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Clauses applicable to ITU-T standard systems – Logic and protocols for the control of signal processing network elements and functions

Logic for the control of echo control devices and functions

ITU-T Recommendation Q.115.1

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ITU-T Recommendation Q.115.1

Logic for the control of echo control devices and functions

Summary

Echo is a common problem in long distance (propagation delay) telephony, and echo control devices are deployed to eliminate the effects of it. The call/bearer control entities involved in a telephony connection must use consistent logical procedures to analyse the available information related to echo control requirements in order to optimize the locations at which echo control devices are provided in the connection.

This Recommendation defines the information and logical procedures employed within call/bearer control entities to optimise echo control device placement. The information elements and logic defined in this Recommendation are applicable to basic telephony calls, and to calls using supplementary services and Intelligent Networking features, in both narrow-band and broadband networks using circuit switched or packet bearer technology, and should be applied regardless of the particular signalling systems that convey information between the call/bearer control entities involved in a connection.

This Recommendation is a revision of the ITU-T Rec. Q.115 (12/1999) and incorporates the contents of Implementor's Guide (12/2000) for ITU-T Rec. Q.115 (12/1999).

Source

ITU-T Recommendation Q.115.1 (2002) was revised from ITU-T. Rec. Q.115 (1999) by ITU-T Study Group 11 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 December 2002.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. 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.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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Logic for the control of echo control devices and functions

1 Scope

The propagation delay in transport networks affects both computer communication protocols and audiovisual communication between humans. The most noted effect is the echo problem for telephony which depends heavily on the propagation delay of the connection.

In order to achieve transmission objectives on long connections (refer to 3.10), it is necessary to take into account the effects of echo. A general discussion of echo considerations is given in ITU-T Rec. G.131 [6]. The characteristics of terminal half-echo control devices are given in ITU-T Rec. G.164 [1]. The characteristics of echo cancellers are given in ITU-T Recs G.165 [2] and G.168 [14].

In order to achieve optimum echo control for each call, it is necessary to control both echo suppressors and echo cancellers (realized as a standalone device or as a function of a signal processing network element).

This can be carried out at call/bearer control entities only if sufficient information is available to coordinate an overall control action.

Logical means to obtain pertinent information and the switching considerations governing its practicable use are detailed below. Control, based on the transfer of signals between call bearer control entities, is given particular attention. Self-contained control action, such as tone disablement of echo suppressors and echo cancellers for data transmission, is not within the scope of this Recommendation.

The target to be reached by the use of echo control logic is:

– to optimize the location of provision/insertion of Echo Control Devices/Functions (ECD). The echo control logic should select an ECD as near to the echo source (hybrid or terminal equipment) as possible. The ECD should be close enough to the source of echo so that its echo control tail length is sufficient to cancel any echo that may be present;

– to provide information about the insertion/provision of ECD in the connection in the forward and in the backward direction.

The delay time counter procedures require the addition of transmission delay values, beginning at the origin of a call and ending at the destination of it. These values could only be representative if the whole, or at least most of, the delay of the connection is considered.

If the configuration of a call is changed after the call set-up (e.g., a new leg is added to a conference call), the call/bearer control entity having knowledge about this change is responsible to initiate the echo control logic procedures for this new configuration. Echo control logic is independent of the signalling systems/protocols involved, but the optimal placement may depend on the capability of the signalling systems used for the call set up. Echo control logic described in this Recommendation is backward compatible with the logic described in ITU-T Rec. Q.115 (12/99).

For new versions of signalling systems/protocols, it is necessary to define parameters and messages to transmit the echo control information and requests as specified in Annex A. It is outside the scope of this Recommendation to determine when signalling messages are initiated.

Echo control logic, i.e., the set of echo control logic procedures, covers the needs of echo control not only in the PSTN but also in the N-ISDN, B-ISDN, PLMN, IN and hybrid networks. The term hybrid networks in this context stands for any combination of PSTN, ISDN, Mobile- and Packet-Network.

NOTE – Echo control devices (realized as standalone device or as a function of a signal processing device) controlled by the logic described in this Recommendation are designed to eliminate echo of a voice/audio signal. These Echo Control Devices/Functions are provided by the network. The technique used in these Echo Control Devices/Functions to eliminate the echo is beyond the scope of this Recommendation.

2 References

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.

2.1 Normative references

[3] ITU-T Recommendation I.230 (1988), *Definition of bearer service categories*.

[4] ITU-T Recommendation G.172 (1988), *Transmission plan aspects of international conference calls*.

[5] ITU-T Recommendation G.173 (1993), *Transmission planning aspects of the speech service in digital public land mobile networks*.

[6] ITU-T Recommendation G.131 (1996), *Control of talker echo*.

[7] ITU-T Recommendation E.220 (1996), *Interconnection of public land mobile networks (PLMN)*.

[9] ITU-T Recommendation Z.100 (2002), *Specification and description language (SDL)*.

2.2 Informative references

[1] ITU-T Recommendation G.164 (1988), *Echo suppressors*.

[2] ITU-T Recommendation G.165 (1993), *Echo cancellers*.

[14] ITU-T Recommendation G.168 (2002), *Digital network echo cancellers*.

[8] ITU-T Recommendation Q.764 (1993), *ISDN user part signalling procedures*.

[10] ITU-T Recommendation Q.271 (1988), *General*.

[11] ITU-T Recommendation Q.724 (1988), *Telephone user part signalling procedures*.

[12] ITU-T Recommendation Q.112 (1988), *Signal levels and signal receiver sensitivity*.

[13] ITU-T Recommendation Q.2764 (1999), *Signalling System No. 7 B-ISDN User Part B-ISUP – Basic call procedures*.

3 Terms and definitions

3.1 Subsequent discussion of control measures will refer to the standard terminal half-echo suppressor specified in ITU-T Rec. G.164 [1] and the echo cancellers specified in ITU-T Recs G.165 [2] and G.168 [14]. The terms "echo suppressor" and "echo canceller" will be used to denote these devices. The term "ECD" will comprise both echo suppressors and echo cancellers.

3.2 Two means of introducing ECDs are considered as acceptable. These are the use of permanently associated echo control devices, and the use of echo control devices inserted from a common pool.

3.3 With respect to control of permanently associated ECDs, control actions are said to enable or disable.

3.4 With respect to echo control devices provided from pools, control actions are concerned with inserting or not inserting. An inserted ECD is controlled in order to enable or disable it.

3.5 With respect to ECD provided in B-ISDN exchanges, the term "ECD" denotes echo cancellers only, as echo suppressors should not be used.

3.6 Information to assist in the placement of echo control devices is communicated between exchanges by ITU-compliant signalling.

3.7 Full ECD describes the situation where both an outgoing echo control device and an incoming echo control device (see 3.11) are enabled at a single exchange.

3.8 **long circuit**: is considered as one which, if used by itself, would require echo control.

3.9 **short circuit**: is considered as one which, if used by itself, would not require echo control.

3.10 **long connection**: is a connection that requires echo control.

A long connection may consist of several circuits in tandem. These circuits may or may not be long circuits, but their total propagation delay is such that echo control is required.

If not detected at call set-up time, the total propagation delay is calculated during call set-up based on information carried in signalling (see 8.2).

3.11 **incoming echo control device (IECD)**: is a device cancelling the echo returned from the destination network with reference to the direction in which the call is set up.

3.12 **outgoing echo control device (OECD)**: is a device cancelling the echo returned from the network of origin with reference to the direction in which the call is set up.

3.13 Two types of exchanges are defined:

3.13.1 **exchange Type 1**: invokes echo control logic procedures for all calls of the bearer capability "speech or 3.1 kHz audio". These procedures are described in this Recommendation. Any exchange in a network can be of Type 1.

3.13.2 **exchange Type 2**: cannot invoke echo logic control procedures. The received echo control information is passed unchanged (in both directions). In case of interworking, the echo control information is mapped from one signalling system/protocol to the other.

3.14 **echo control initiating exchange**: is the first exchange that recognizes the need to apply echo control procedures.

3.15 **propagation delay initiating exchange**: is the exchange that initiates the propagation delay determination procedure; e.g., a typical case is the originating local exchange.

3.16 **propagation delay terminating exchange**: is the exchange that terminates the propagation delay determination procedure; e.g., typically the local destination exchange.

3.17 **node of the Intelligent Network** (IN): is a node which belongs temporarily or permanently to the IN, e.g.,

a) an SSP is normally considered to be a node of the PSTN/N-, B-ISDN, but when connecting a Specialized Resource Function (SRF) for the user interaction it is considered to be a node of the IN; and

b) an SCP is considered to be a permanent node of the IN.

4 Abbreviations

This Recommendation uses the following abbreviations:

B-ISDN	Broadband ISDN
B-ISUP	Signalling System No. 7 Broadband ISDN User Part ITU-T Recs Q.2761-Q.2764
CHI	Call History Information
CII	Control Information for IECD
CIO	Control Information for OECD
ECD	Echo Control Device/Function
ECIB	Echo Control Information Backward
ECIBA	Echo Control Information Backward, Additional (ECD availability)
ECIBAp	Procedure to set the information in ECIBA
ECIBp	Procedure to set the information in the ECIB passed to the previous exchange when ECIB has been received from the subsequent exchange
ECIF	Echo Control Information Forward
ECIF/Ap	Procedure that is called when selecting an outgoing circuit
ECIFA	Echo Control Information Forward, Additional (ECD availability)
ECIFAp	Procedure for handling echo control information received from the previous exchange in ECIFA
ECIFp	Procedure for handling echo control information received from the previous exchange in ECIF
ECRB	Echo Control Request Backward (OECD request/IECD request)
ECRBp	Procedure for handling information in a backward echo control request
ECRF	Echo Control Request Forward (OECD request/IECD request)
ECRFp	Procedure for handling a forward request message (e.g., after fallback) when no ECDs are available in a previous exchange
ECRR	Echo Control Request for Release (OECD to be released/IECD to be released)
ECRRB	Echo Control Request for Release, backward direction
ECRRF	Echo Control Request for Release, forward direction
GMSC	Gateway Mobile Switching Centre
I.a.	Incoming echo control device available
I.i.	IECD included
I.n.a.	Incoming echo control device not available
I.n.i.	IECD not included
I.n.r.	IECD not requested
I.n.x.	IECD not to be released
I.r.	IECD requested
I.x.	IECD to be released
IECD	Incoming Echo Control Device/Function

IN	Intelligent Network
IP	Intelligent Peripheral (IN)
ISUP'92	Signalling System No. 7 ISDN User Part ITU-T Recs Q.761-Q.764
N-ISDN	Narrow-band ISDN
NNI	Network Node Interface
NOECDIp	Procedure called by ECIFp if no ECDs are in the connection up to this point
O.a.	Outgoing echo control device available
O.i.	OECD included
O.n.a.	Outgoing echo control device not available
O.n.i.	OECD not included
O.n.r.	OECD not requested
O.n.x.	OECD not to be released
O.r.	OECD required/requested
O.x.	OECD to be released
OECD	Outgoing Echo Control Device/Function
OECDIp	Procedure called by ECIFp when a previous exchange has included an OECD
OECDRp	Procedure called by ECIFp when a previous exchange has requested this exchange to provide an OECD
PDC	Propagation Delay Counter
PLMN	Public Land Mobile Network
ROSRFp	Procedure for analysing the need to provide an OECD for the user interaction (SRF)
RROSRFp	Procedure for initiating the request for release of an OECD (SRF)
SCP	Service Control Point (IN)
SN	Service Node (IN)
SRF	Specialized Resource Function (IN)
SSP	Service Switching Point (IN)
T	If propagation delay > T, then echo control device(s) is (are) required (if at least one of the accesses has a source of echo) (refer to ITU-T Rec. G.131 [6])
TUP	Signalling System No. 7 Telephone User Part ITU-T Recs Q.721-Q.724
UNI	User Network Interface

5 Bearer capabilities for which echo control is required

For connections controlled by ISUP'92 or later versions, the echo control logic procedures apply to the following bearer capabilities:

– 3.1 kHz audio or speech; and

– 64 kbit/s unrestricted preferred.

For connections controlled by B-ISUP, echo control applies when the Narrow-band Bearer Capability parameter is present in the B-ISUP Initial Address Message with the information transfer capability values:

– 3.1 kHz audio or speech.

The handling of ECDs in the case of different bearer capabilities is described in clause 12.

6 Arrangements of echo control devices with respect to signalling

Arrangements should be incorporated in the switching equipment to prevent echo control device action from disturbing simultaneous forward and backward in-band signalling via the speech paths.

Arrangements should be incorporated in the Systems No. 6 and No. 7 equipment to prevent actions by echo control devices from disturbing the procedure for making the continuity check of the speech path. Echo control devices must be permanently disabled if a circuit is used as a signalling channel for common channel signalling.

Echo control devices must be enabled when signalling indicates that a call has encountered fallback from 64 kbit/s preferred to speech/3.1 kHz audio (see 2.5/Q.764) if echo control is required for the call.

Typical arrangements are:

i) locating the echo control devices in a position that does not lead to interference with signalling tones;

ii) where echo control devices are located in a position where they interfere with signalling tones, they must be capable of being disabled by an appropriate condition extended from the signalling equipment to the ECD while signalling is in progress;

iii) using an echo control device that is designed to be transparent to signalling tones (see Note 3).

NOTE 1 – The standard half-echo suppressor (see ITU-T Rec. G.164 [1]), if located on the line side of line signalling equipment, may adversely affect signalling. This difficulty is possible because, with the new standard half-echo suppressor, normal operation will, at times, cause 6 dB additional loss to appear in the path to a line signalling receiver. Operating margins are correspondingly reduced. For example, with signalling receivers for System No. 5 as specified in ITU-T Rec. Q.112 [12], signalling reliability could be impaired. Accordingly, adequate operating margins should be assured or the echo suppressor should not be located on the line side of line signalling receivers. With regard to inter-register signalling which requires simultaneous transmission in both directions, similar considerations call for disabling the echo suppressors while inter-register signalling is in progress, in order to prevent the 6 dB loss.

NOTE 2 – Echo cancellers will not introduce any fixed loss during in-band signalling. However, some can cause a problem during the continuity check used in Signalling Systems No. 6 (see ITU-T Rec. Q.271 [10]) and No. 7 (see ITU-T Recs Q.724 [11] and Q.764 [8]), or with compelled signals having the same frequency(ies) on both directions of transmission in Signalling System No. 5 (see ITU-T Rec. Q.112 [12]) where the received signal is processed through the existing echo path model and produces an interfering signal in the return path.

NOTE 3 – Some echo control devices are capable of internally providing either signalling bypass or an appropriate internal function which permits transparent operation to in-band signalling or other in-band tones.

7 Operation without signals

In Signalling Systems No. 5 and R1, signals are not available for echo control information. In System No. 4, a signal may be applied only if multilateral or bilateral agreements authorize its use. Accordingly, the recommended control plan relies on means other than signals in cases where it has not been found practicable to provide signals. In the case of System No. 5, the normal field of

application to long circuits typically indicates the presence of echo control devices. In the case of System R1, regional control procedures not requiring signals are applicable.

8 Considerations for the need of ECDs

8.1 Information taken into consideration

Exchanges must make decisions with respect to echo control requirements at the time an outgoing circuit is selected or at a later stage of call set-up. Unless echo control devices are not available, one or more of the following items of information should influence this decision:

i) address information indicating the destination (e.g., country code, area code);

ii) information about the actual routing of the call (this includes information related to the routing of a call to a destination, and to any interaction with intelligent network entities);

iii) nature of outgoing circuit (e.g., satellite circuit);

iv) nature of incoming circuit;

v) signalling information received in forward and backward direction:

- I.i. IECD included;
- I.n.i. IECD not included;
- I.r. IECD requested;
- I.n.r. IECD not requested;
- O.i. OECD included;
- O.n.i. OECD not included;
- O.r. OECD required/requested;
- O.n.r. OECD not requested;
- O.a. Outgoing echo control device available (Note);
- I.a. Incoming echo control device available (Note);
- O.n.a. Outgoing echo control device not available;
- I.n.a. Incoming echo control device not available;

vi) bearer capability requested (see clause 12);

vii) propagation delay counter, call history information;

viii) connecting a Specialized Resource Function (SRF).

