

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.1110

(06/2021)

SERIES J: CABLE NETWORKS AND TRANSMISSION
OF TELEVISION, SOUND PROGRAMME AND OTHER
MULTIMEDIA SIGNALS

Switched digital video over cable networks

**Functional requirements specification for
self-interference cancellation function of
in-band full-duplex in a HFC based network**

Recommendation ITU-T J.1110

ITU-T



Recommendation ITU-T J.1110

Functional requirements specification for self-interference cancellation function of in-band full-duplex in a HFC based network

Summary

Keywords such as ultra-high-resolution content delivery, end-to-end access service proliferation, high-speed transmission and broadband transmission are becoming the basic requirements that should be accommodated by network providers who are responsible for data transmission.

In particular, as various IoT services, personal media and cloud-based services gradually become common, there is a subscriber demand for a high data rate.

Cable networks are also undergoing various network evolution processes to develop and apply technologies that satisfy the requirements of the service ecosystem.

Currently, cable broadcasting networks have limited upstream frequency bands that can transmit data.

In order to overcome these limitations and enable symmetric upstream and downstream transmission, we are developing in-band full-duplex (IFDX) transmission technology that enables simultaneous transmission and reception in the same band. For the efficiency performance of the IFDX transmission technology, self-interference cancellation is one of the important factors, and Recommendation ITU-T J.1110 is focused on the functional specification of self-interference cancellation for the IFDX transmission system in a hybrid fibre coaxial (HFC) based network.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T J.1110	2021-06-13	9	11.1002/1000/14646

Keywords

IFDX

* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents/software copyrights, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the appropriate ITU-T databases available via the ITU-T website at <http://www.itu.int/ITU-T/ipr/>.

© ITU 2021

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

Recommendation ITU-T J.1110

Functional requirements specification for self-interference cancellation function of in-band full-duplex in a HFC based network

1 Scope

This Recommendation describes the functional requirements specification for the self-interference cancellation function of in-band full-duplex (IFDX) in HFC based network. The purpose of the functional requirement specification for the self-interference cancellation function of IFDX in HFC based network is to specify the functional requirements for performance which will meet the need for simultaneous transmission and reception in the same band using the HFC based cable TV network. This Recommendation is focused on the functional specification of self-interference cancellation for the IFDX transmission system.

2 Reference

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T J.1109] Recommendation ITU-T J.1109 (2019), *Requirement for in-band full-duplex in a HFC based network*.

3 Definitions

3.1 Terms defined elsewhere

None

3.2 Terms defined in this Recommendation

None

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CMTS	Cable Modem Termination System
FDX	Full-Duplex
HFC	Hybrid Fibre Coaxial
IFDX	In-band Full-Duplex

5 Conventions

In this Recommendation:

The keywords "**is required to**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

The keywords "**is recommended**" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "**can optionally**" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

In the body of this Recommendation, the words *should*, and *may* sometimes appear, in which case they are to be interpreted, respectively, as *is recommended* and *can optionally*.

6 Overview

In a conventional cable network, upstream and downstream signals are transmitted in different frequency bands. The upstream band is allocated very much less than the downstream band due to the transmission of the multichannel broadcasting service. In order to secure upstream bandwidth without downstream bandwidth reduction in a cable network, a full-duplex (FDX) transmission technique capable of simultaneously transmitting upstream and downstream in the same band is needed. However, since transmission and receive are simultaneously performed in the FDX mode, a downstream signal as a transmission signal is received in addition to an upstream signal as a receive signal.

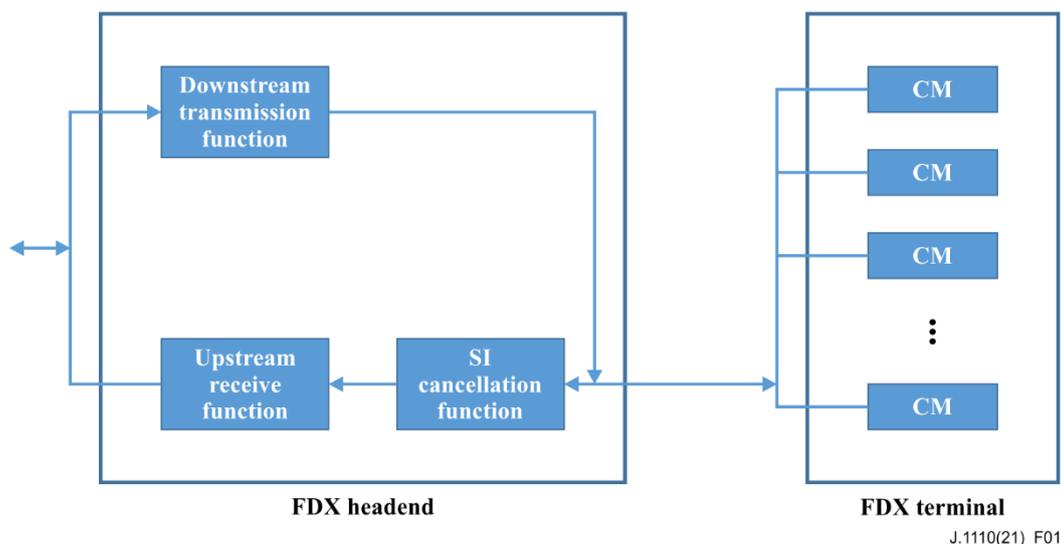


Figure 6-1 – A simplified diagram of the self-interference (SI) cancellation function of the FDX transmission system (CM – cable modem)

That is, when the upstream signal generated from the cable modems on the subscriber side is to be received, the downstream signal generated in the same band interferes with the upstream signal receive. Therefore, in order to receive a desired upstream signal, it is necessary to be able to remove a transmission signal existing as a self-interference. The purpose of this Recommendation is to implement the self-interference signal cancellation function in the Headend cable modem termination system (CMTS) of the cable network (see the diagram in Figure 6-1). That is, since the downstream signal generated by the base station itself interferes with reception of the upstream signal, the upstream signal can be received if the downstream signal is a self-interference signal and can sufficiently remove the downstream signal. The removal of the self-interference signal means that the generated downstream signal is re-estimated and compensated to generate and subtract the same signal.

7 Functional requirement specifications

7.1 It is recommended that the FDX system be able to provide a function to estimate downstream signals including self-interference signals.

7.2 It is recommended that the FDX system be able to provide a function to model downstream signals including self-interference signals.

7.3 It is recommended that the FDX system be able to provide a function to estimate various distortion factors.

7.4 It is recommended that the FDX system be able to provide a function to model various distortion factors.

7.5 It is recommended that the FDX system be able to support the self-interference cancellation frequency bandwidth up to the maximum frequency bandwidth determined by the system.

7.6 It is recommended that the FDX system be able to use the time/frequency offset estimation algorithm of the self-interference signals.

7.7 It is recommended that the FDX system be able to use the time/frequency offset compensation algorithm of the self-interference signals.

7.8 It is recommended that the FDX system be able to estimate the channel/nonlinear distortion component of the self-interference signals.

7.9 It is recommended that the FDX system be able to compensate the channel/nonlinear distortion component of the self-interference signals.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems