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Access, Terminals, Transmission and Multiplexing (ATTM); European Requirements for Reverse Powering of Remote Access Equipment; Part 2: Coaxial Cable Networks

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

The present document is part 2 of a multi-part deliverable. Full details of the entire series can be found in part 1 [1].

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

As various Operators consider the deployment of fibre-fed remote nodes that contain G.fast DSLAM equipment [i.1], it is necessary to consider the means of powering such remotely located equipment. One such method, known as "reverse power feed", transmits the power from the customer premises to the fibre-fed remote node using a point to point coaxial cable network. The present document defines a reverse power feed transmission standard which allows Operators to source suitably compliant equipment for inclusion in their networks.

1 Scope

The present document defines architectures and specifications for reverse powering of a remote network node from one or multiple G.fast CPEs over Point to Point (P2P) coaxial cable (coax), where there is no coexistence with other services over an operational Hybrid Fibre Coax (HFC) network. The present document specifies the reverse powering for two coax configurations with G.fast as described in Annex D.1 of BBF TR-285 [3], Issue 1 Amendment 1: G.fast with satellite TV and G.fast only. The relevant clauses to ETSI TS 101 548-1 [1] are referenced where appropriate.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 101 548-1: "Access, Terminals, Transmission and Multiplexing (ATTM); European Requirements for Reverse Powering of Remote Access Equipment; Part 1: Twisted Pair Networks".

[2] EN 62368-1: "Audio/video, information and communication technology equipment - Part 1: Safety requirements", produced by CENELEC.

[3] Broadband Forum TR-285: "Broadband Copper Cable Models".

[4] Broadband Forum TR-301: "Architecture and Requirements for Fiber to the Distribution Point".

[5] EN 60728-11: "Cable networks for television signals, sound signals and interactive services - Part 11: Safety" Edition 4.0 2016-3, produced by CENELEC.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Recommendation ITU-T G.9700: "Fast access to subscriber terminals (G.fast) - Power spectral density specification".

[i.2] Recommendation ITU-T G.9701: "Fast access to subscriber terminals (G.fast) - Physical layer specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

Core Conductor (CC): conductor at the center of a coax cable, normally a solid wire

diplexer: passive device that implements frequency-domain multiplexing, in which the two ports (in different frequency bands) are multiplexed onto a third port Consequently, the input signals can coexist on the output port without interfering with each other

metallic connection: physical connectivity providing a DC path between two points, typically provided via a coaxial cable

normal operation: state of a system (i.e. a DPU reversely powered by a PSE) reached after the start-up procedure has been completed

Outer Shield Conductor (OSC): conductor surrounding the core conductor insulation, normally a braided conductive material

power splitter: device that performs a frequency splitting/combining function between the AC part of the services being carried (which can include G.fast based services) and the injected DC electrical power

RG-x: Radio Guide - Standard Coaxial Cable designations

start-up mode: start-up procedure of a system (powering part of a DPU and PSE)

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Ω	Ohm
µF	micro Farad
nF	nano Farad
U-R	Reference point at CPE containing both DC power and service data
U-R2	Reference point at CPE containing the filtered service data
U-R2P	Reference point at CPE containing the injected DC power
U-O	Reference point at DPU containing both DC power and service data
U-O2	Reference point at DPU containing the filtered service data
U-O2P	Reference point at DPU containing the extracted DC power
U-OG	Reference Point at DPU containing the G.fast signal
U-OS	Diplexer Reference Point at the DP
U-RG	Reference Point at CPE containing the G.fast signal
U-RS	Diplexer Reference poin at CP
SAT TV	Reference Point at DPU containing the satellite TV signal
STB TV	Reference Point at CPE containing the satellite TV signal

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
ACM	Alternating Current Mains
ATA	Analogue Telephone Adapter
BAT	Battery
BBA	Battery Back-up Available
CC	Core Conductor
CO	Central Office
CP	Customer Premises

CPE ME	CPE's Management Entity
CPE	Customer Premises Equipment
CPF	Common Power Feed
DC	Direct Current
DGL	Dying Gasp Loss
DN	Distribution Network
DP	Distribution Point
DPU ME	DPU's Management Entity
DPU	Distribution Point Unit
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
ECL	Error Line Condition
ELC	Error Line Condition
FTU	G.fast Transceiver Unit

NOTE: See Recommendation ITU-T G.9701 [i.2].