NOTE – O.a. and I.a. also apply for accesses with no source of echo.

With respect to iii) and iv), the characteristic of primary interest is propagation time. Two general categories, long and short, are the basis of control action. See 3.8 and 3.9, for definition of terminology.

Signalling procedures convey echo control information to enable exchanges to perform echo control in a call-dependent way. For example, see clauses 2.6/Q.764, 2.7/Q.764 and Annex C/Q.764 [8].

Echo control logic will not be invoked in an exchange (acting as a Service Switching Point of the Intelligent Network) while interacting with Intelligent Network entities, unless there is a request to connect to a SRF during call set-up. The protocol entity will use routing or other information from call control to detect that the exchange is interacting with Intelligent Network entities. Echo control logic is invoked at the completion of Intelligent Network interactions when the onward routing of the call is determined. The echo control logic uses the echo control information that was received (e.g., in the IAM), and was stored until needed.

8.2 Propagation delay counter, call history information

Some signalling protocols provide procedures to determine the total propagation delay for a connection in order to have better means to evaluate the need for routing and/or echo control on the connection concerned.

The propagation delay information is accumulated during call set-up in the forward direction. The result is sent in the backward direction as call history information before the active phase of the call. This accumulated result normally represents the propagation delay of the whole connection. However, if the propagation delay terminating exchange has knowledge of the propagation delay of a possible succeeding part of the connection, the value of this delay will be added to the value of the propagation delay as received, and the total value will be returned in the call history information. The call history information can be used by echo control logic at a later time during the call set-up.

The propagation delay initiating exchange has the possibility to start accumulating the propagation delay with a value > 0. The initiating exchange may set the propagation delay counter to a fixed value stored in the exchange.

The increment of the propagation delay counter is 1 ms, the maximum delay value is $2^{16} - 1$ ms.

The propagation delay counter is accumulated for every link in the connection for every call, if possible.

The propagation delay may not be used by every exchange for the decision to include echo control devices into a connection.

As not all exchanges support the propagation delay counting, the other criteria listed in 8.1. have to be used for echo control.

9 Functions of an exchange initiating echo control

All exchanges of Type 1 involved in a connection determine, by factors i) to vii) in 8.1 above, whether echo control devices are needed in the connection. If there is no need to provide echo control devices in a particular connection, then there is no distinction between these exchanges.

If the information related to the factors i) to vii) indicates that the connection to be established will require echo control devices, the following distinction is made:

The exchange that first detects the requirement for echo control devices becomes the EC initiating exchange. This exchange has the responsibility for the optimum placement of the OECD.

If the EC initiating exchange has detected the requirement for echo control devices during forward call set-up, then that exchange has the responsibility for the optimum placement of an OECD. The EC initiating exchange either requests the preceding exchange/network to provide an OECD (when it has information that an OECD is available in the preceding exchange/network), or it provides an OECD. The EC initiating exchange informs the succeeding exchange/network that an OECD is being included, if this is possible on the outgoing signalling system/protocol.

If the EC initiating exchange has detected the requirement for echo control devices during backward call set-up, then that exchange has the responsibility for the optimum placement of an IECD. The EC initiating exchange provides the IECD. The EC initiating exchange informs the preceding exchange/network that an IECD has been included, if this is possible on the incoming signalling system/protocol.

Information on the action to be taken when an EC initiating exchange is unable to provide an IECD or OECD on the connection is provided in clause 10.

See clause 11 for information regarding the possibility of an exchange providing both an OECD and an IECD.

In the event that an EC initiating exchange is unable to provide an outgoing ECD when a need is known, it may call for cooperative action. (Signal I-11 in Signalling System R2 is specifically assigned to make possible a cooperative transfer of responsibility for ECD control from an outgoing gateway exchange, being the EC initiating exchange, to the transit exchange.) The EC logic in an EC initiating exchange will not cause a negotiation process (similar to that used in ISUP'92) to enable an OECD in the preceding exchange/network when it has no knowledge that an OECD is available in the preceding exchange/network.

10 Unavailability of echo control devices

It is recognized that when ECDs are inserted from pools, there is a small probability that no ECD will be available when needed. In this case, the echo control may be done by another exchange. Where EC logic recognizes that proper echo control is not in the connection, the call may be either allowed to complete or terminated. This decision is outside the scope of this Recommendation.

11 Placement of echo control devices in the network

The objective of the EC logic is to select an outgoing echo control device and an incoming echo control device as near as possible to the sources of echo.

ECDs should be placed in such a position in the network that the echo cancellation tail length is sufficient to cover the round-trip end delay between the ECD and the source of echo.

Echo control devices in a connection should preferably be provided in the proper sequence. This means the incoming echo control device should be placed after the outgoing echo control device, seen in the direction of call set-up.

It follows from the above that, in every case where a transit exchange interconnects two circuits and knows that ECD will be provided at a preceding location and also at a more distant location, the transit centre may disable or not insert its own ECD. The provision of tandem ECD for transit calls may be considered provided it does not result in degradation of the call.

An ECD (i.e., IECD and OECD) can be permanently associated with a circuit of the incoming and outgoing signalling system, or can be provided from a pool.

Information about placement of echo control devices for PLMN to PSTN or ISDN interworking is given in ITU-T Recs G.173 [5] and E.220 [7].

B-ISDN networks may or may not provide ECDs or an equivalent functionality. For B-ISDN to N-ISDN interworking, the ECDs or the equivalent functionality may be provided in either the B-ISDN or the N-ISDN.

Service Nodes and Intelligent Peripherals in an IN should provide their own ECDs, if full duplex user interaction is supported. Where an SN/IP has not provided an ECD, then an OECD should be provided in the connection. This is necessary in a full-duplex operation mode even when the end-to-end delay would not require ECDs, in order to prevent unwanted echo of the SRF speech output from being mistaken as a subscriber input.

12 Handling of echo control devices in the case of different bearer capabilities

Echo control logic is invoked when the bearer capability information indicates that it is appropriate.

Different bearer capabilities are needed to provide the different services. Where common circuits are used to provide different basic services, ECDs have to be enabled depending on the requested service, and the results of echo control logic.

- If the bearer capability is speech or 3.1 kHz audio, an ECD should be enabled for this connection at the appropriate exchanges when echo control is required.

- If the bearer capability is 64 kbit/s unrestricted or multirate, or if digital connectivity is requested in TUP, no ECD is inserted. If the ECD is permanently associated, these ECDs have to be disabled and provide bit transparency.
- If the bearer capability is 64 kbit/s preferred, an ECD should be provided in the disabled mode for this connection, at the appropriate exchanges. If the bearer capability for the call changes to speech/3.1 kHz audio from 64 kbit/s preferred, the ECDs should then be enabled.

13 Other considerations

Nothing in this Recommendation should be construed as discouraging control measures which may supplement the plan described and lead to improved results in specific situations. For example, regional procedures which introduce loss to control echo may be arranged to satisfy both regional and international needs on a selective basis.

Annex A

Echo control logic

A.1 General principles and definitions

A.1.1 General principles

The echo control logic is based on the following principles:

– Echo control devices can be either fix assigned to the circuits and associated with the incoming and/or outgoing signalling system/protocol or arranged in a pool (the probability of the availability of an echo control device in the pool should be very close to 1). Either method of providing ECDs will adequately meet the needs of network services and supplementary services (Note 1).

– Reservation of ECDs is not considered in this logic, as it would cause unnecessary complications in signalling procedures.

– Evaluation of propagation delay counter, if present.

– Evaluation of call history information, if present.

– Connections with only one echo control device (OECD or IECD) are treated as a regular case, i.e., these connections are not released.

– Signalling systems/protocols are required to transmit ECIFA, indicating whether a preceding exchange/network has the possibility to provide an OECD if required (Note 2).

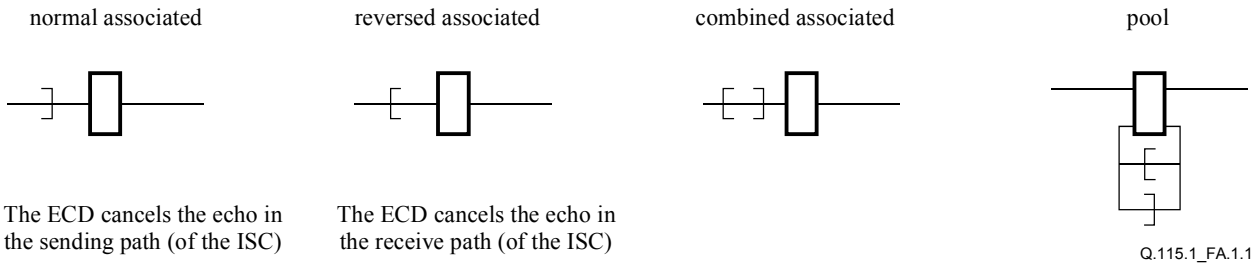
– Signalling systems/protocols are required to transmit ECIBA, indicating whether a succeeding exchange/network has the possibility to provide an IECD if required (Note 3).

– Signalling systems/protocols are required to transmit ECIF, indicating whether a preceding exchange/network has provided an OECD (Note 2).

– Signalling systems/protocols are required to transmit ECIB, indicating whether a succeeding exchange/network has provided an IECD (Note 3).

– Calls having a connection type allowing the change of the bearer capability during the call are subject to echo control.

NOTE 1 – These are the basic configurations for providing ECDs:



NOTE 2 – Incoming circuits (supported by signalling systems/protocols not capable of transmitting ECIFA) connected to an exchange where the availability of OECD in a preceding exchange/network is known, are marked accordingly (this allows an exchange to send an explicit request for OECD backward, only if it makes sense). Where the availability of ECD in the preceding network is not known, the default value of "ECD not available" should be used. Where ECIF is not supported, the default value "OECD not included" should be used, if it is known that the access/network cannot provide an OECD, otherwise the default value "OECD included" should be used.

NOTE 3 – Outgoing circuits (supported by signalling systems/protocols not capable of transmitting ECIBA) connected to an exchange where the availability of IECD in a succeeding exchange/network is known, are marked accordingly (this allows an exchange to send an explicit request for IECD forward, only if it makes sense). Where the availability of ECD in the succeeding network is not known, the default value of "ECD not available" should be used. Where ECIB is not supported, the default value "IECD not included" should be used, if it is known that the access/network cannot provide an IECD, otherwise the default value "IECD included" should be used.

A.1.2 Definitions

– An exchange of Type 1 contains echo control logic (see Figure A.1a).

– An exchange of Type 2 does not contain echo control logic (see Figure A.1b).

The term "circuit" when used in the context of routing, denotes both a TDM circuit (of switched circuit networks) and a virtual circuit (of packet networks).

Any access that does not have a source of echo (hybrid) is characterized by the attribute "ECD available"; e.g., mobile phones (built in acoustic echo cancellation), ISDN terminals, H.323 terminals.

If it is known that a preceding or succeeding exchange/node or network can provide an Echo Control Device (ECD), then those interconnecting circuits/terminations are also characterized by the attribute "ECD available".

So the meaning of "ECD available" is:

a) the preceding or succeeding exchange/node or network can provide an Echo Control Device; or

b) the originating or terminating access does not have a source of echo.

A.2 Abstract model

A.2.1 General description

Echo control logic is part of call control and has a common interface to the logic procedures of the incoming and outgoing signalling systems/protocols.

Echo control logic provides information to populate the echo control indicators in signalling messages.

The following information elements are interchanged between echo control logic and the signalling systems/protocol involved in setting up the connection:

- *Echo Control Information Forward (ECIF)*
  - O.n.i. OECD not in the connection
  - O.i. OECD in the connection
  - O.r. OECD required in subsequent exchange
- *Echo Control Information Backward (ECIB)*
  - I.n.i. IECD not in the connection
  - I.i. IECD in the connection
- *Echo Control Request Forward (ECRF)*
  - I.n.r. IECD not required
  - I.r. IECD required
  - O.r. OECD required
  - O.n.r. OECD not required
- *Echo Control Request Backward (ECRB)*
  - I.n.r. IECD not requested
  - I.r. IECD requested
  - O.r. OECD requested
  - O.n.r. OECD not requested
- *Echo Control Information Forward, Additional (ECIFA)*
  - O.n.a. OECD not available in preceding exchange/network
  - O.a. OECD available in preceding exchange/network (Note 1)
- *Echo Control Information Backward, Additional (ECIBA)*
  - I.n.a. IECD not available in succeeding exchange/network
  - I.a. IECD available in succeeding exchange/network (Note 1)
- *Echo Control Request for Release Forward/Backward (ECRRF/B)*
  - I.n.x. IECD not to be released
  - I.x. IECD to be released
  - O.n.x. OECD not to be released
  - O.x. OECD to be released
- *Control Information for IECD (CII)*
  - Enable
  - Disable
- *Control Information for OECD (CIO)*
  - Enable
  - Disable

NOTE 1 – O.a. and I.a. also apply for accesses with no source of echo.

The following information is available from call control (routing):

- *Propagation Delay Counter (PDC)* (Note 2)

  Received: PDC = Di

  Sent forward: PDC = Di + Do

- *Call History Information* (Note 2)

  Total propagation delay sent backward.

- *Routing Information*

  This includes information related to the routing of a call to a destination, and to any interaction with intelligent network entities.

NOTE 2 – Di Propagation Delay time of the originating access, or of the incoming connection (PDC received).

Do Propagation delay of the terminating access, or of the outgoing section of the connection.

If propagation delay/call history > T then echo control is required.

