be liable to the Licensee for any loss of use or for loss of profits or of contracts arising directly or indirectly out of any such infringement of patent, registered design, trademark or copyright.

7.4 Other than as may be covered by the indemnity provisions of Clauses 7.1, 7.2 and 7.3 Aeroflex shall not, under any circumstances, be liable to the Licensee for any direct, indirect, special, consequential and/or contingent loss or damage (and such loss or damage shall include without limitation loss of use or profit, loss of revenue, loss of product, liquidated damages or penalties, economic loss, delay in operations, loss of contracts or loss of business) whether or not the same are foreseeable and whether arising out of breach of contract, tort, statutory duty or otherwise. The total liability of Aeroflex and its employees, in contract, tort, or otherwise (including negligence, warranty, indemnity, and strict liability) howsoever arising out of this Licence shall be limited to the total amount of the Licence Fee and total support fees actually paid to Aeroflex by the Licensee.

8. TERMINATION

8.1 Notwithstanding anything herein to the contrary, this Licence shall forthwith determine if the Licensee:

8.1.1 As an individual has a Receiving Order made against him or is adjudicated bankrupt or compounds with creditors or as a corporate body, compounds with creditors or has a winding-up order made against it or

8.1.2 Parts with possession of the Designated Equipment.

8.2 This Licence may be terminated by notice in writing to the Licensee if the Licensee shall be in breach of any of its obligations hereunder and continue in such breach for a period of 21 days after notice thereof has been served on the Licensee.

8.3 On termination of this Agreement for any reason, Aeroflex may require the Licensee to return to Aeroflex all copies of the Licensed Software in the custody of the Licensee and the Licensee shall, at its own cost and expense, comply with such requirement within 14 days and shall, at the same time, certify to Aeroflex in writing that all copies of the Licensed Software in whatever form have been obliterated from the Designated Equipment.

9. THIRD PARTY LICENCES

9.1 The Licensed Software or part thereof may be the proprietary property of third party licensors. In such an event such third party licensors (as may be referenced on the software media, or any on screen message on start up of the software or on the order acknowledgement) and/or Aeroflex may directly enforce the terms of this Agreement and may terminate the Agreement if the Licensee is in breach of the conditions contained herein.

9.2 If any third party software supplied with the Licensed Software is supplied with, or contains or displays the third party's own licence terms then the Licensee shall abide by such third party licence terms (for the purpose of this Article the term "third party" shall include other companies within the Aeroflex group of companies).

10. EXPORT REGULATIONS

The Licensee undertakes that where necessary the Licensee will conform with all relevant export regulations imposed by the Governments of the United Kingdom and/or the United State of America.

11. U.S. GOVERNMENT RESTRICTED RIGHTS

The Licensed Software and documentation are provided with RESTRICTED RIGHTS. Use, duplication, or disclosure by the Government is subject to restrictions as set forth in subparagraph (c)(1)(ii) of the Rights in Technical Data and Computer Software clause at DFAR 252.227-7013 or subparagraphs (c)(1) and (2) of the Commercial Computer Software-Restricted Rights at 48 CFR 52.227-19, as applicable.

12. NOTICES

Any notice to be given by the Licensee to Aeroflex shall be addressed to:

Aeroflex Limited, Longacres House, Six Hills Way, Stevenage, SG1 2AN, UK.

13. LAW AND JURISDICTION

This Agreement shall be governed by the laws of England and shall be subject to the exclusive jurisdiction of the English courts. This agreement constitutes the whole agreement between the parties and may be changed only by a written agreement signed by both parties.

CHINA Beijing
Tel: [+86] (10) 6539 1166
Fax: [+86] (10) 6539 1778

CHINA Shanghai
Tel: [+86] 21 2028 3588
Fax: [+86] 21 2028 3558

CHINA Shenzhen
Tel: [+86] (755) 3301 9358
Fax: [+86] (755) 3301 9356

FRANCE
Tel: [+33] 1 60 79 96 00
Fax: [+33] 1 60 0177 69 22

GERMANY
Tel: [+49] 89 99641 0
Fax: [+49] 89 99641 160

INDIA
Tel: [+91] (0) 80 4115 4501
Fax: [+91] (0) 80 4115 4502

JAPAN
Tel: [+81] 3 3500 5591
Fax: [+81] 3 3500 5592

KOREA
Tel: [+82] (2) 3424 2719
Fax: [+82] (2) 3424 8620

SCANDINAVIA
Tel: [+45] 9614 0045
Fax: [+45] 9614 0047

SINGAPORE
Tel: [+65] 6873 0991
Fax: [+65] 6873 0992

TAIWAN
Tel: [+886] (2) 2698 8058
Fax: [+886] (2) 2698 8050

UK
Tel: [+44] (0) 1438 742200
Fax: [+44] (0) 1438 727601
Freephone: 0800 282388 (UK only)

USA
Tel: [+1] (316) 522 4981
Fax: [+1] (316) 522 1360
Toll Free: (800) 835 2352 (US only)

web: **www.aeroflex.com**   Email: **info-test@aeroflex.com**