Application Note

Anritsu

Multiple Source Synchronization for MIMO

MG3700A
Vector Signal Generator

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- Multiple Source Synchronization for MIMO -

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MG3700A

Vector Signal Generator

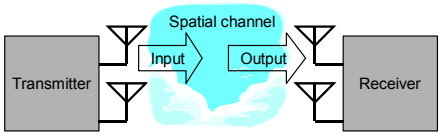
September 2007
(1.00)

Introduction

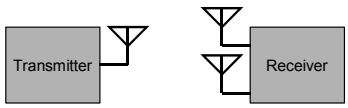
- This application note gives a brief description of the fundamentals of MIMO technology, and the test configuration techniques for a MIMO receiver.
  - MIMO is pronounced “my-mo”.

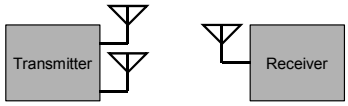
Contents

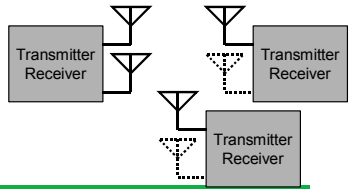
MIMO Definitions



- MIMO
  - » Multiple Input Multiple Output
    - – Multiple transmitting and receiving antennas system
      - "Input" means the input to spatial channel (i.e. transmitting antenna), "Output" means the output from spatial channel (i.e. receiving antenna).
- SIMO
  - » Single Input Multiple Output
    - – Receiver diversity
    - – Receiver beamforming
- MISO
  - » Multiple Input Single Output
    - – Transmitter diversity
    - – Transmitter beamforming
- MIMO-MU
  - » Multiple Input Multiple Output - Multiple User



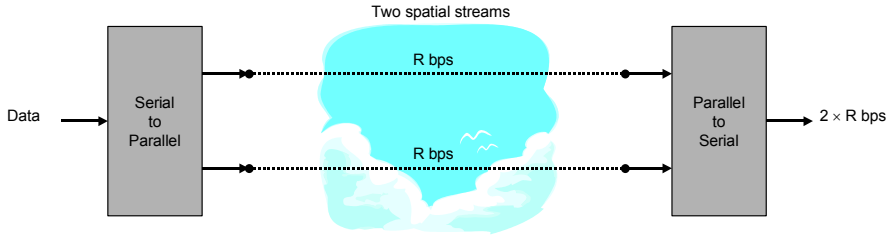




MIMO Concept

- MIMO offers a higher transmission rate for the same bandwidth using spatial multiplexing with parallel data streams.

- Transmitter sends different data streams in parallel on same frequency from multiple antennas.
- Receiver detects signals to separate spatial streams.

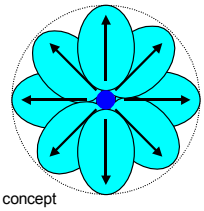


MIMO Practical Application

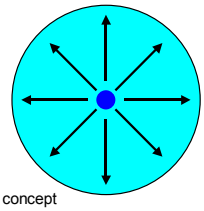
- 3GPP
  - Release '99
    - WCDMA Transmit diversity (2×1 MISO)
      - STTD: Space Time Transmit Diversity
      - TSTD: Time Switched Transmit Diversity
  - Release 7
    - HSPA+
      - HSDPA-MIMO (28 Mbps)
  - Release 8
    - LTE
      - MIMO-OFDMA
- IEEE802.11n
  - Wi-Fi WLAN
    - Minimum two spatial streams Maximum four spatial streams
    - SDM-MIMO SDM: Spatial Division Multiplexing
    - BF-MIMO or SVD-MIMO (option) BF: Beamforming SVD: Singular Value Decomposition
    - STBC (option) (2×1 MISO) STBC: Space Time Block Coding
      - Similar to transmit diversity technique
- IEEE802.16e
  - Mobile WiMAX
    - STC-MIMO (Matrix A option) (2×1 MISO) STC: Space Time Coding
      - Similar to transmit diversity technique
    - SM-MIMO (Matrix B option) SM: Spatial Multiplexing

SDM and SM

- Spatial Division Multiplexing
  - » Beamforming in desirer or null-steering in interferer, with directional radio emission patterns, using weighting-control of amplitude and phase for array antenna
  - » Directivity control technique
    - – Eigenbeam-SDM, beamforming with Channel State Information (CSI) known to transmitter
- Spatial Multiplexing
  - » Integrating coding and error correction technologies into transmit and receive diversity technologies
  - » Antennas decorrelation technique
    - – Space-Time coding and Layered Space-Time coding



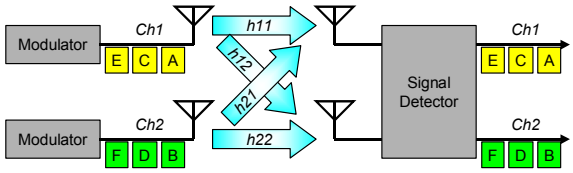
SDM concept

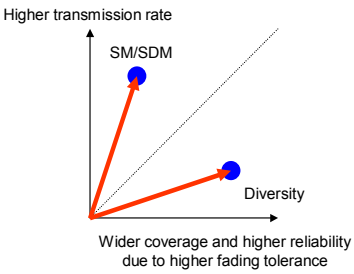


SM concept

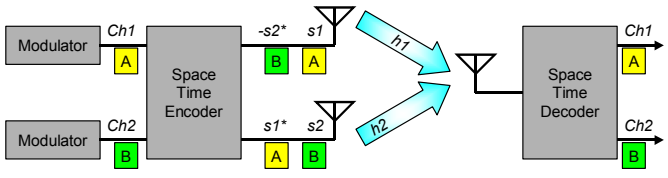
SM/SDM and Diversity

- SM/SDM





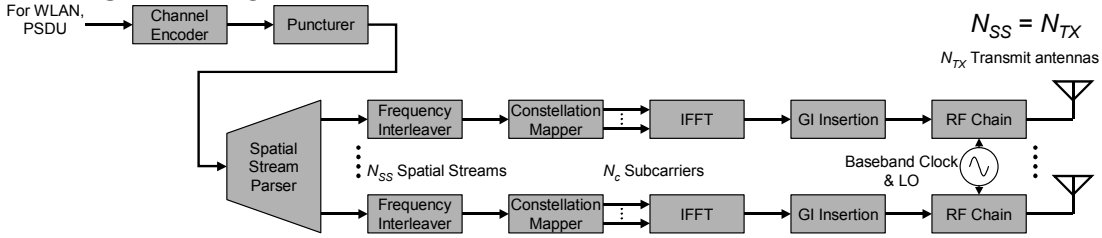
- Transmit Diversity



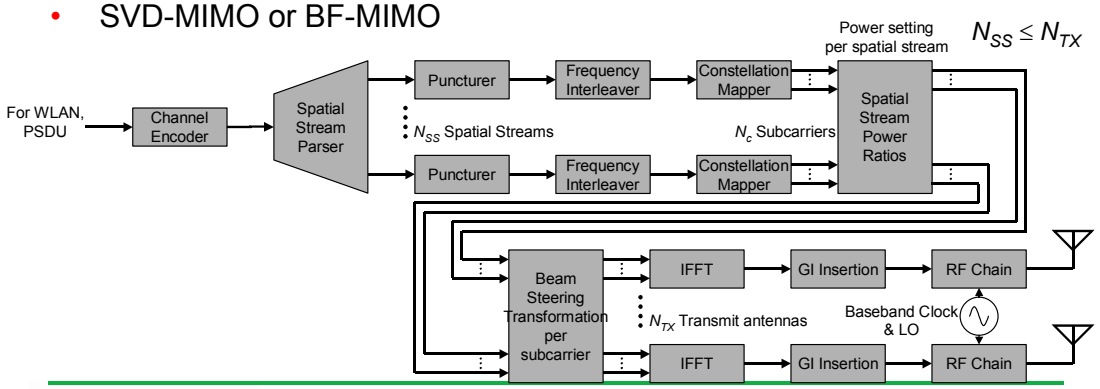
*s** represents *complex conjugate* of *s*.