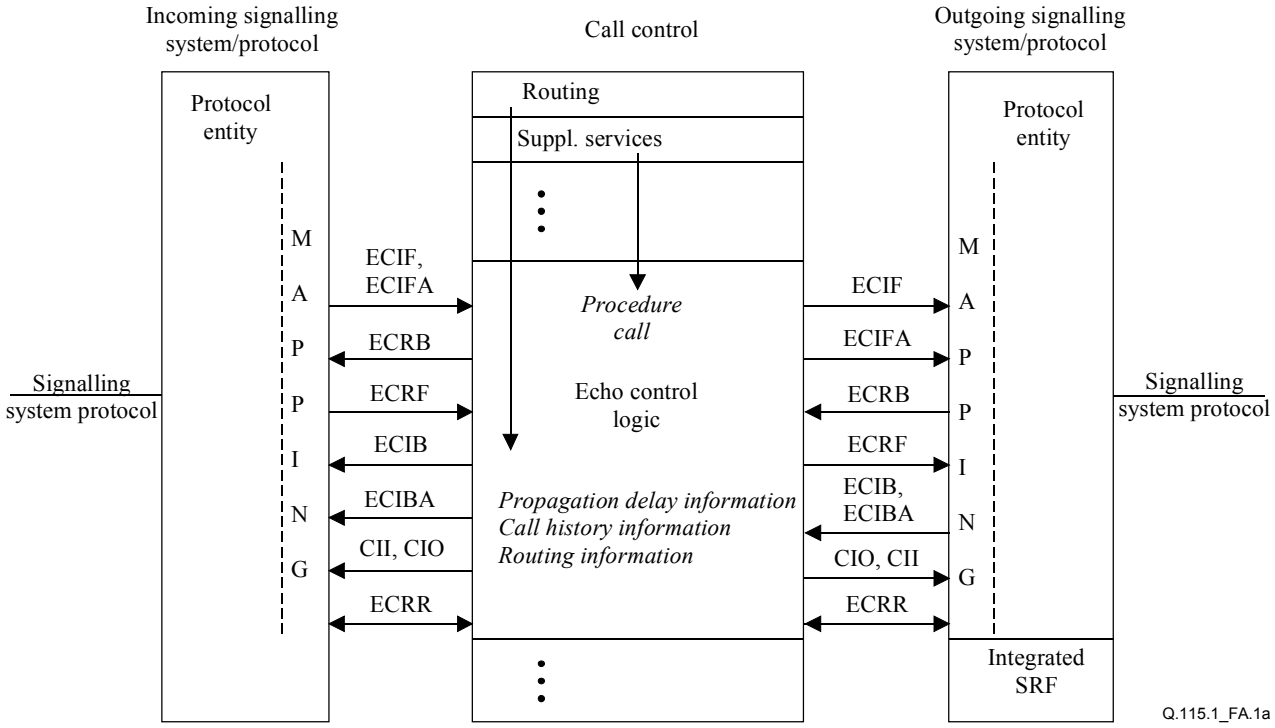
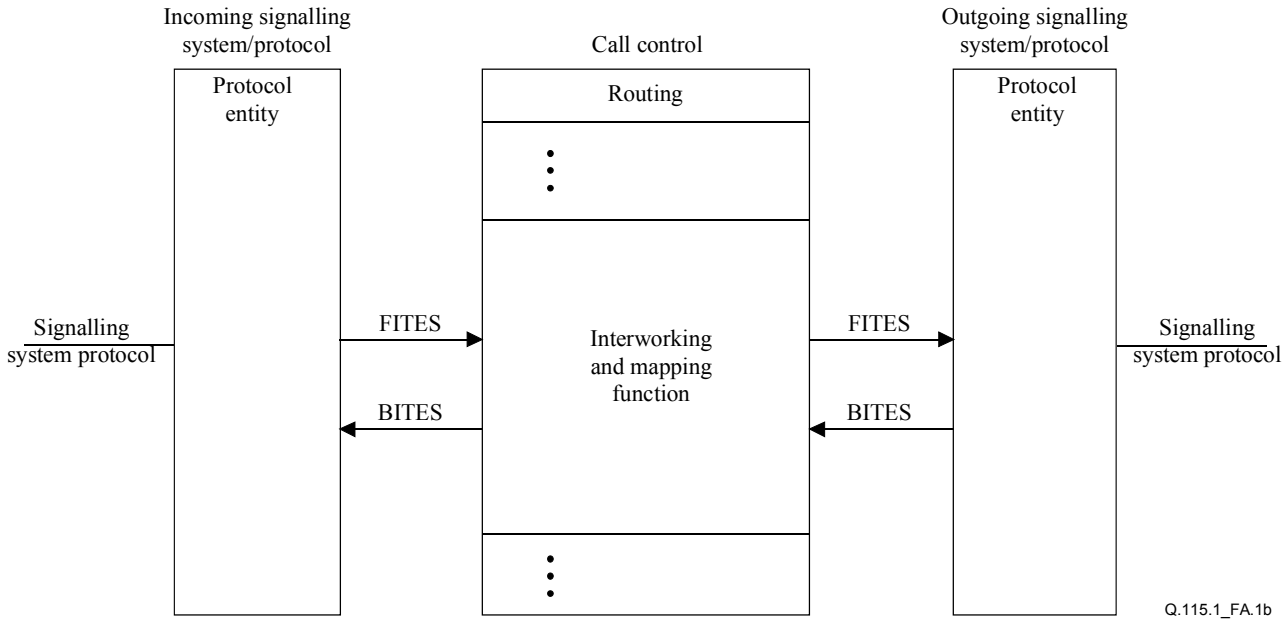


Figure A.1a/Q.115.1 – Exchange Type 1



NOTE – Echo control information elements are included in FITES and BITES (see Annex A/Q.601-Q.695 (03/1993)).

Figure A.1b/Q.115.1 – Exchange Type 2

A.2.2 Signalling system/protocol

A.2.2.1 General

The echo control information/requests received by the signalling systems/protocols have to be stored so that they can be interpreted by the echo control logic procedures (see A.2.1); ECIF has to be sent in conjunction with ECIFA (if not supported by the signalling system/protocol, a default value based on the knowledge of the adjacent exchange/network has to be used). The same applies for ECIB and ECIBA. The protocol entity of the signalling systems/protocols is responsible for the control of the echo control devices, i.e., the carrying out of the control information received from echo control is based on timing requirements (e.g., continuity check running) and on the bearer capability actually used (e.g., fall back). The signalling systems/protocols transmit the echo control information/requests resulting from echo control logic. See Table I.1 for details of the transmission of echo control information.

A.2.2.2 Backward compatibility

Some existing signalling systems/protocols have echo control signalling procedures based on their signalling information transfer capabilities. These signalling procedures may not adhere fully to the echo control logic described in this Recommendation. Therefore, a backward compatibility mechanism may be required in an exchange using the echo control logic defined in this Recommendation. The figures in Appendix I show examples of such mechanisms.

A.2.2.3 Interactions with the Intelligent Network (IN)

In a Service Switching Point (SSP), the protocol entity is responsible for providing default echo control values in a backward direction when interaction to intelligent network entities occurs during call set-up. Echo control information received (e.g., in an IAM) is stored during this period. The default values for the echo control information are "I.n.i." and "I.n.a.". This is applicable to both Type 1 and Type 2 exchanges.

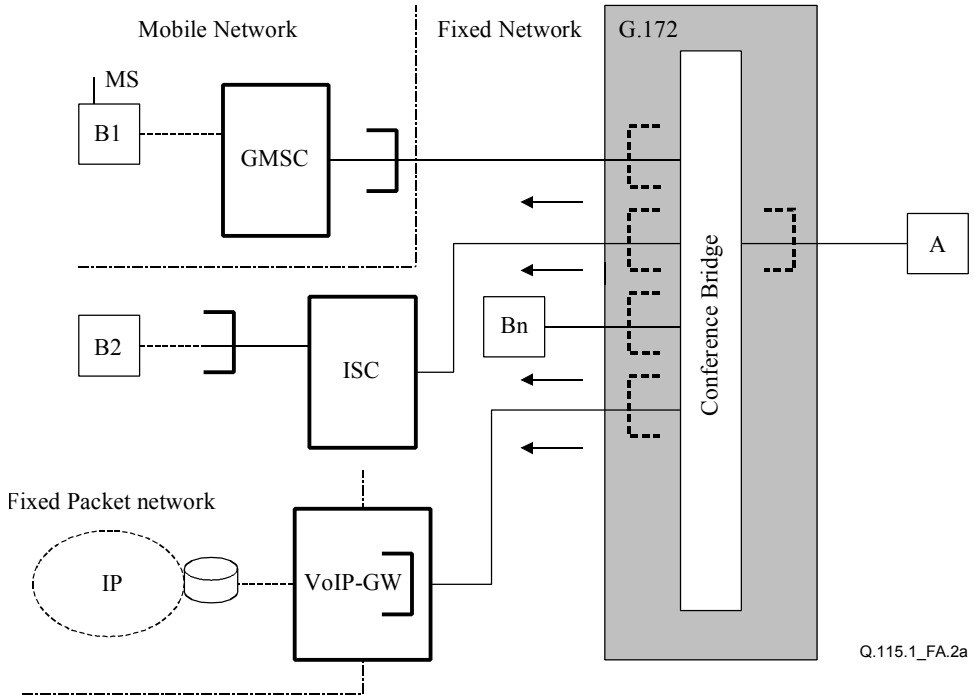
Connection to a Specialized Resource Function (SRF): if an answer message is required to allow user network interaction, it should not include, in case of ISUP, Call History information. If this

node is a Type 1 exchange supporting full-duplex user interaction, then echo control logic will decide, if an OECD is required.

A.2.2.4 Supplementary services

A.2.2.4.1 Multi-party (three-party service, conference calling)

Conference Bridge in the fix network: The echo control logic assumes that the conference bridge, used for the multi-party service, complies to ITU-T Rec. G.172 [4]. Therefore, by using the echo control logic described in this Recommendation, and the echo control signalling procedures for basic call for each individual call and the sending of an *Echo Control Request for Release Forward* (OECD to be released), initiated by the multi-party functional entity on each leg (of a called party) of the conference bridge, optimal echo control performance is guaranteed.



Echo Cancellation Device/Function (e.g., ITU-T Rec. G.168)

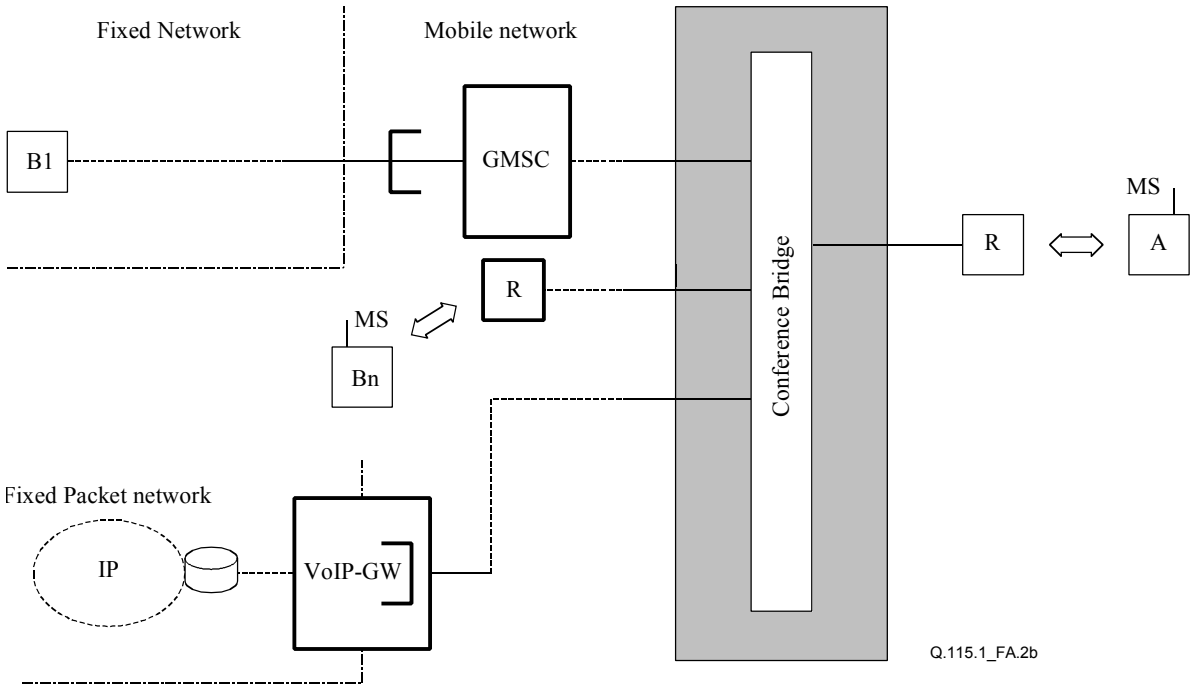
Echo and Noise Control (see ITU-T Rec. G.172)

Echo Control Request for Release of OECD

A	Conferee (calling)
B1, .., Bn	Conferees (called)
IP	Internet Protocol-based Network
ISC	International Switching Centre
GMSC	Gateway Mobile Switching Centre
MS	Mobile Station

Figure A.2a/Q.115.1 – Example of a network scenario (fixed network)

Conference Bridge in the mobile network: Mobile stations are supposed to have built in control mechanisms for acoustic echo and noise. Therefore, by using the echo control logic described in this Recommendation and the echo control signalling procedures for basic call for each individual call, optimal echo control device placement is guaranteed.



Echo Cancellation Device/Function (e.g., ITU-T Rec. G.168)

Radio Link

A	Conferee (calling)
B1, .., Bn	Conferees (called)
IP	Internet Protocol-based Network
GMSC	Gateway Mobile Switching Center
MS	Mobile Station
R	Radio System

Figure A.2b/Q.115.1 – Example of a network scenario (mobile network)

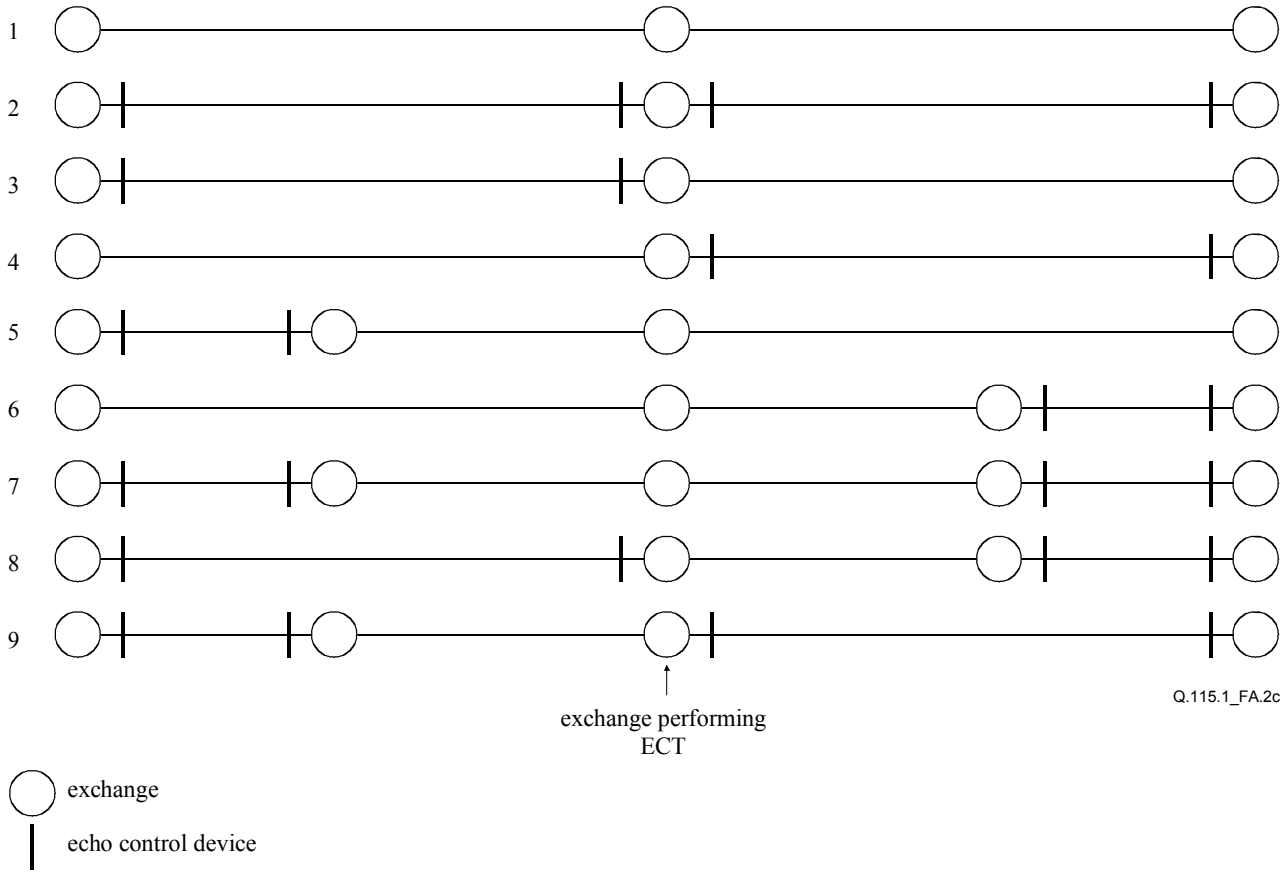
A.2.2.4.2 Call offering

A.2.2.4.2.1 Call forwarding (busy, no reply, unconditional)

All call forwarding exchanges have to pass all relevant echo control information (e.g., O.i./O.n.i., propagation delay) to the new leg in the diverted call. The use of echo control signalling procedures for basic call, which are based on the echo control logic described in this Recommendation, will then guarantee optimal echo control performance.