FTU-O	FTU at the DPU
FTU-R	FTU at the remote site
HON	Higher Order Node
IFN	Intensity of current Feed Now
MDSU	Metallic Detection based Start-Up protocol
MDU	Multi Dwelling Unit
ME	Management Entity
MELT	Metallic Loop Test
MET	Main Earthing Terminal
NMS	Network Management System
NT	Network Termination
NTE	Network Termination Equipment
OAM	Operations And Maintenance
OSC	Outer Shield Conductor
PC	Power Class
PE	Power Extractor
PHY	Physical (layer)
PIS	Potential Ignition Source
PME-C	CPE's Power Management Entity
PME-D	DPU's Power Management Entity
PMT	Power Management Transceiver
PS	Power Splitter
PSD	Power Spectral Density
PSE	Power Source Equipment
PSE-IE	Power Source Equipment - Injected Energy
PSU	Power Supply Unit (including the combiner function if multiple lines are active)
RBW	Resolution Bandwidth
RG	Radio Guide - Standard Coaxial Cable designations
RPF	Reverse Power Feed
RPFA	Reverse Power Feed Architecture
RPFA-CGO	Reverse Power Feed Architecture - Coax G.fast Only
RPFA-CGS	Reverse Power Feed Architecture - Coax G.fast with Satellite TV
R_{SIG}	Signature Resistor
SAT	Satellite
SG	Service Gateway
SIG	Signature
SR	Short Range
STB	Set Top Box
VA	Volt Ampere
VPSE	Steady state voltage from PSE

4 Introduction to Reverse Power Feed

The basic architecture of a fibre-fed remote node with reverse power feed over coax is shown in Figure 1.

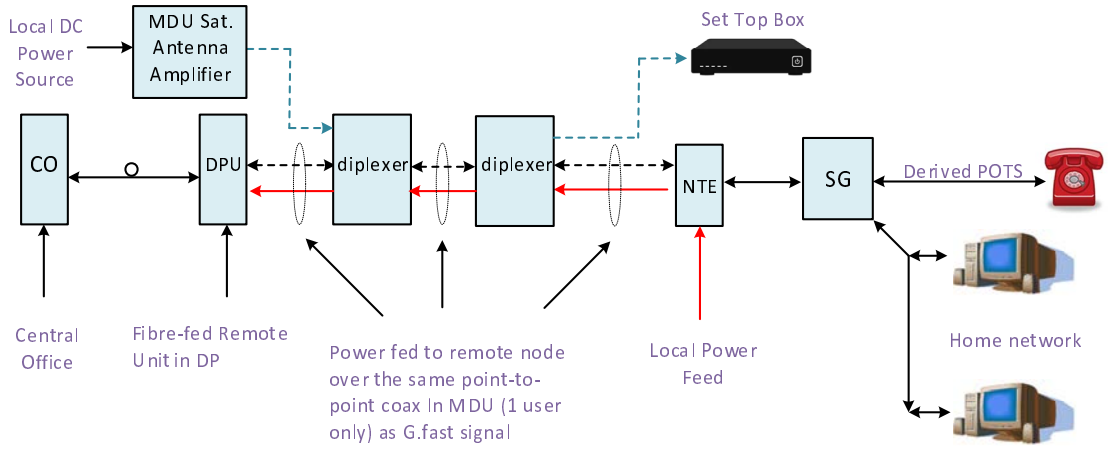

Figure 1: Generic Fibre-fed Remote Node Coaxial Architecture with Reverse Power Feed

Figure 1 applies to two architecture scenarios, G.fast co-existing with Satellite TV and G.fast on its own. It shows power being injected at the NTE from a local power source (located within the home and/or building) which traverses the coaxial cable to power a fibre-fed remote node, located at the Distribution Point (DP).This is the same coaxial cable that is used to transport the G.fast signal between the home and the fibre-fed remote node. Voice service can also be implemented as derived POTS from the Service Gateway (SG). In the case of G.fast with satellite TV, a set of diplexers is required to merge the satellite TV signals onto the same coax as used for the reverse power feed and G.fast signals. Furthermore, reverse powering is not compatible with any use case where a DC component is used in the signalling between the Set Top Box and the satellite TV distribution equipment.

An issue with regards to reverse powered fibre-fed nodes is that of who or what is responsible for the powering of common circuitry contained within the node. It is easy to envisage that an individual user should be responsible for the powering of the remote line terminating/driver electronics corresponding to his particular circuit. However, it is not so easy to determine who or what is responsible for powering of say the DPU that terminates the fibre link.

The present document defines the following two deployment scenarios:

- Scenario 1 - DPU located G.fast only
- Scenario 2 - DPU located G.fast with satellite television

These two scenarios are shown below. These are derived from Figures 25 and 26 in TR-285 [3].