Basic Transmitter Model

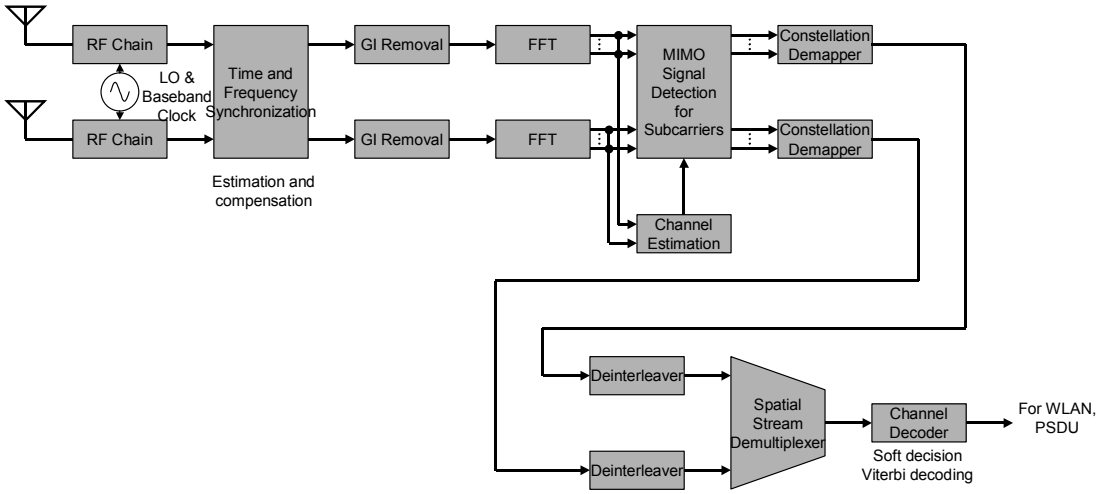
- SDM-MIMO



- SVD-MIMO or BF-MIMO

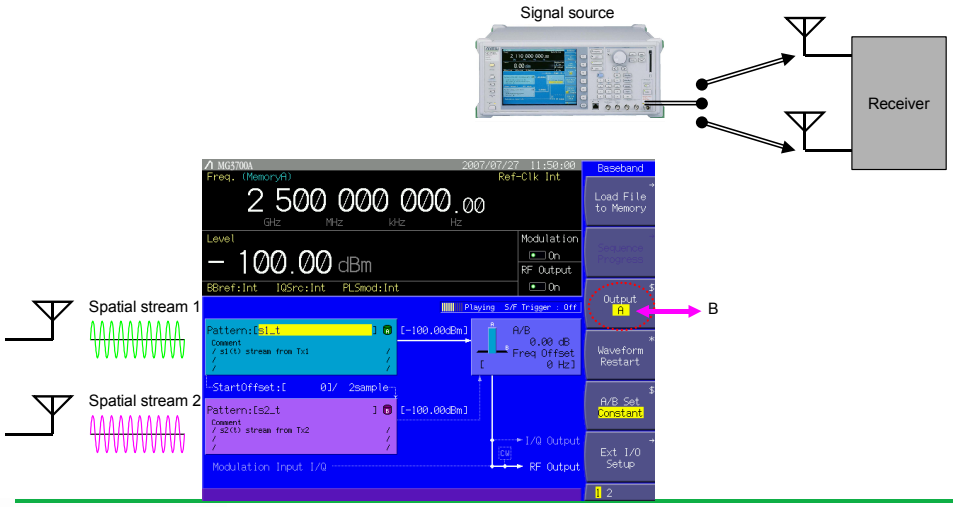


Basic Receiver Model



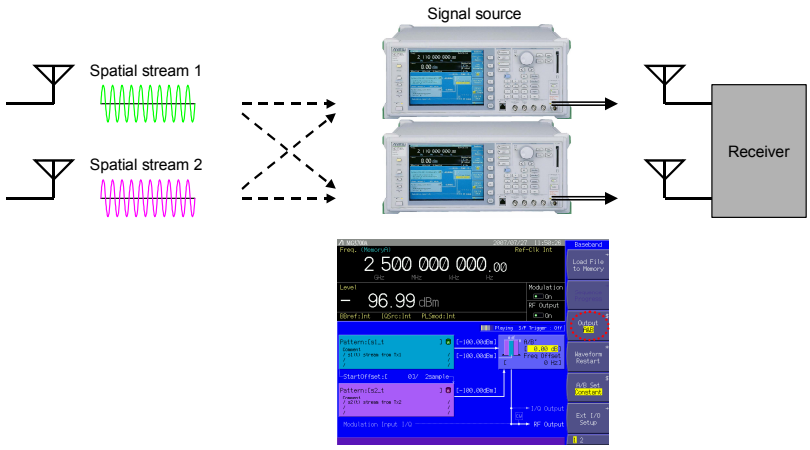
MIMO Receiver Test

- Single source
  - » Receiver testing starts with single channel tests using a single signal source. Receiving antenna chains are tested separately.
  - » Simulation of signal conditions is comparatively simple.



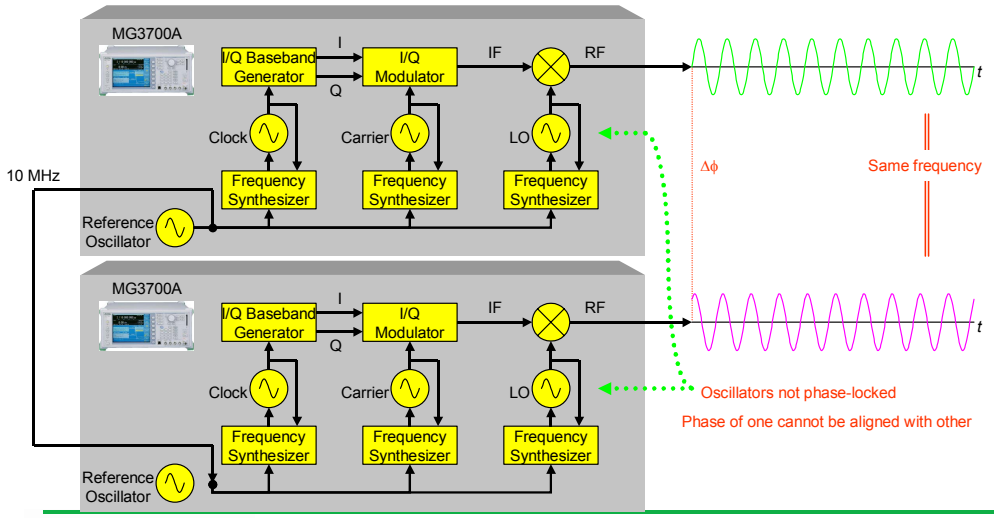
MIMO Receiver Test

- Multiple source
  - » Consider needs for the following:
    - – Timing alignment of baseband signals because of different arrival time
    - – Requirement for common local oscillator due to phase-coherence between signal generators