A.2.2.4.2.2 Explicit call transfer

In case of explicit call transfer in an exchange Type 1, the echo control logic procedure for ECT analyses the changed situation and decides if and where ECDs have to be provided. ECT, combining two connections (legs) which have been previously set up independently, leads to one of the following configurations.



NOTE – If ECT occurs in an exchange Type 2, this may result in a non-optimal placement of ECDs or no ECDs (however required) respectively.

Figure A.2c/Q.115.1 – ECD grouping to be analysed by echo control logic

A.2.2.5 Connection type allowing fallback

Based on the actual bearer capability the protocol entity carries out or ignores the CII (enable IECD) or the CIO (enable OECD) received from echo control logic.

A.2.3 Interworking

In case of exchange Type 2, the received echo control information/requests are mapped (by the interworking function) from one signalling system/protocol to the other.

A.2.4 Special network nodes

A.2.4.1 Nodes belonging to the Intelligent Network (IN)

Those nodes with a circuit interface can be set up either as a Type 1 or Type 2 exchange.

Type 1: In a Service Switching Point (SSP) with integrated SRF, echo control logic will decide for a connection to an SRF, if the network has to provide an OECD. At disconnect of the SRF, the echo control logic will issue an OECD release request in those cases where an OECD request has been issued. Echo control logic will perform the above stated functions within an Intelligent Peripheral (IP) and within a Service Node (SN).

Type 2: If backward messages/information have to be sent to the network, the following default values have to be used; "IECD not included", "IECD/OECD not requested" and "no call history".

A.2.4.2 Gateway of mobile networks

Mobile networks are connected to the fixed network (ISDN/PSTN) through the Gateway Mobile Switching Centre (GMSC). This is a Type 1 exchange. The GMSC may provide on a per call basis an ECD to cancel the echo originated in the fixed network in case the fixed network does not provide the ECD itself. The mobile terminal is considered to be free of echo; see ITU-T Rec. E.220.

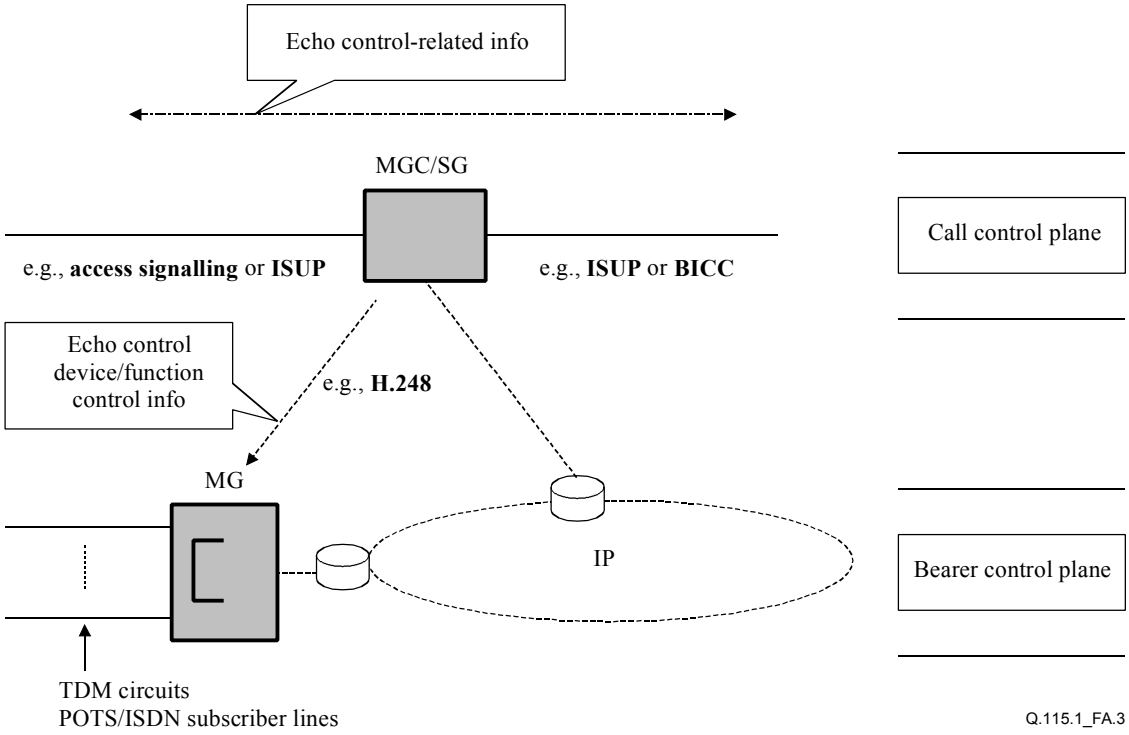
Mobile originating call: The echo control information sent from the GMSC towards the fixed network is "OECD available" (if supported by the signalling system) and "OECD included". The GMSC will provide the IECD in case the echo control information "IECD not included" and "IECD not available" (if supported by the signalling system) is received from the fixed network.

Mobile terminating call: If the received echo control information indicates "OECD not included" and "OECD not available" (if supported by the signalling system), the GMSC will provide the OECD. The echo control information "IECD available" (if supported by the signalling system) and "IECD included" is sent in the backward direction towards the fixed network.

NOTE – Propagation delay and call history should also be conveyed between the networks.

A.2.4.3 SCN – packet network Gateway

Figure A.3 shows a VoIP scenario. The decomposed architecture of the gateway and the relation to call/bearer control protocols are shown.



Echo Cancellation Device/Function

IP Internet Protocol-based Network
MG Media Gateway
MGC/SG Media Gateway Controller with Signalling Gateway

Figure A.3/Q.115.1 VoIP scenario

A.2.4.3.1 Gateway to support PSTN/N-ISDN services over IP

The so-called Voice over IP Gateway connects the switched circuit network (SCN) to the Internet. This allows voice traffic going from the SCN to the Internet and vice versa. The VoIP Gateway is a type 1 exchange/node. It may also provide on a per call basis an ECD to cancel the echo generated at the access of the SCN in those cases where the exchanges in the SCN do not provide ECDs for voice traffic going to or coming from the Internet. IP terminals are considered not to generate electric echo; cancellation of acoustic echo is handled in the terminal itself (see ITU-T Rec. H.323).

Voice call from the SCN towards the Internet: When selecting an IP port it is recommended to apply the propagation delay procedure as defined in ISUP. In order to comply with the requirements of ITU-T Rec. G.177 (*Transmission planning for voiceband services over hybrid Internet/PSTN connections*), which states that an echo canceller is required an all voice over IP calls, the Routing Information in the gateway should indicate "echo control required". Normal echo control logic applies. The IP termination at the gateway is considered to be an access without source of echo, i.e., "IECD available" applies.

Voice call from the Internet towards the SCN: When selecting a circuit of the SCN, the propagation delay procedure as defined in ISUP shall apply. Depending on the destination the Routing Information will indicate "echo control required" or "echo control not required". Normal echo control logic applies. The IP termination at the gateway is considered to be an access without source of echo, i.e., "OECD available" applies.

A.2.4.3.2 Gateway to support PSTN/N-ISDN services over ATM

The ATM trunking Gateway connects the N-ISDN to an ATM backbone network. This allows for N-ISDN services over an ATM backbone network. The ATM trunking Gateway is a type 1 exchange/node. It may also provide on a per call basis an ECD to cancel the echo generated at the access of the N-ISDN in those cases where the exchanges in the N-ISDN do not provide ECDs for voice traffic going to or coming from the ATM backbone network.

Voice call from the N-ISDN towards the ATM backbone: When selecting a VC (port), the value received in the propagation delay counter has to be increased by the value administered for that VC; the propagation delay procedure as defined in ISUP shall apply. When the delay added by the inclusion of the ATM network exceeds 5 ms, the Routing Information in the gateway should indicate "echo control required", in order to comply with the requirements of ITU-T Rec. G.176 (*Planning guidelines for the integration of ATM technology into networks supporting voiceband services*), which states that an echo canceller is required on such voice over ATM calls. Normal echo control logic applies. The ATM termination at the gateway is considered to be an access without source of echo, i.e., "IECD available" applies.

Voice call from the ATM backbone towards the N-ISDN: When selecting a circuit of the SCN, the value received in the propagation delay counter has to be increased by the propagation delay administered for that circuit; the propagation delay procedure as defined in ISUP shall apply. Depending on the destination the Routing Information will indicate "echo control required" or "echo control not required". If echo control is not required based upon Routing Information, the propagation delay counter is then examined to see whether an echo canceller is required. Normal echo control logic applies. The ATM termination at the gateway is considered to be an access without source of echo, i.e., "OECD available" applies.

A.2.5 Echo control logic

The echo control logic analyses the echo control information/requests and propagation delay/call history values received via the signalling systems/protocols, as well as origin/destination-related information that is stored in the database of the exchange. Based on all these data, the echo control logic determines:

a) echo control device-related actions; and

b) the echo control information/requests that have to be transmitted by the signalling systems/protocols.

The echo control logic does not directly control the echo control devices. It is the task of the protocol entity of the signalling systems/protocols to disable and enable echo control devices. The reason is: The echo control logic does not know if, for example, in-band signalling is still going on, if continuity check is still running, or the value of the currently used bearer capability.

A.3 SDL diagrams

The following pages (Figures A.4 to A.23) show the finite state machine and the procedures. Refer to ITU-T Rec. Z.100 [9] for definitions of the symbols and syntax used in these diagrams.

NOTE – In the context of the SDLs:

– "normal associated" is referred to as "IECD associated with the incoming circuit" and "OECD associated with the outgoing circuit" respectively.

– "reversed associated" is referred to as "IECD associated with outgoing circuit" and "OECD associated with incoming circuit".

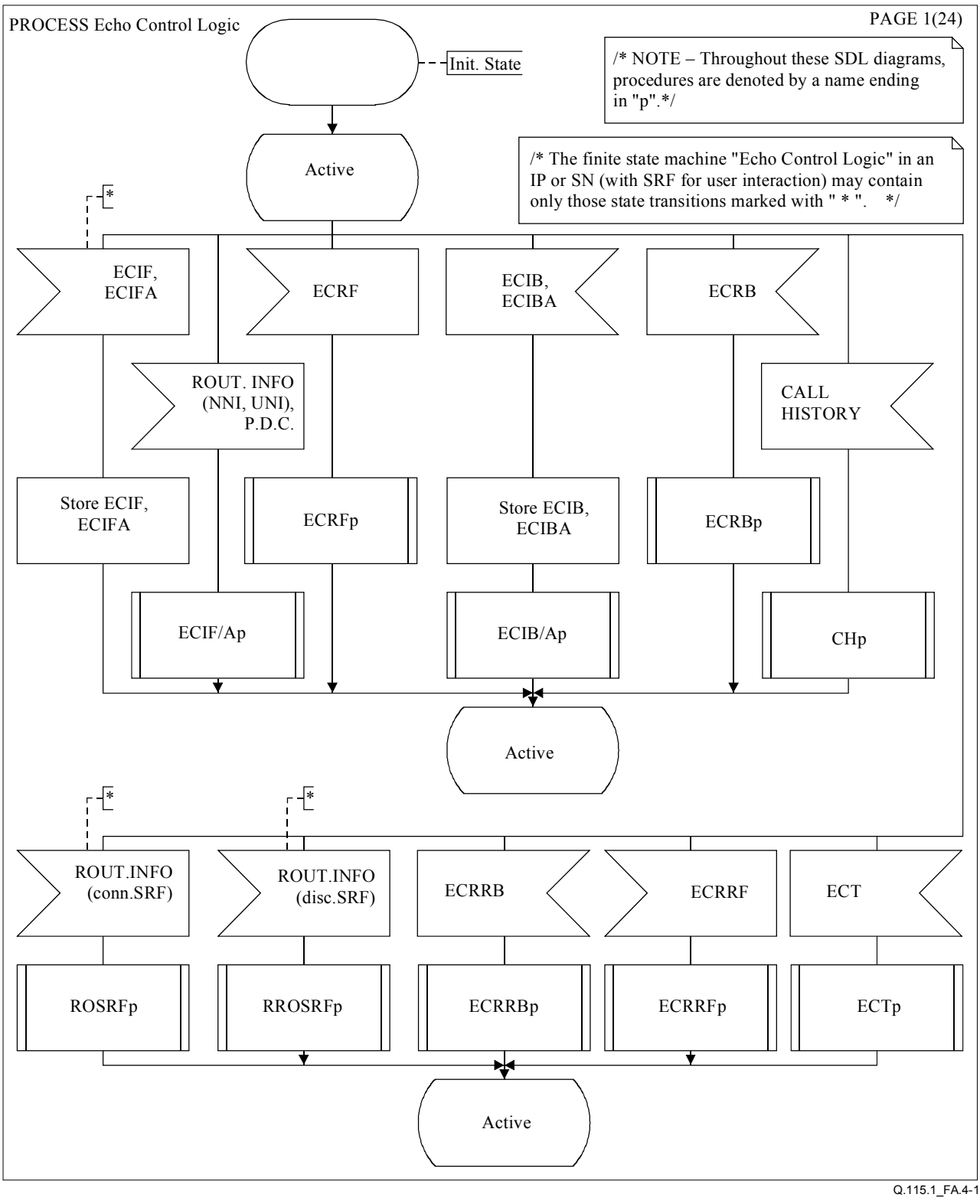


Figure A.4/Q.115.1 – Finite state machine "Echo Control Logic" ***(sheet 1 of 2)***

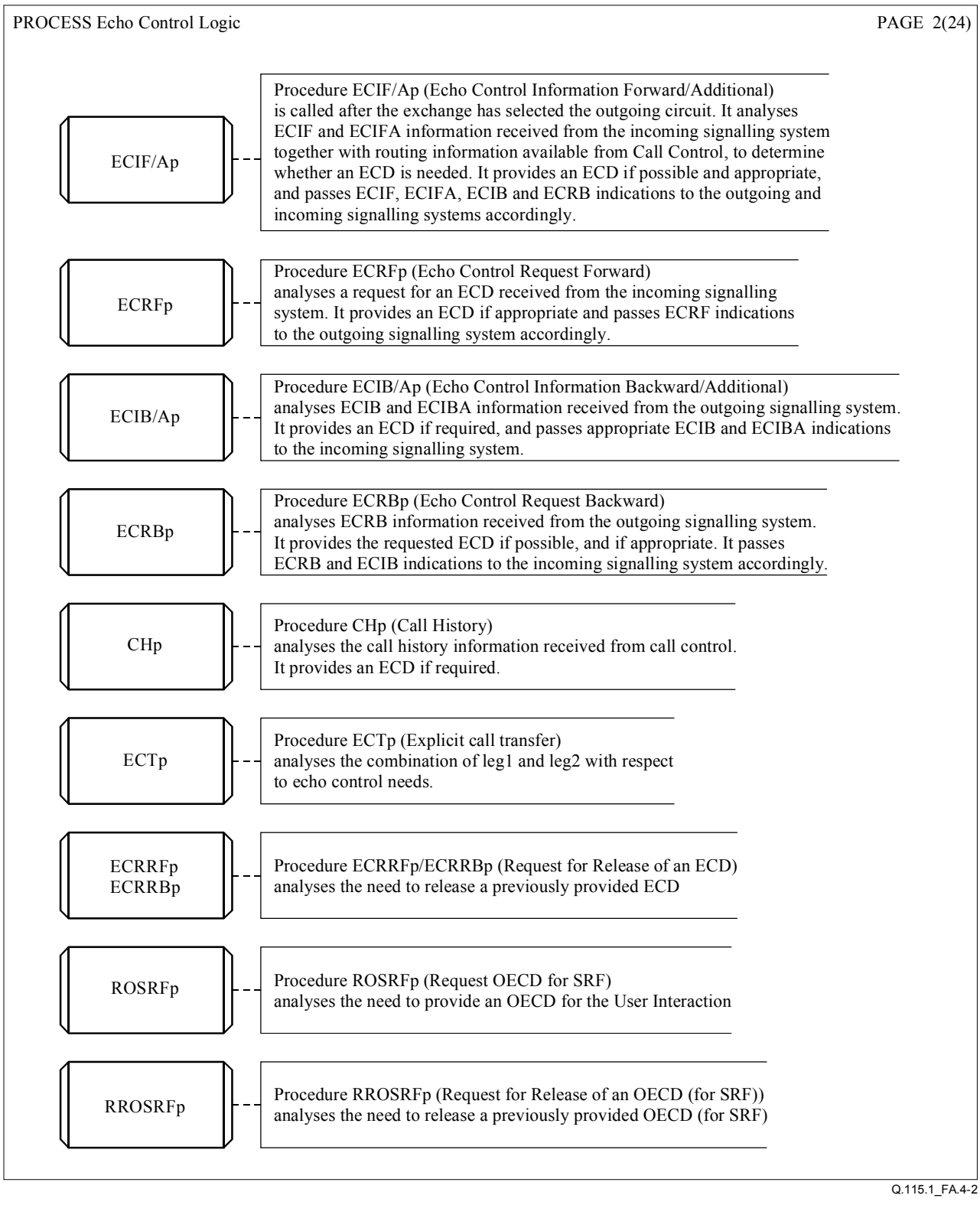


Figure A.4/Q.115.1 – Finite state machine "Echo Control Logic" ***(sheet 2 of 2)***