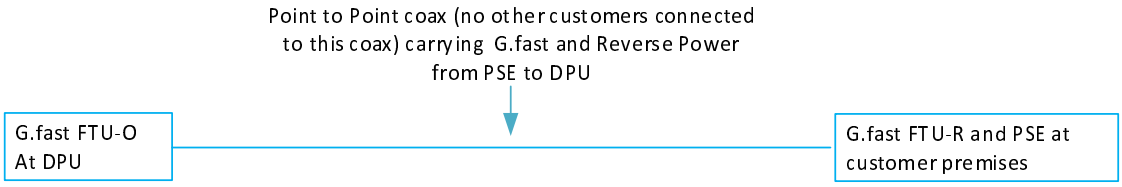

Figure 2: Coax configuration for DPU located G.fast only

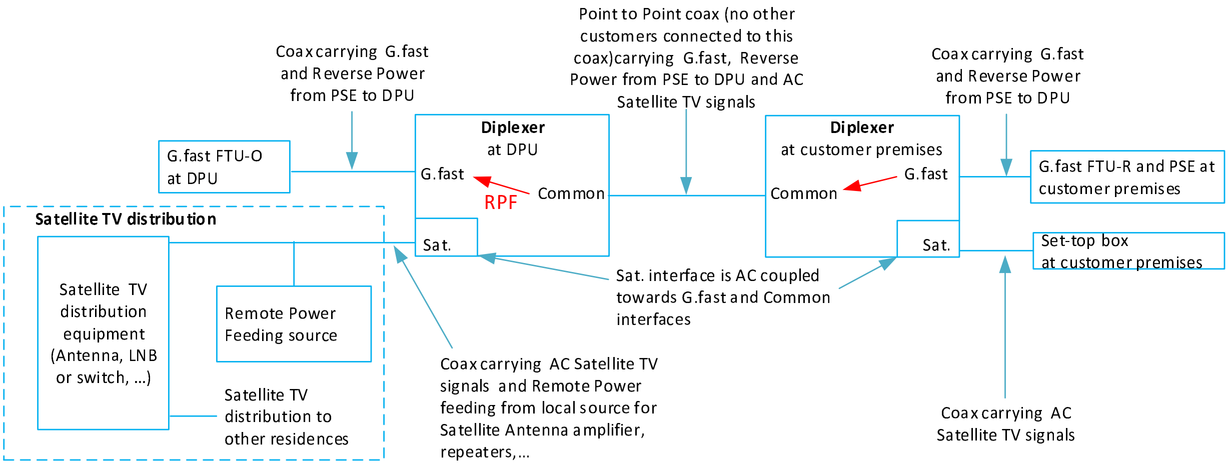
Point to Point coax (no other customers connected to this coax)carrying G.fast, Reverse Power from PSE to DPU and AC Satellite TV signals
Coax carrying G.fast and Reverse Power from PSE to DPU
Coax carrying G.fast and Reverse Power from PSE to DPU
G.fast FTU-O at DPU
Diplexer at DPU
G.fast
RPF
Common
Sat.
Diplexer at customer premises
Common
G.fast
Sat.
G.fast FTU-R and PSE at customer premises
Set-top box at customer premises
Satellite TV distribution
Satellite TV distribution equipment (Antenna, LNB or switch, ...)
Remote Power Feeding source
Satellite TV distribution to other residences
Sat. interface is AC coupled towards G.fast and Common interfaces
Coax carrying AC Satellite TV signals and Remote Power feeding from local source for Satellite Antenna amplifier, repeaters,...
Coax carrying AC Satellite TV signals

Figure 3: Coax configuration for DPU located G.fast with Satellite TV

In the present document, two different implementations of Power Source Equipment (PSE) for Customer Premises are considered: standalone (i.e. a two box model where the PSE and NTE are separate) or integrated (i.e. a single box model where the PSE and NTE are integrated). In these implementations, the Power Splitter (PS) may either be integrated or stand alone.

5 Reverse Power Feed Architectures

5.1 Basics of RPF

Reverse power feed is one of three DPU powering methods defined in TR-301 [4]. Here, the DPU draws its power from the customer premises via the coaxial cable running between those premises and the DPU. The reverse power feed capacity and DPU power consumption need to be such that the DPU can be fully operational when only a single customer is connected. Any back-up battery would be located in the customer premises.

The other two methods are:

- Forward Power from a Network Power Node. In this case, any back-up battery would be located at the network power node.
- Local Power from AC mains source. In this case, any back-up battery would be located at the DPU location.

The combination of reverse powering with one or both of the other two methods is outside the scope of the present document.

Reverse powering shall have two power splitters (one located at the customer premises and another at the remote node) to enable power to be inserted at the customer end of a link and extracted at the remote node. Each power splitter performs a frequency splitting and combining function between the G.fast service being carried and the injected DC electrical power.

Within the remote node, if it operates with multiple power-fed lines then there shall be a power extraction and combiner unit. The purpose of this unit is to combine the multiple power feed inputs to produce a single power source output. The power load should be shared amongst the input power sources.

The technical specifications in the present document shall apply to each architecture described below as one of the two options shown in Table 1. The optional reverse power battery backup at the customer premises is illustrated in block BAT for each reference models in Figure 4 and Figure 5.

Table 1: Architecture Options for Reverse Power Feed Over Coax

Option	Name	Description
1	RPFA-CGO	Reverse Power Feed Architecture - Coax G.fast Only
2	RPFA-CGS	Reverse Power Feed Architecture - Coax G.fast with Satellite TV

5.2 Reverse Power Feed Coax Architecture - G.fast Only (RPFA-CGO)

The functional reference model of the reverse power feed coax architecture with G.fast only (RPFA-CGO) is shown in Figure 4 (single derived POTS port) and Figure 5 (single derived POTS port distributed over internal in-premises wiring). In each case, derived POTS (i.e. an ATA connected to the service gateway) is an option, shown as red dashed lines. The associated reference points are detailed in Table 2.