Synchronous Frequency on Common Reference Oscillator

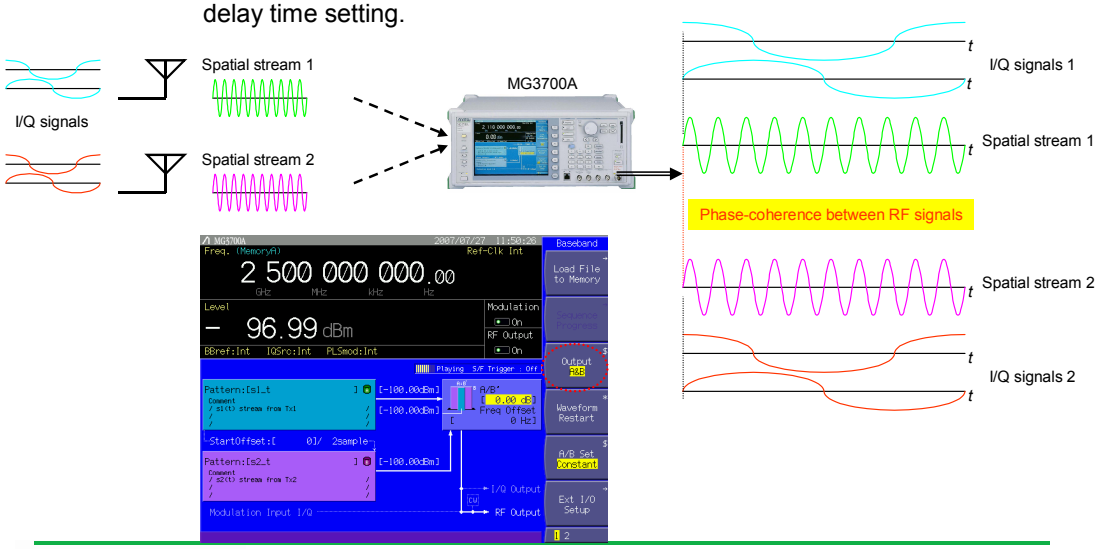
- Common 10 MHz reference signal for multiple signal generators allows synchronization of each generating frequency.



Synchronous Timing Alignment of Baseband Signal Generation

- When two spatial streams on baseband generated simultaneously,
  - » 2×1 MISO

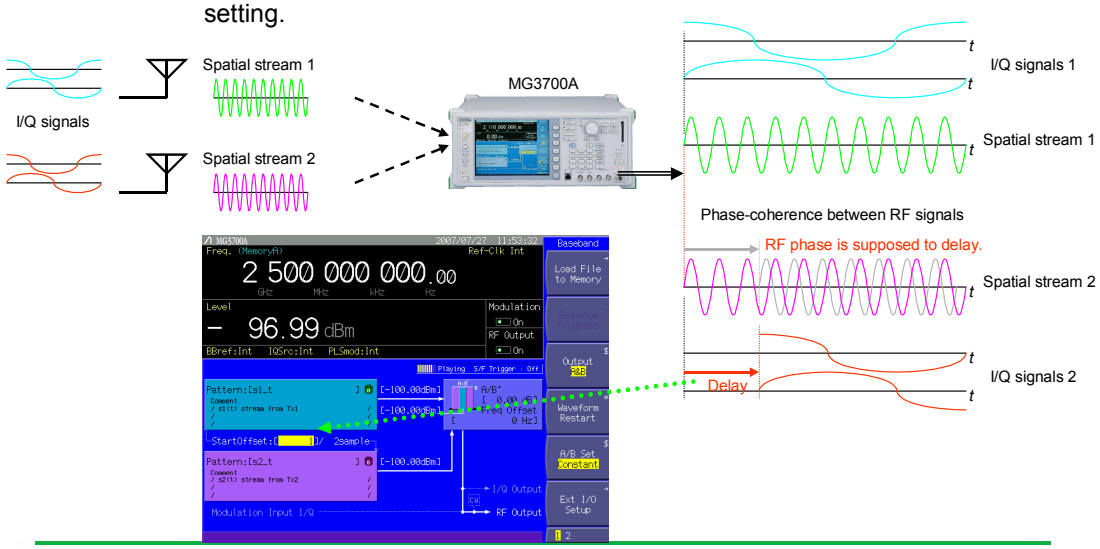
    One MG3700A unit provides phase-coherence between RF signals at zero delay time setting.



Synchronous Timing Alignment of Baseband Signal Generation

- When two spatial streams on baseband generated with time difference,
  - » 2×1 MISO

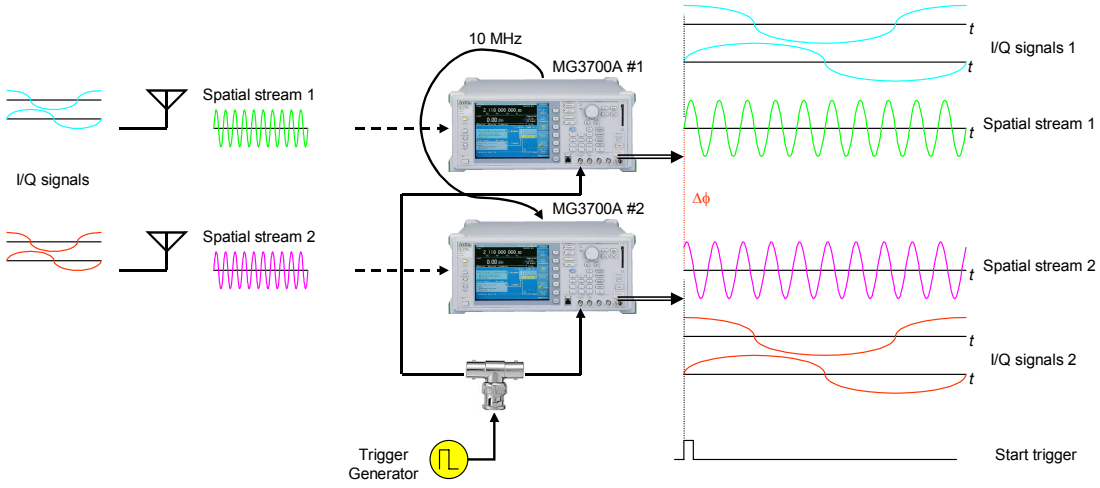
    One MG3700A unit cannot provide correlation with RF delay at any delay time setting.



Synchronous Timing Alignment of Baseband Signal Generation

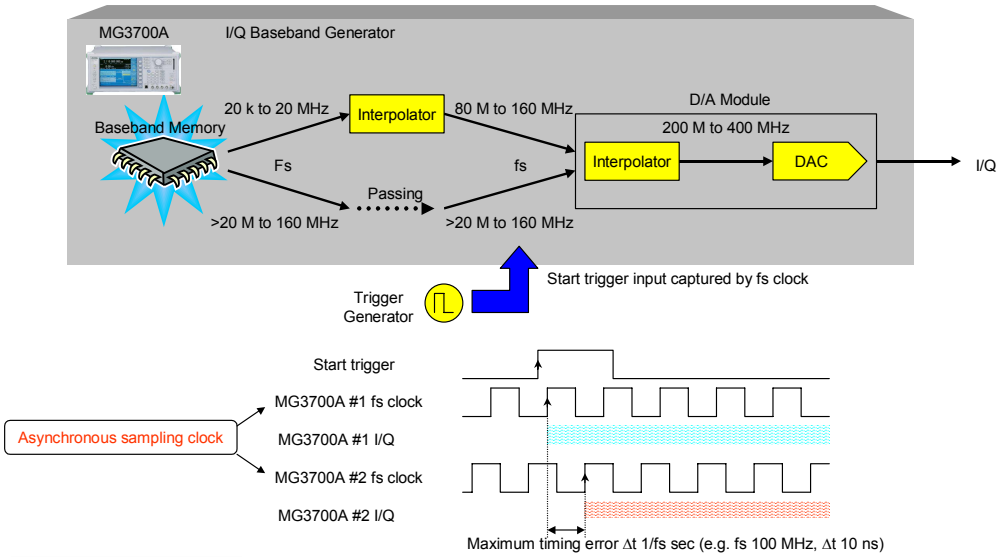
- When two spatial streams on RF generated simultaneously,
  - » 2×2 MIMO

    Multiple MG3700As cannot provide phase-coherence between RF signals.