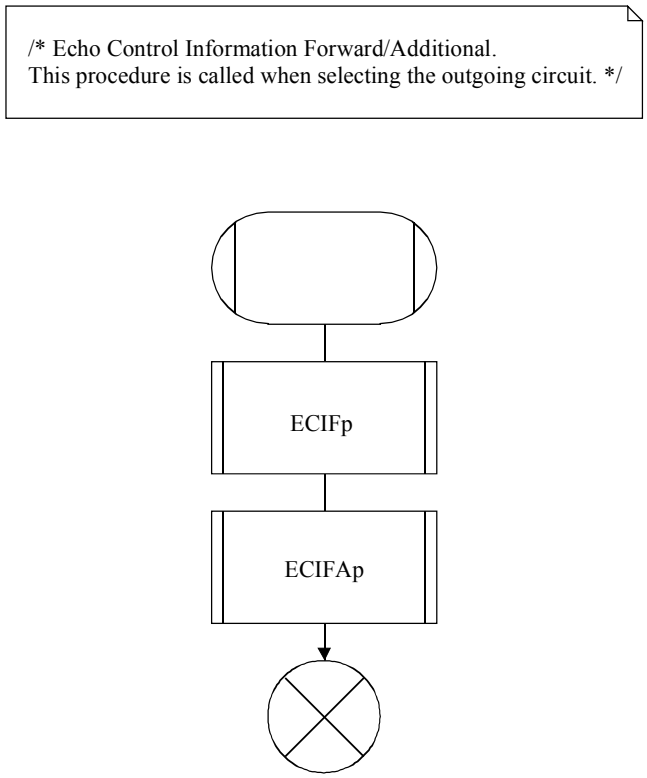
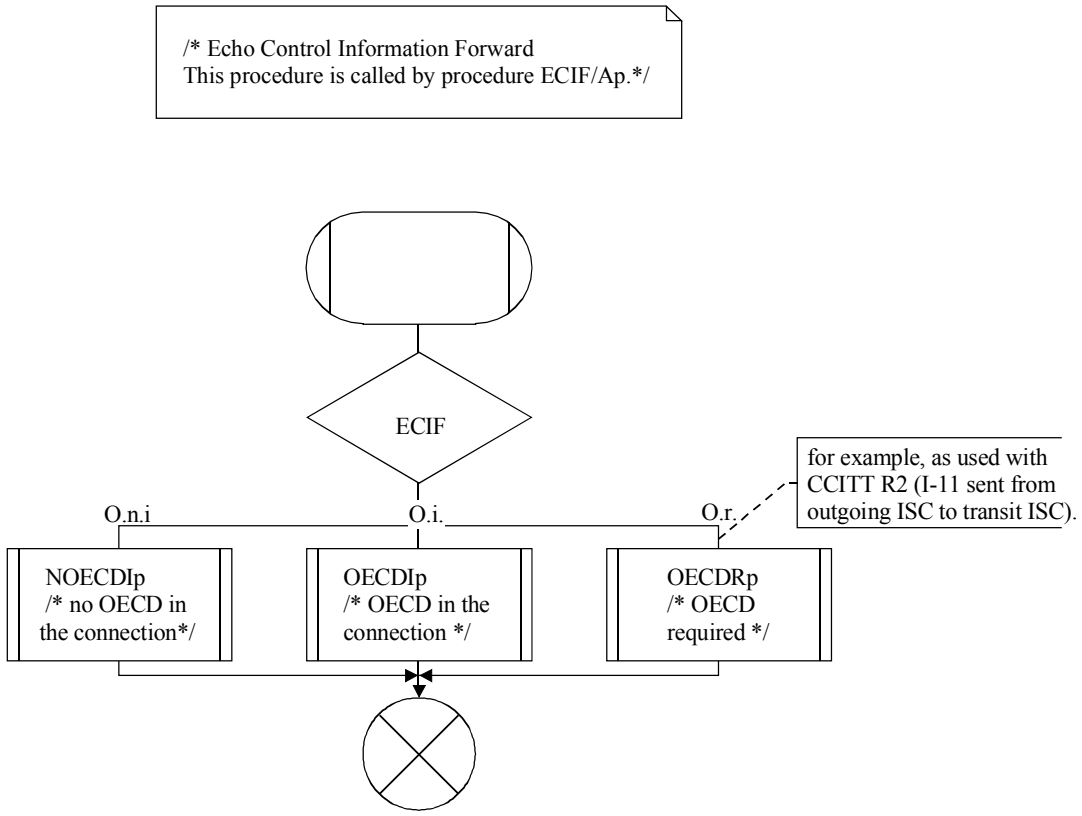


Figure A.5/Q.115.1 – Echo control procedure for ECIF/A



Q.115.1_FA.6

Figure A.6/Q.115.1 – Echo control procedure for ECIF

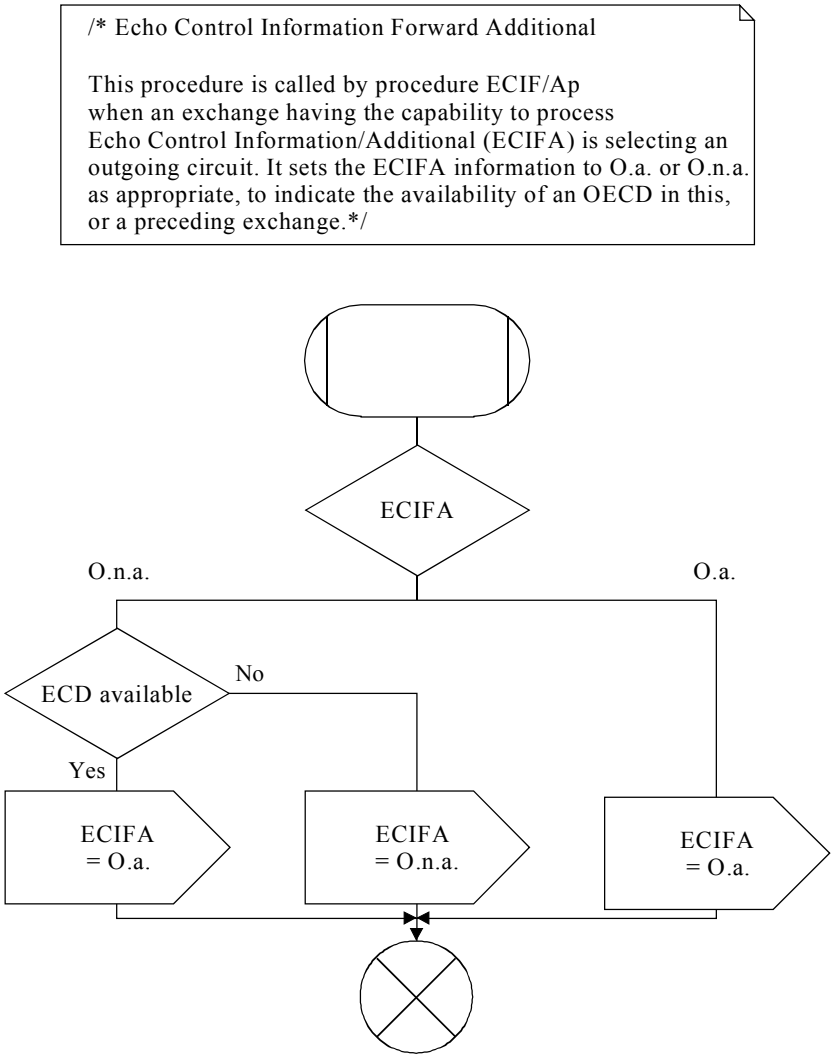


Figure A.7/Q.115.1 – Echo control procedure for ECIFA

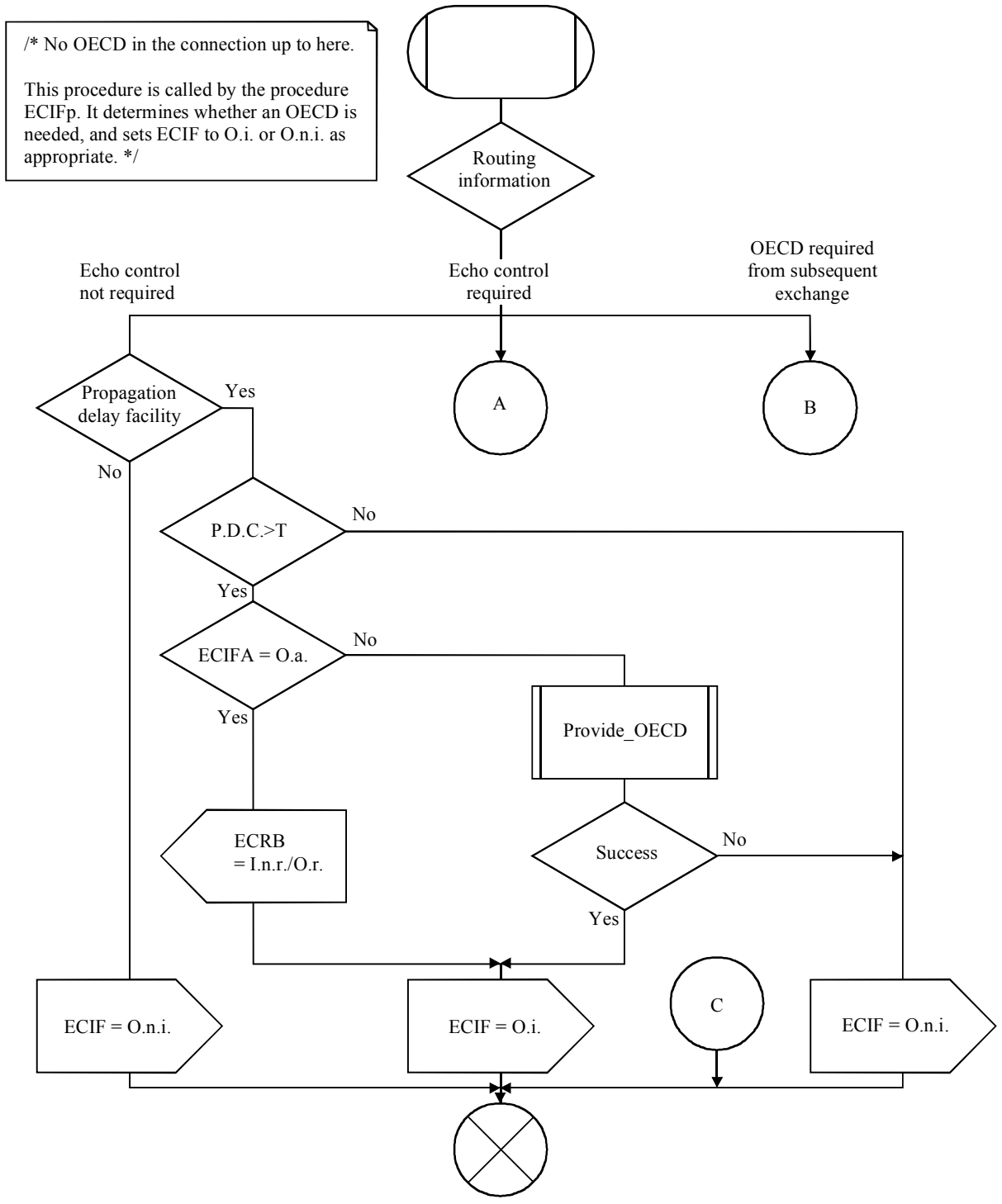


Figure A.8/Q.115.1 – Echo control procedure for ECIF = O.n.i. ***(sheet 1 of 2)***

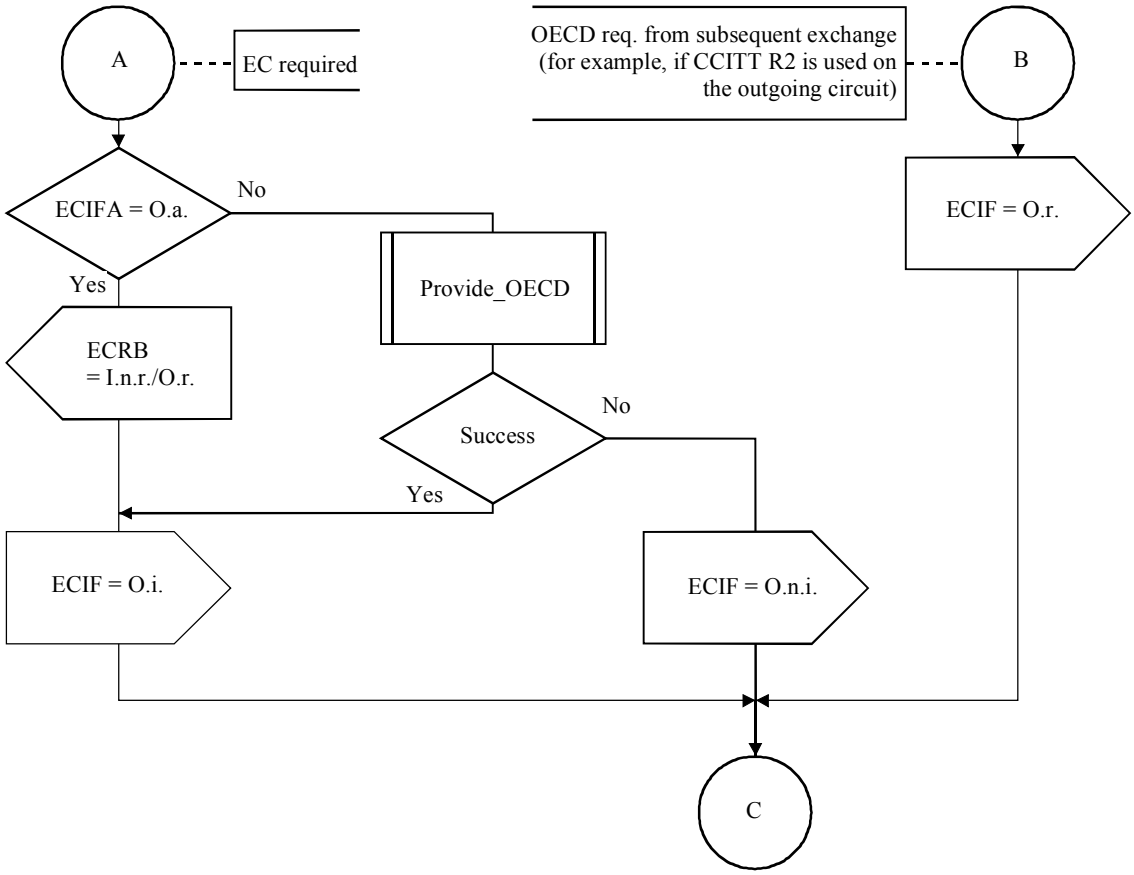


Figure A.8/Q.115.1 – Echo control procedure for ECIF = O.n.i. ***(sheet 2 of 2)***

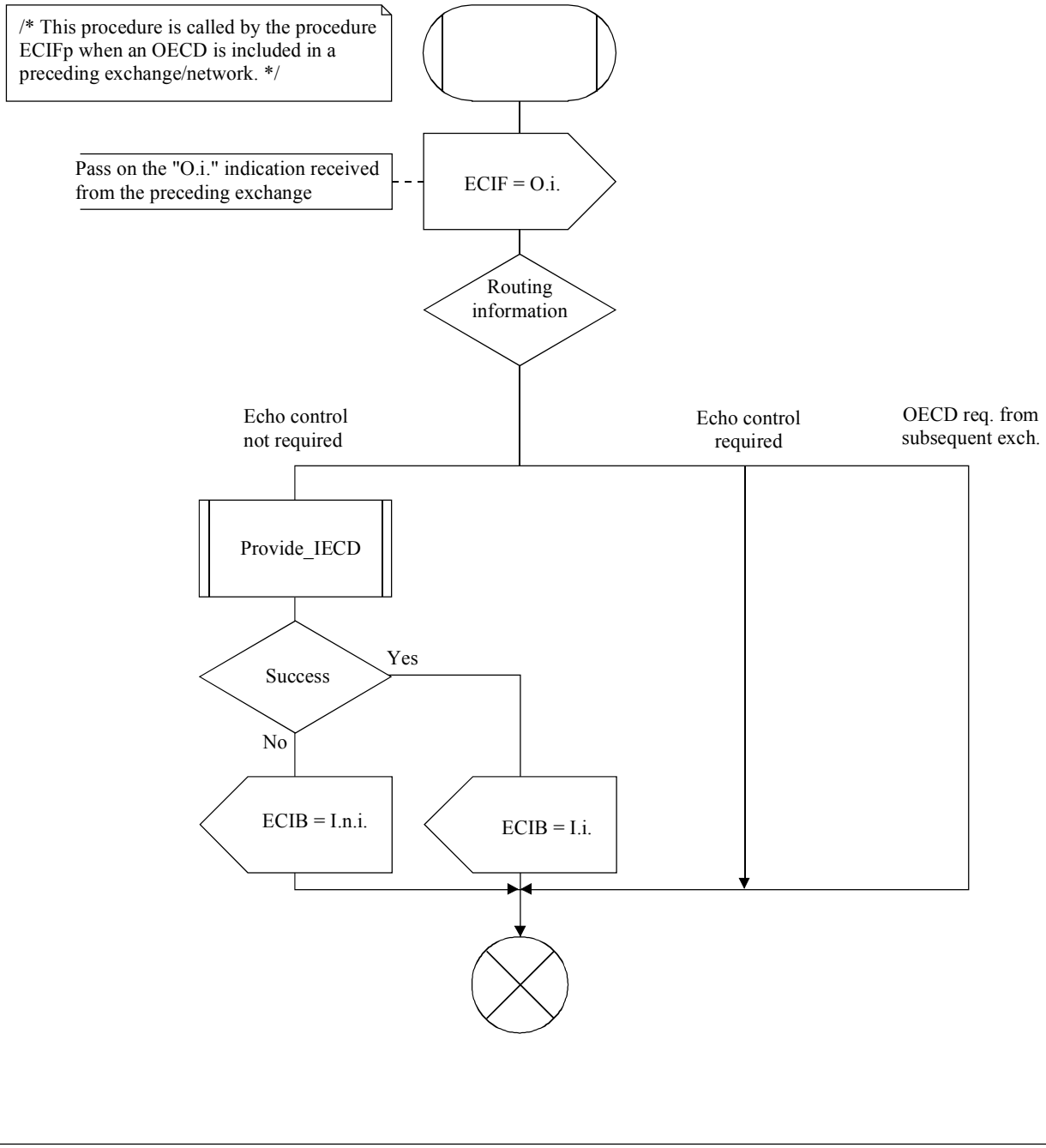
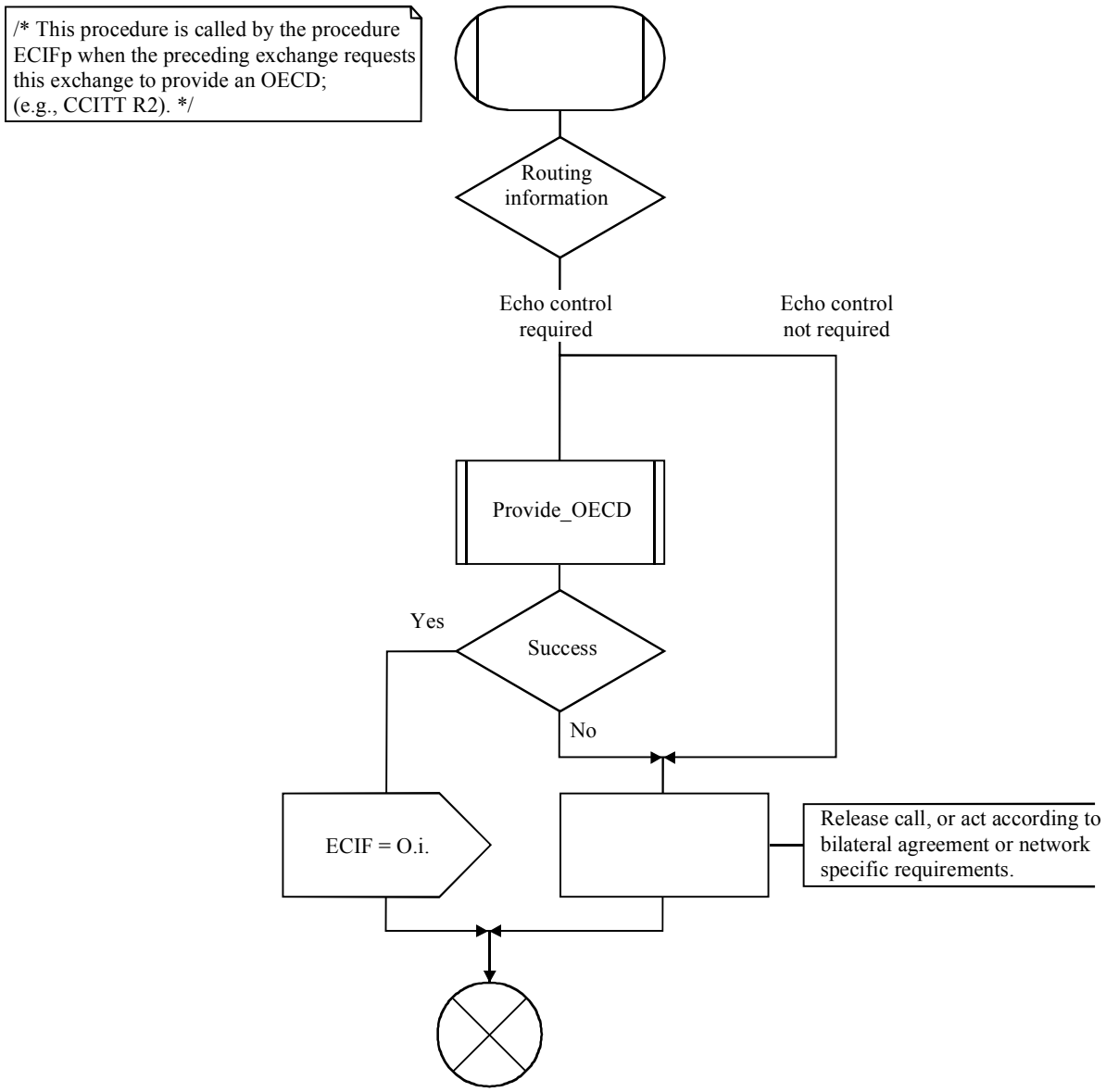


Figure A.9/Q.115.1 – Echo control procedure for ECIF = O.i.



Q.115.1_FA.10

Figure A.10/Q.115.1 – Echo control procedure for ECIF = O.r.

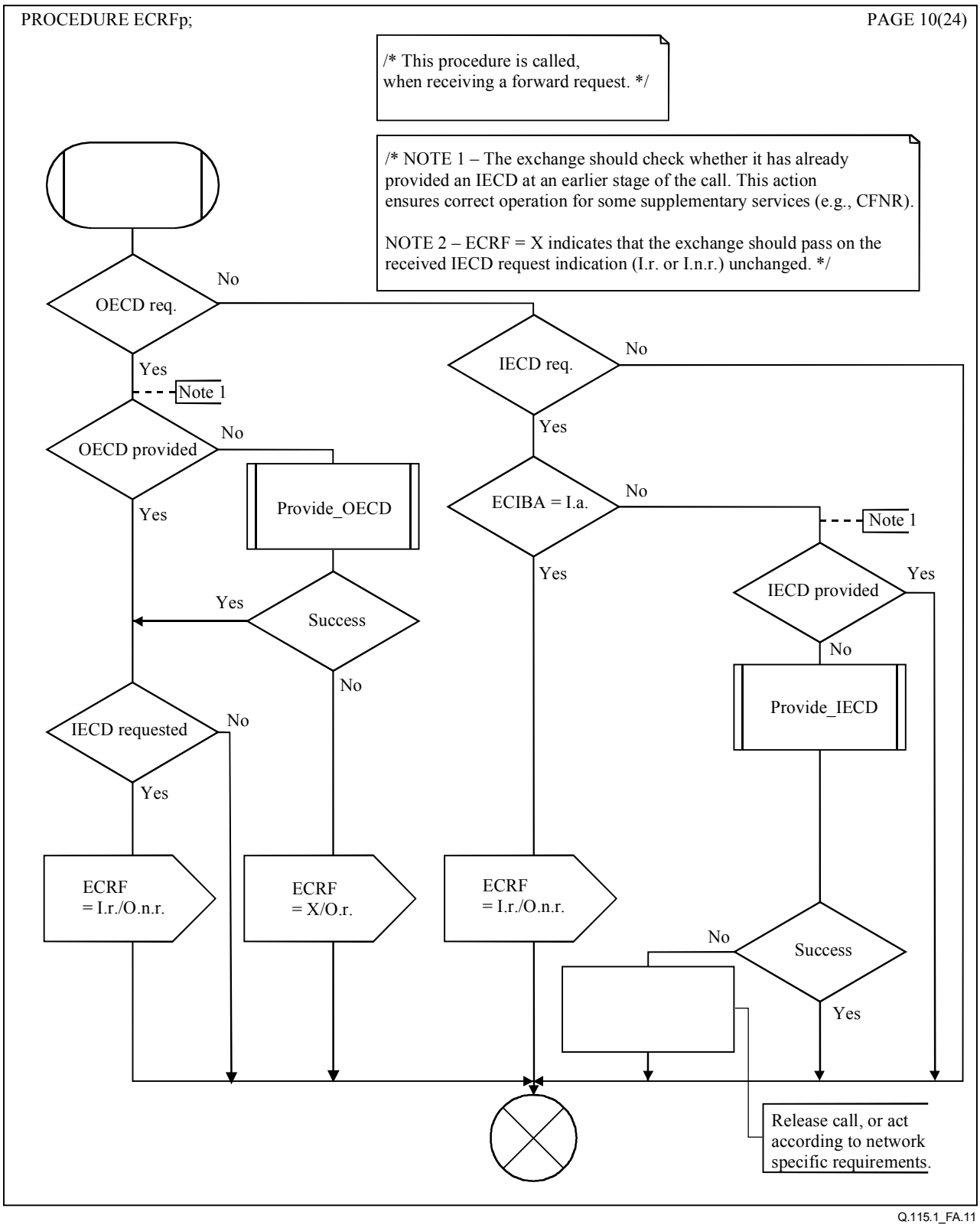


Figure A.11/Q.115.1 – Echo control procedure for ECD request (forward)