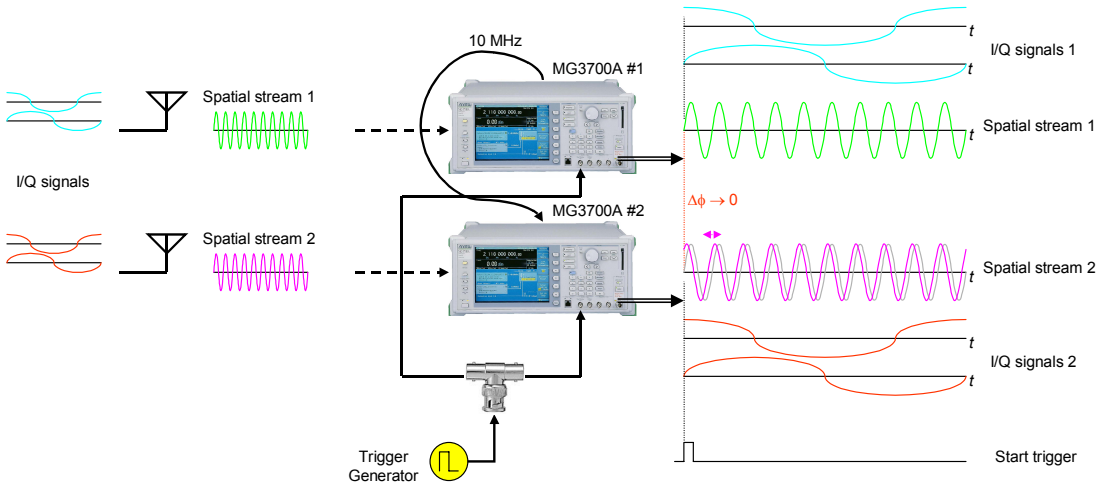
Synchronous Timing Alignment of Baseband Signal Generation

- The two separate baseband clock for each of MG3700A I/Q baseband generator do not be phase-locked.

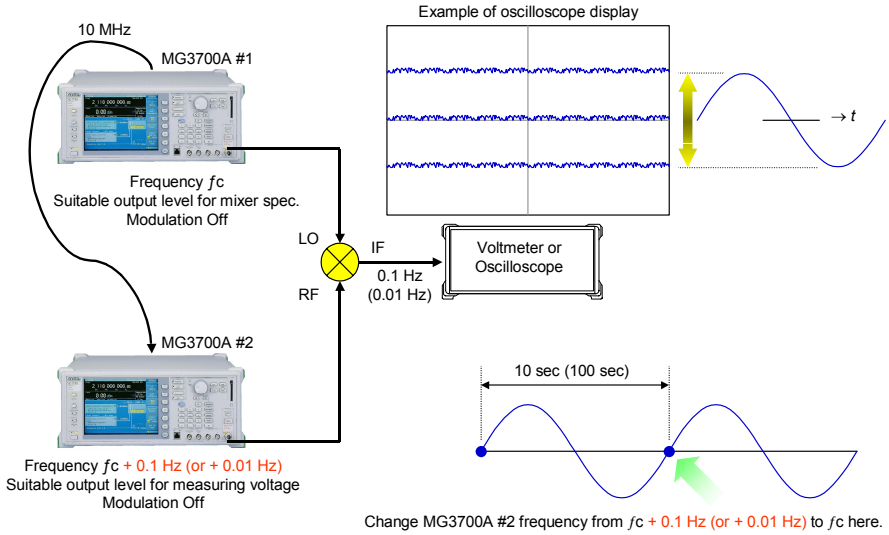


Phase Synchronous RF Signal Generation

- The phase between the RF signals can be precisely adjusted using the MG3700A Phase Adjust function.
  - This phase adjustment is lost if the frequency is changed.