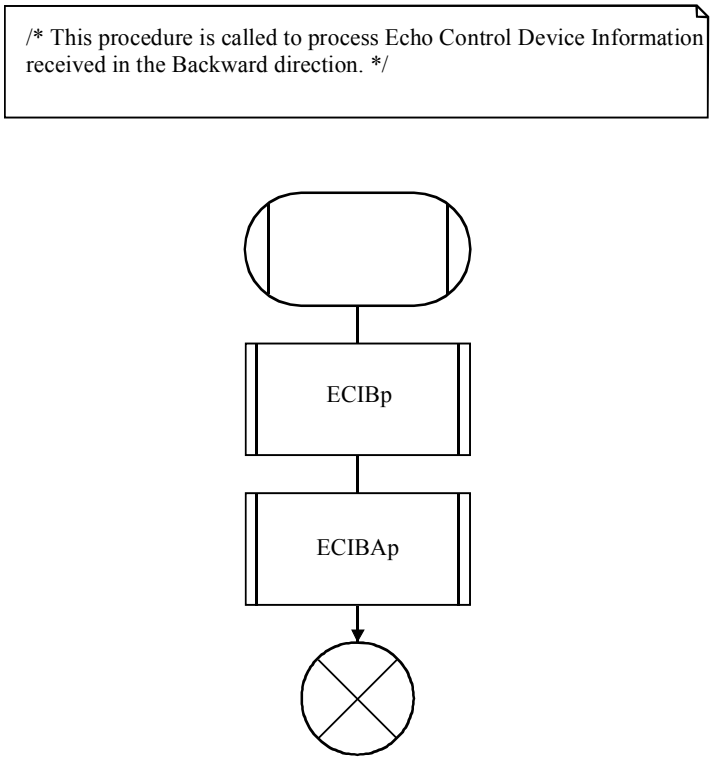
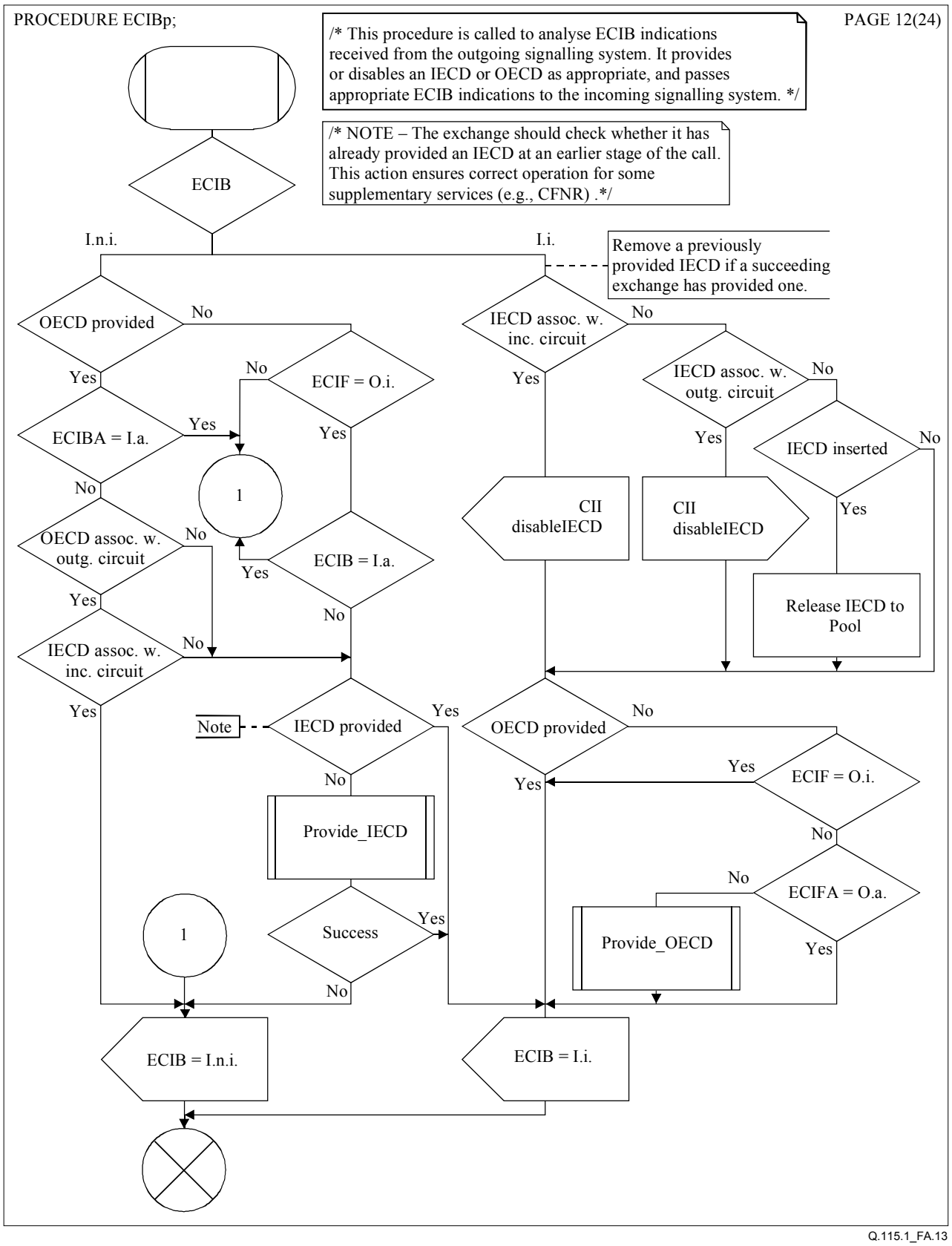
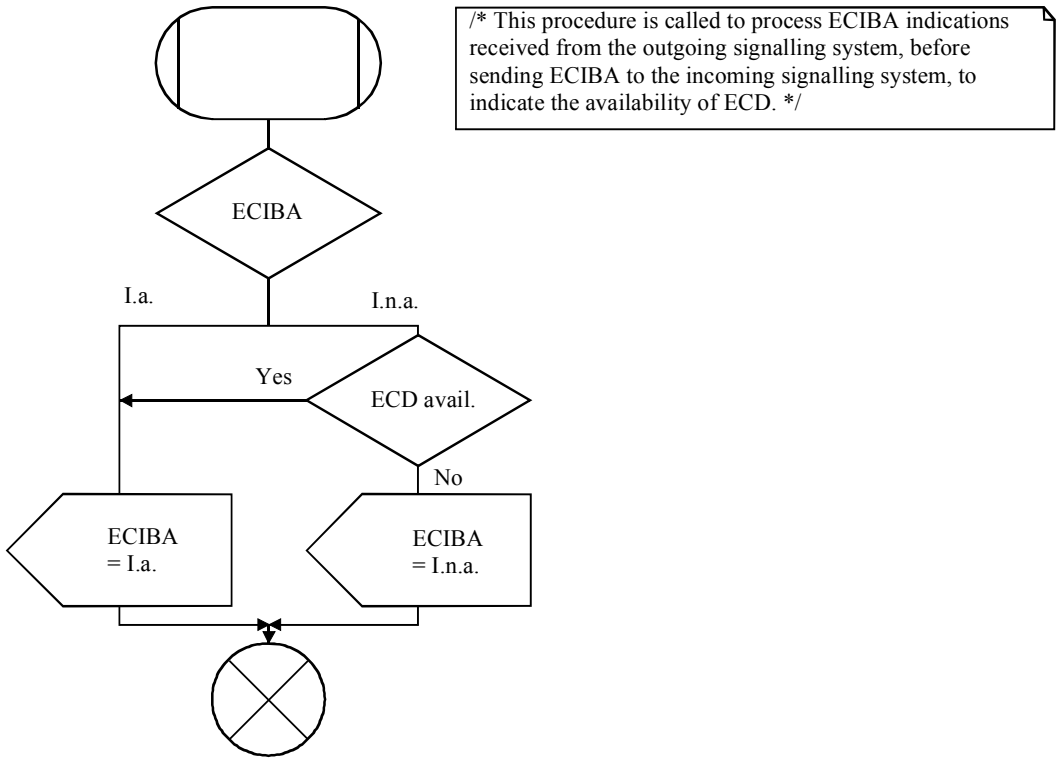


Figure A.12/Q.115.1 – Echo control procedure for ECIB/A



Q.115.1_FA.13

Figure A.13/Q.115.1 – Echo control procedure for ECIB



Q.115.1_FA.14

Figure A.14/Q.115.1 – Echo control procedure for ECIBA

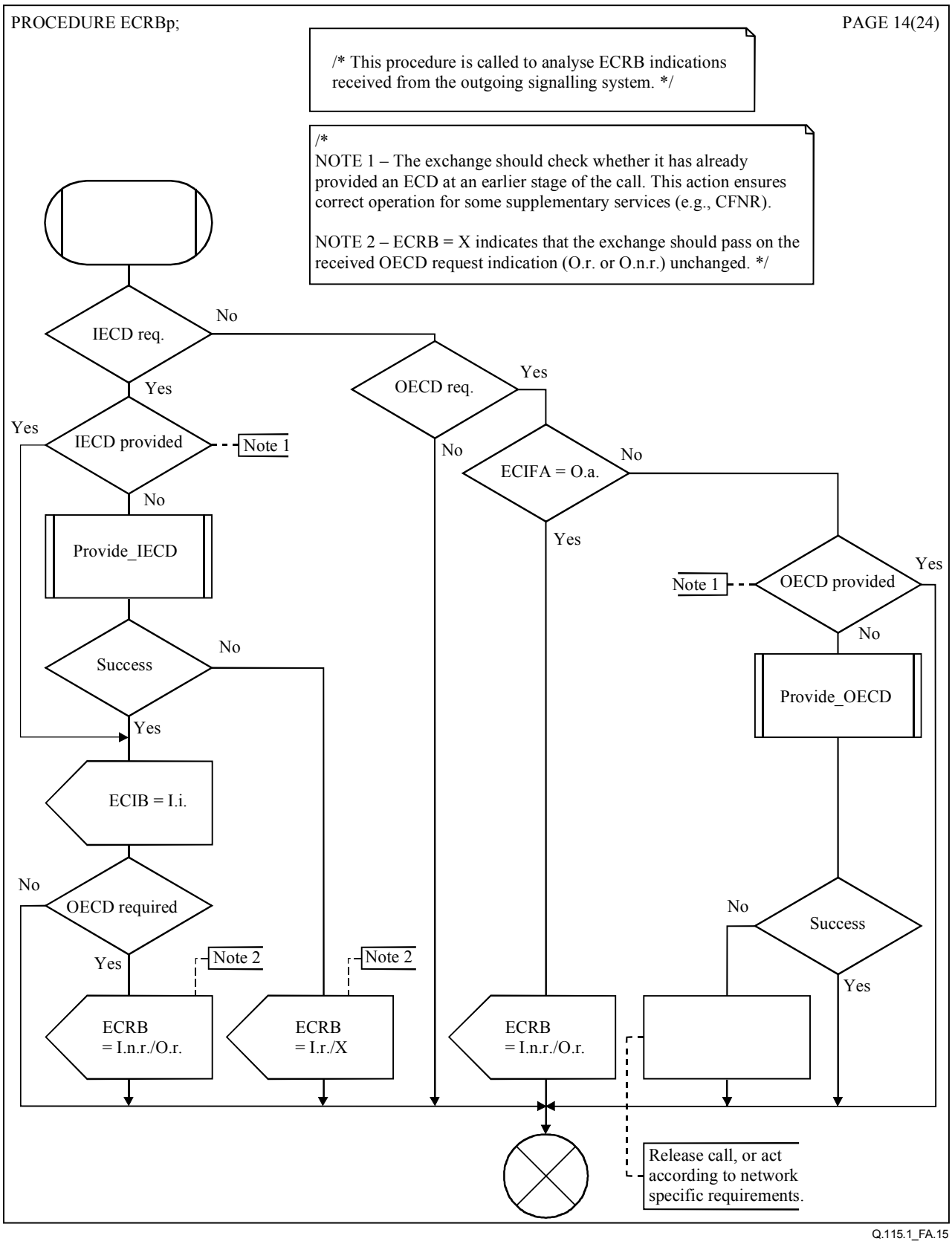


Figure A.15/Q.115.1 – Echo control procedure for ECD request (backward)