Technique for Calibrating RF Signal Phase



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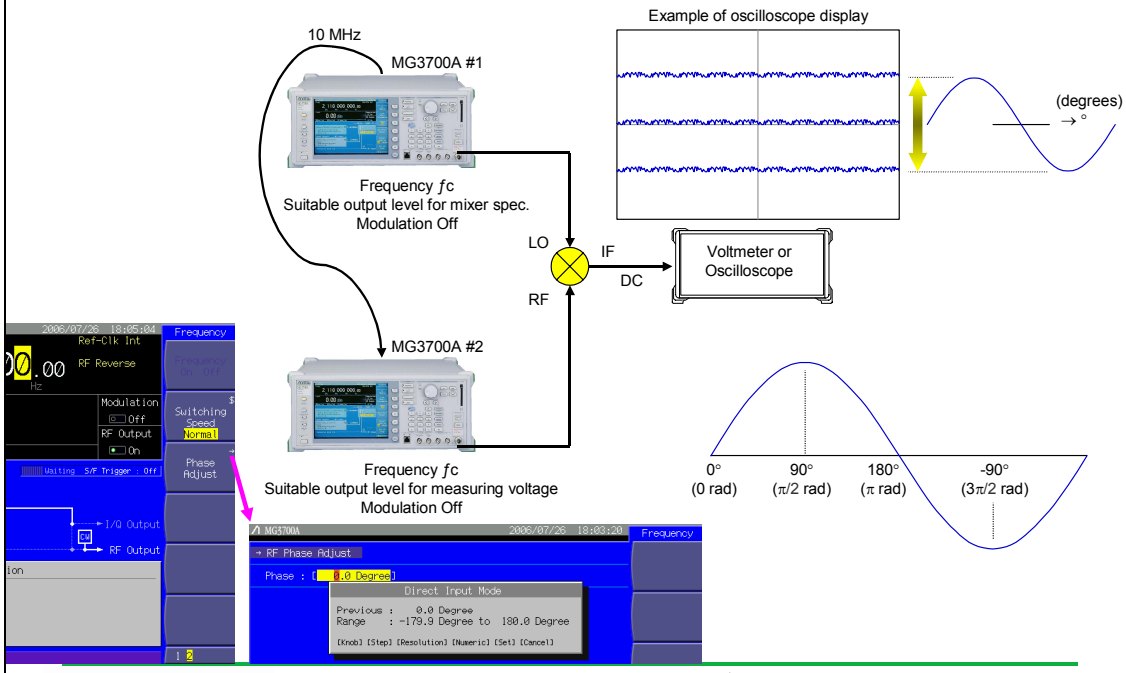
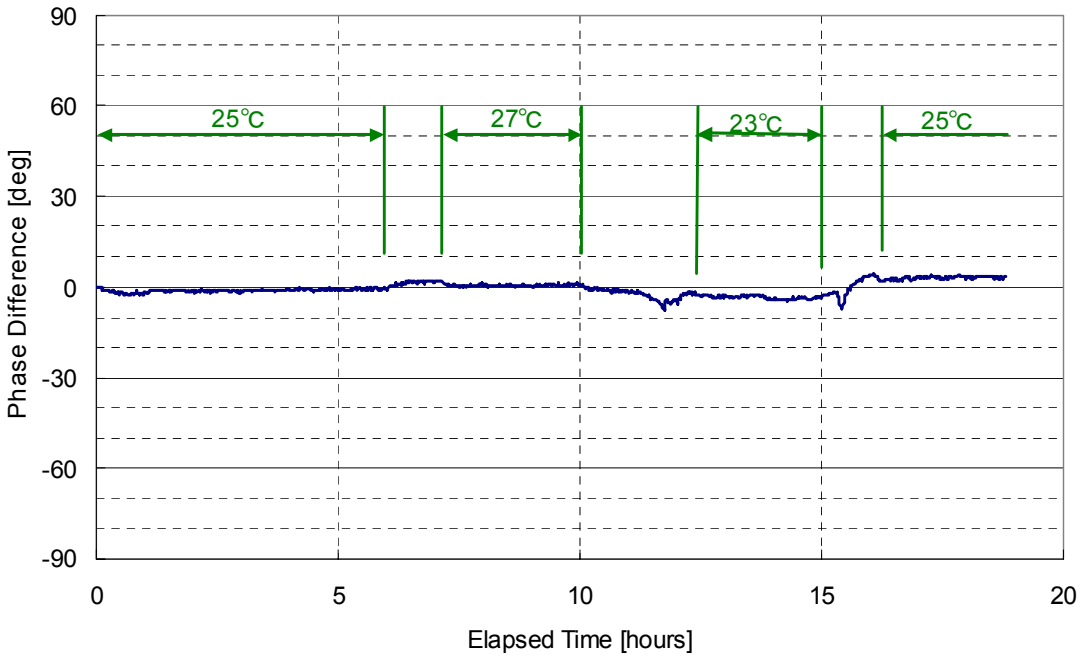


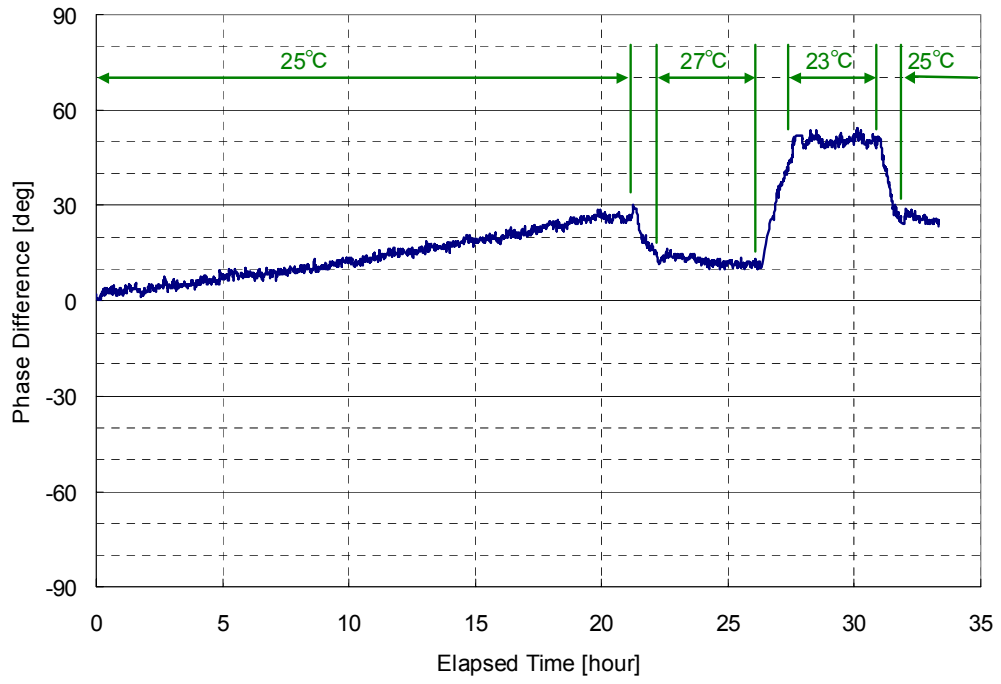
Phase Stability and Repeatability

- Temperature affects phase drift of the MG3700A RF output.
  - » If all MG3700A temperature changes are the same, the phase difference change is lower.
- The difference in phase between two MG3700A RF outputs is measured to check performance.
  - » Output frequency 3 GHz and 5.8 GHz
    - 3 GHz for 3 GHz RF unit, and 5.8 GHz for 6 GHz RF unit (Option)
  - » Temperature 25 ± 2°C
    - 25°C → 27°C → 23°C → 25°C

Measured Phase difference at 3 GHz



Measured Phase difference at 5.8 GHz



Anritsu

Specifications are subject to change without notice.

Anritsu Corporation
5-1-1 Onna, Atsugi-shi, Kanagawa, 243-8555 Japan
Phone: +81-46-223-1111
Fax: +81-46-296-1264

● **U.S.A.**
Anritsu Company
1155 East Collins Blvd., Suite 100, Richardson,
TX 75081, U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

● **Canada**
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120, Kanata,
Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

● **Brazil**
Anritsu Eletrônica Ltda.
Praca Amadeu Amaral, 27 - 1 Andar
01327-010-Paraiso-São Paulo-Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

● **U.K.**
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire, LU1 3LU, U.K.
Phone: +44-1582-433200
Fax: +44-1582-731303

● **France**
Anritsu S.A.
16/18 avenue du Québec-SILIC 720
91961 COURTABOEUF CEDEX, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

● **Germany**
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

● **Italy**
Anritsu S.p.A.
Via Elio Vittorini 129, 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

● **Sweden**
Anritsu AB
Borgafjordsgatan 13, 164 40 KISTA, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

● **Finland**
Anritsu AB
Teknobulevardi 3-5, FI-01530 VANTAA, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

● **Denmark**
Anritsu A/S
Kirkebjerg Allé 90, DK-2605 Brøndby, Denmark
Phone: +45-72112200
Fax: +45-72112210

● **Spain**
Anritsu EMEA Ltd.
Oficina de Representación en España
Edificio Veganova
Avda de la Vega, n° 1 (edf 8, pl 1, of 8)
28108 ALCOBENDAS - Madrid, Spain
Phone: +34-914905761
Fax: +34-914905762

● **United Arab Emirates**
Anritsu EMEA Ltd.
Dubai Liaison Office
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suit 701, 7th Floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

● **Singapore**
Anritsu Pte. Ltd.
60 Alexandra Terrace, #02-08, The Comtech (Lobby A)
Singapore 118502
Phone: +65-6282-2400
Fax: +65-6282-2533

● **India**
Anritsu Pte. Ltd.
India Branch Office
Unit No. S-3, Second Floor, Esteem Red Cross Bhavan,
No. 26, Race Course Road, Bangalore 560 001, India
Phone: +91-80-32944707
Fax: +91-80-22356648

● **P.R. China (Hong Kong)**
Anritsu Company Ltd.
Units 4 & 5, 28th Floor, Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong
Phone: +852-2301-4980
Fax: +852-2301-3545

● **P.R. China (Beijing)**
Anritsu Company Ltd.
Beijing Representative Office
Room 1515, Beijing Fortune Building,
No. 5, Dong-San-Huan Bei Road,
Chao-Yang District, Beijing 10004, P.R. China
Phone: +86-10-6590-9230
Fax: +86-10-6590-9235

● **Korea**
Anritsu Corporation, Ltd.
8F Hyunjuk Building, 832-41, Yeoksam Dong,
Kangnam-ku, Seoul, 135-080, Korea
Phone: +82-2-553-6603
Fax: +82-2-553-6604

● **Australia**
Anritsu Pty. Ltd.
Unit 21/270 Ferntree Gully Road, Notting Hill,
Victoria 3168, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

● **Taiwan**
Anritsu Company Inc.
7F, No. 316, Sec. 1, Neihu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

Please Contact:

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