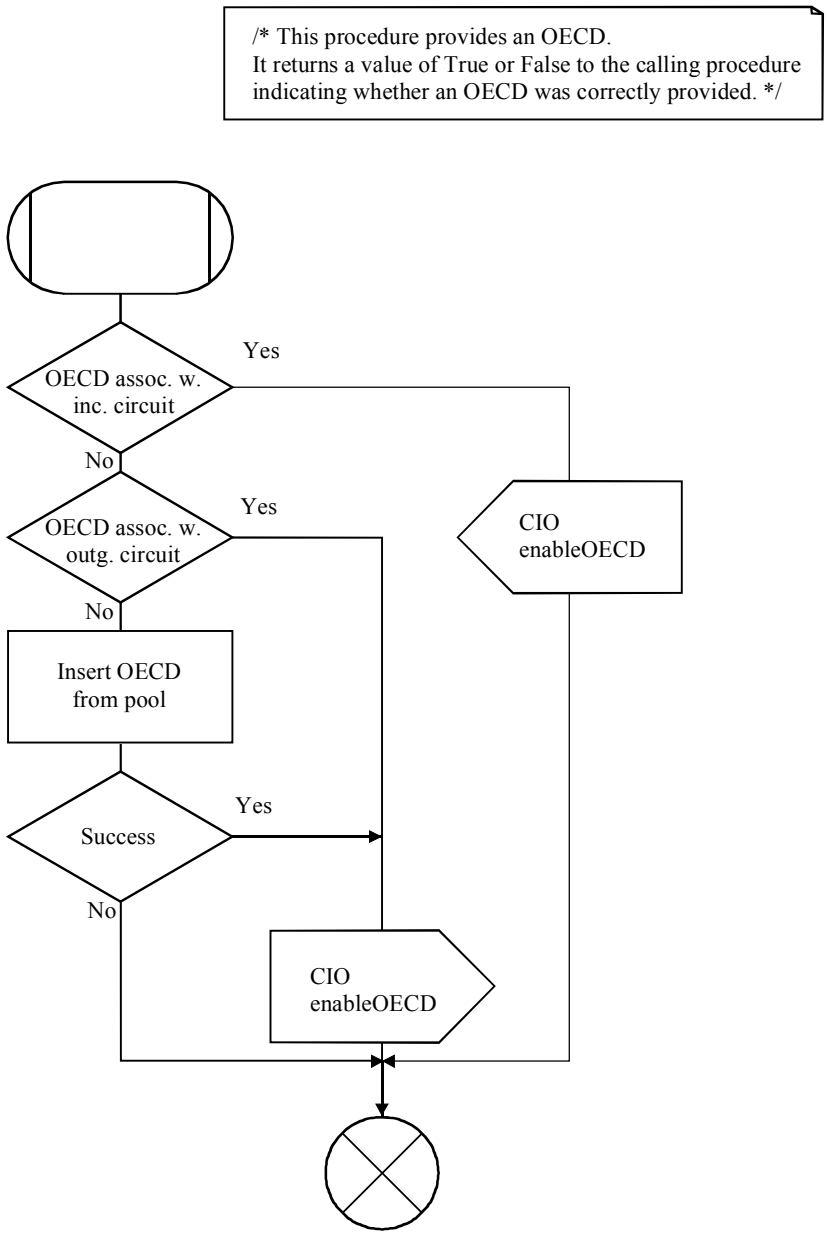


Figure A.16/Q.115.1 – Echo control procedure for providing an OECD

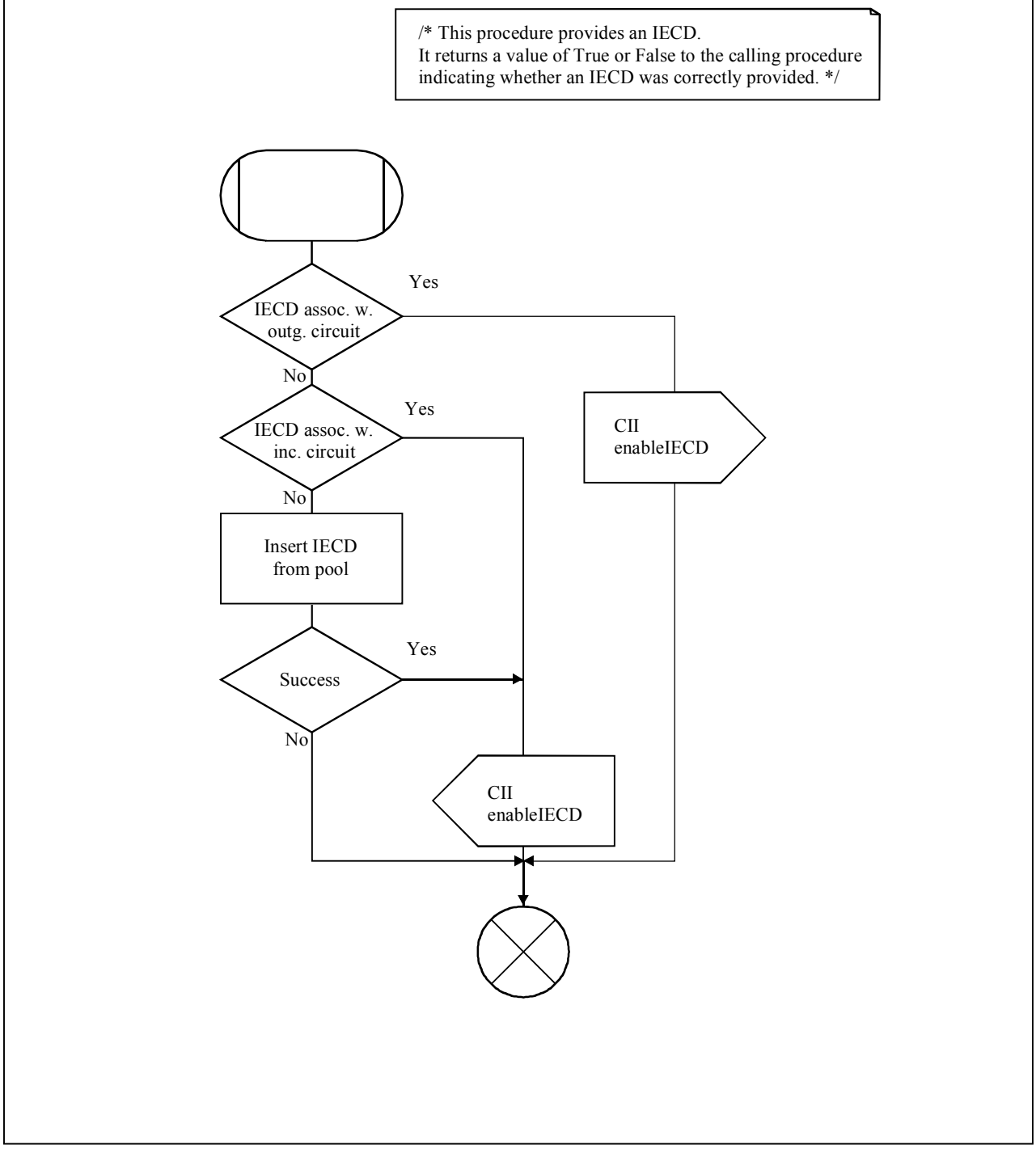


Figure A.17/Q.115.1 – Echo control procedure for providing an IECD

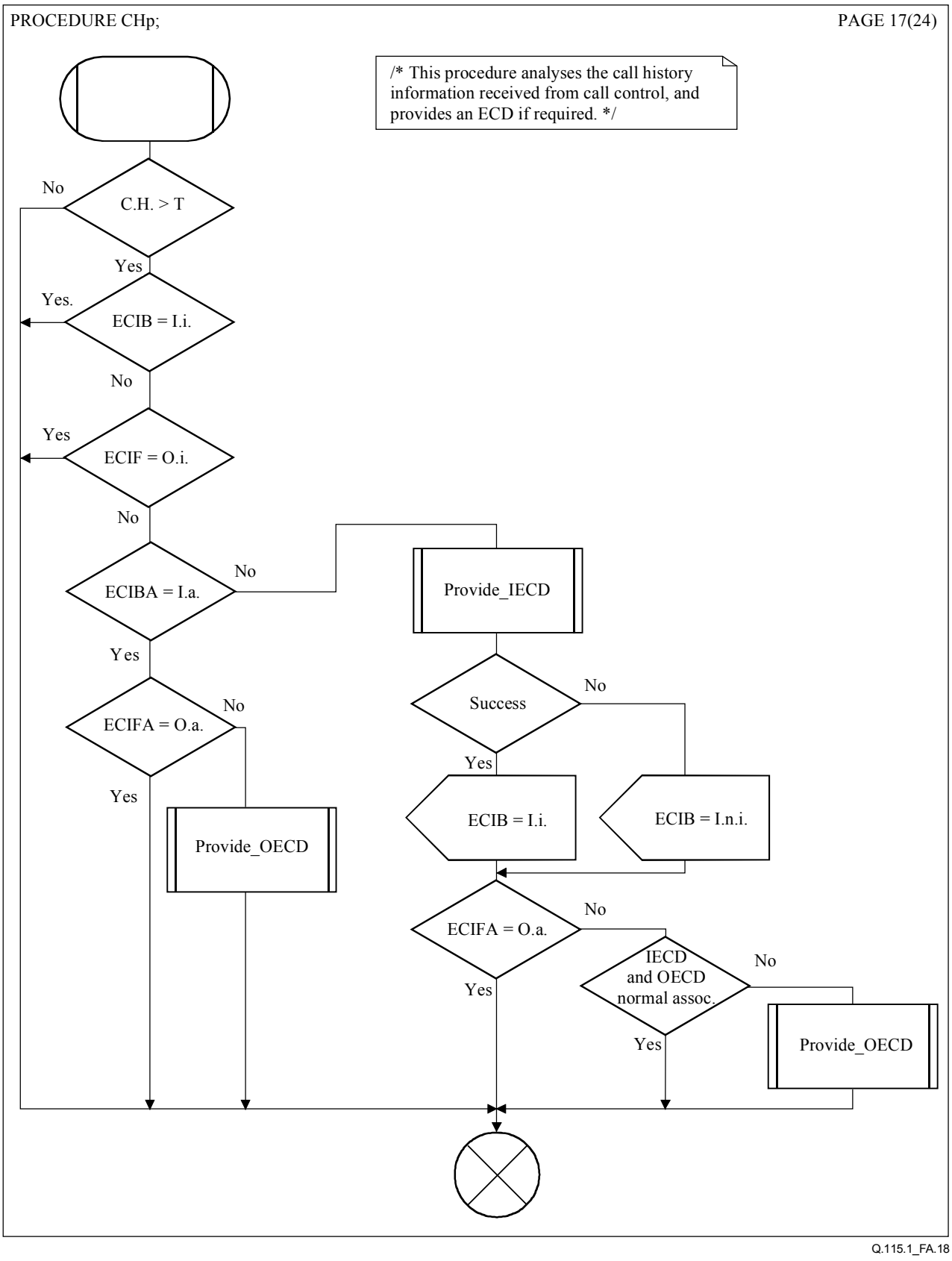
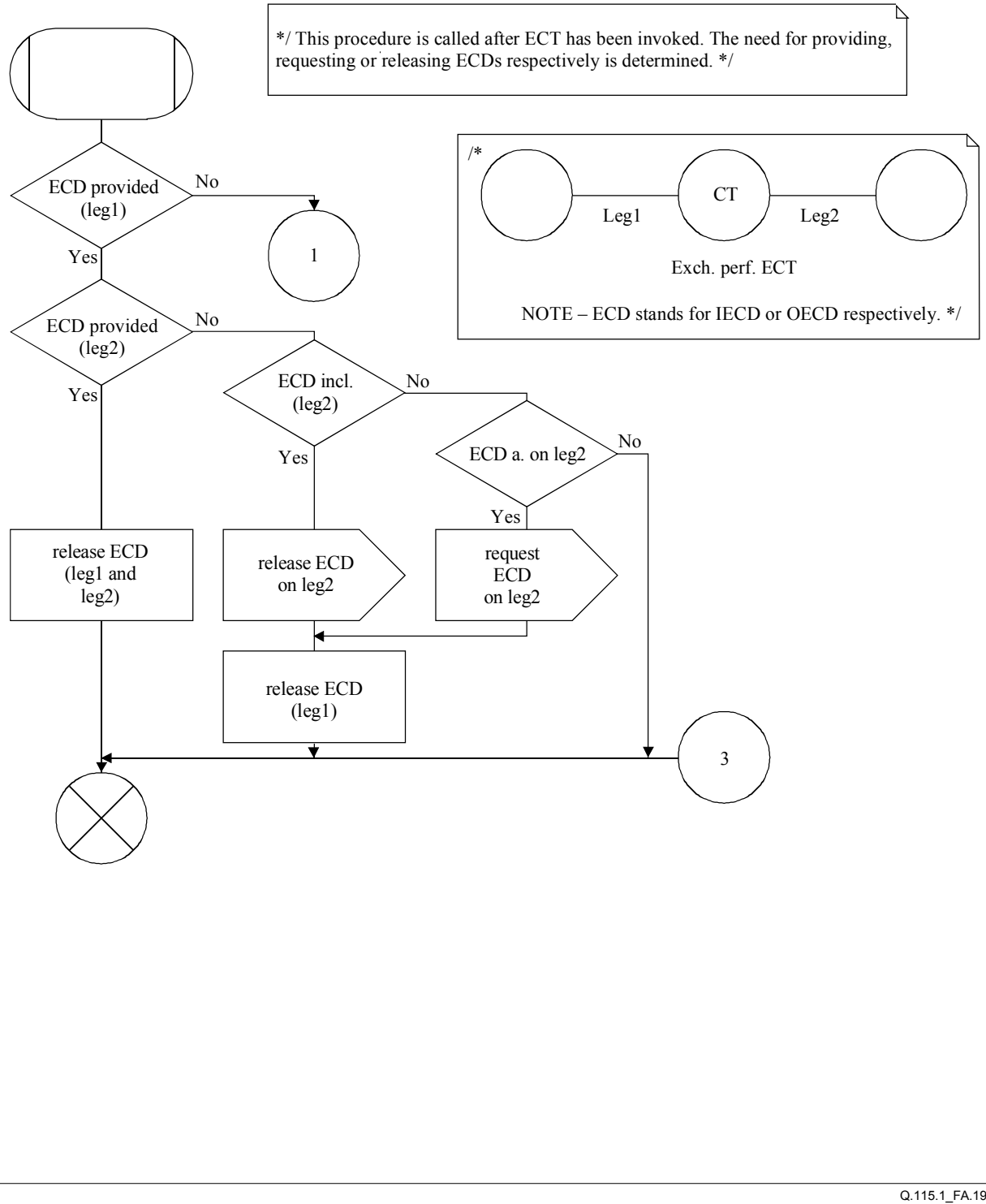


Figure A.18/Q.115.1 – Echo control procedure for call history



Q.115.1_FA.19-1

Figure A.19/Q.115.1 – Echo control procedure for explicit call transfer *(sheet 1 of 3)*

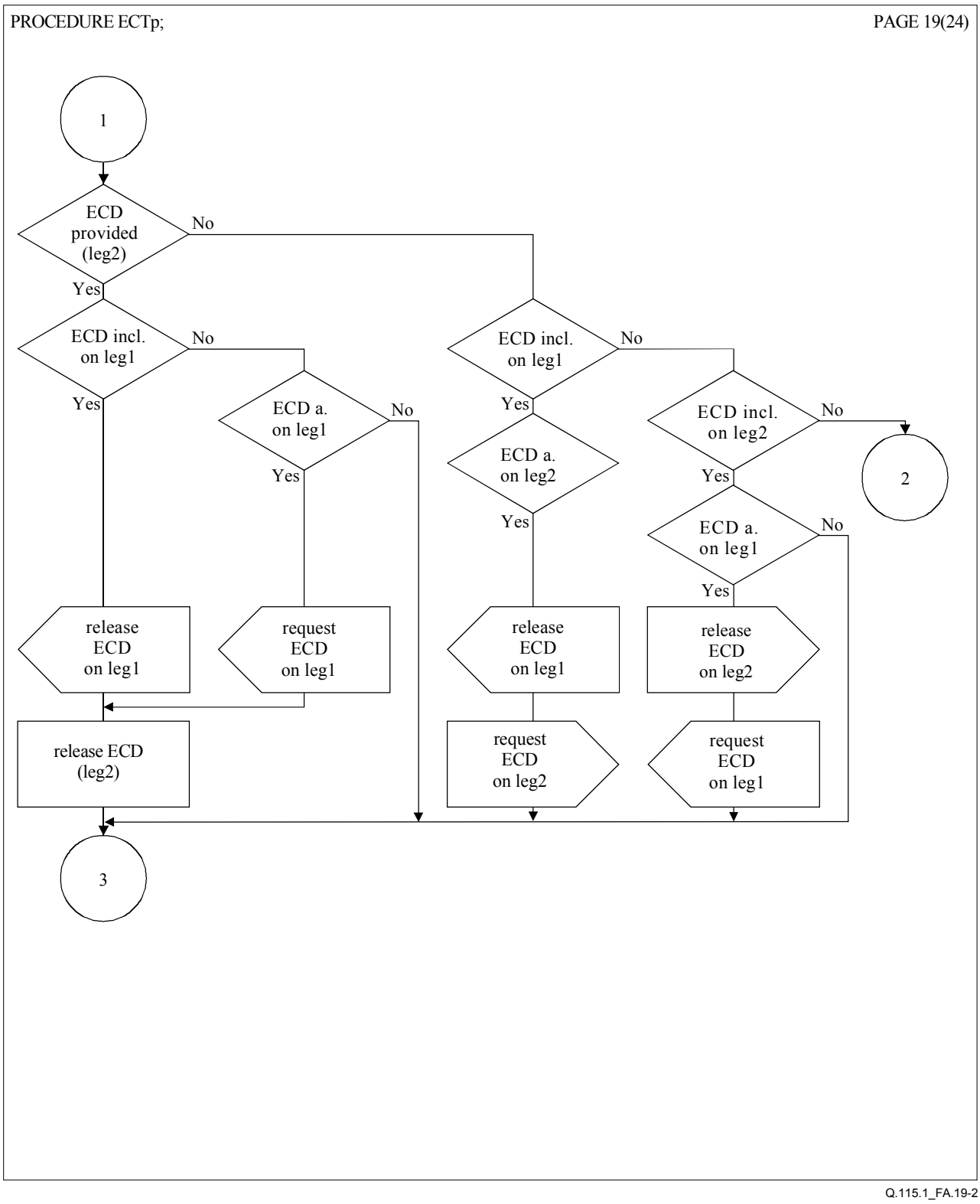


Figure A.19/Q.115.1 – Echo control procedure for explicit call transfer *(sheet 2 of 3)*

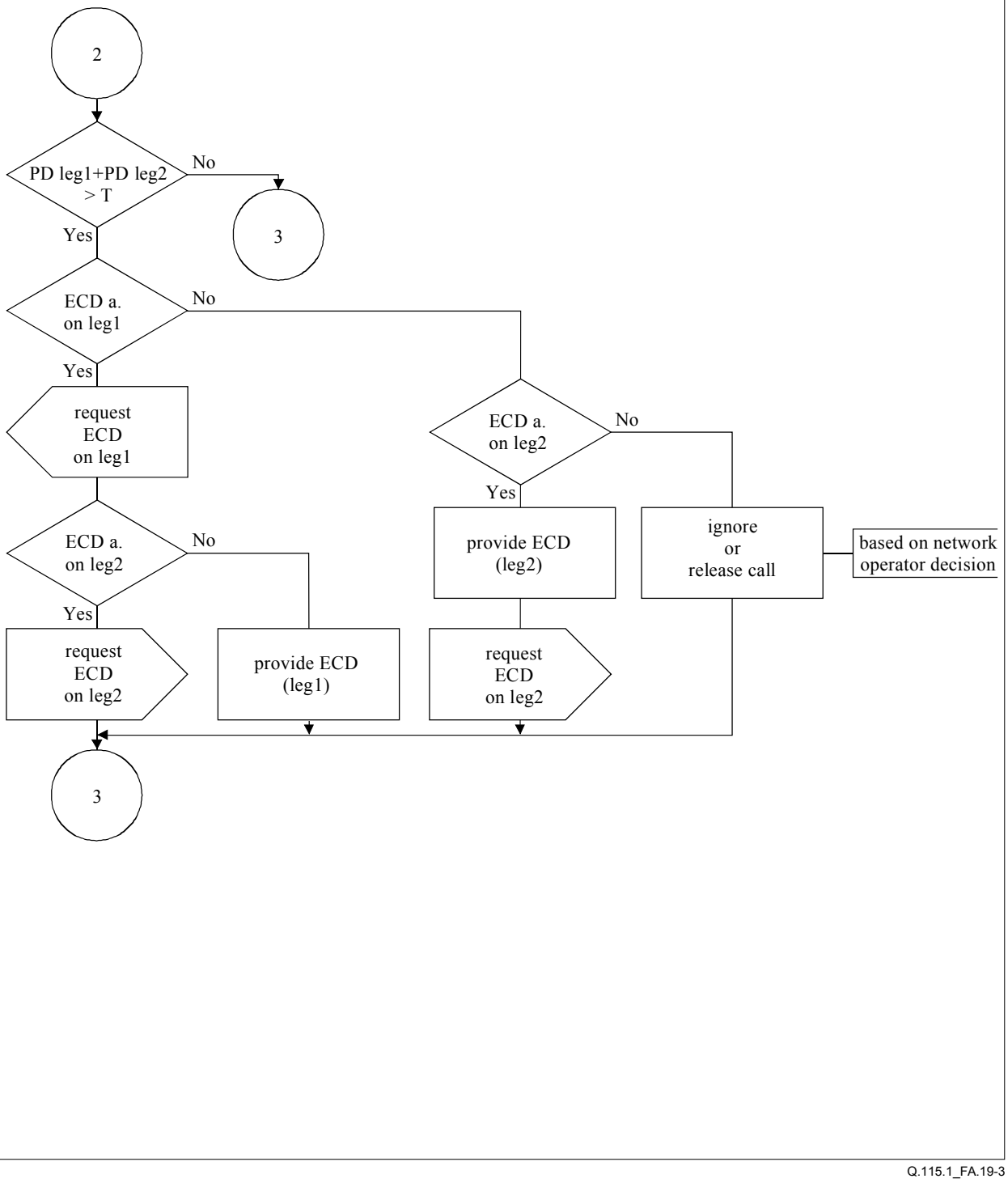


Figure A.19/Q.115.1 – Echo control procedure for explicit call transfer *(sheet 3 of 3)*

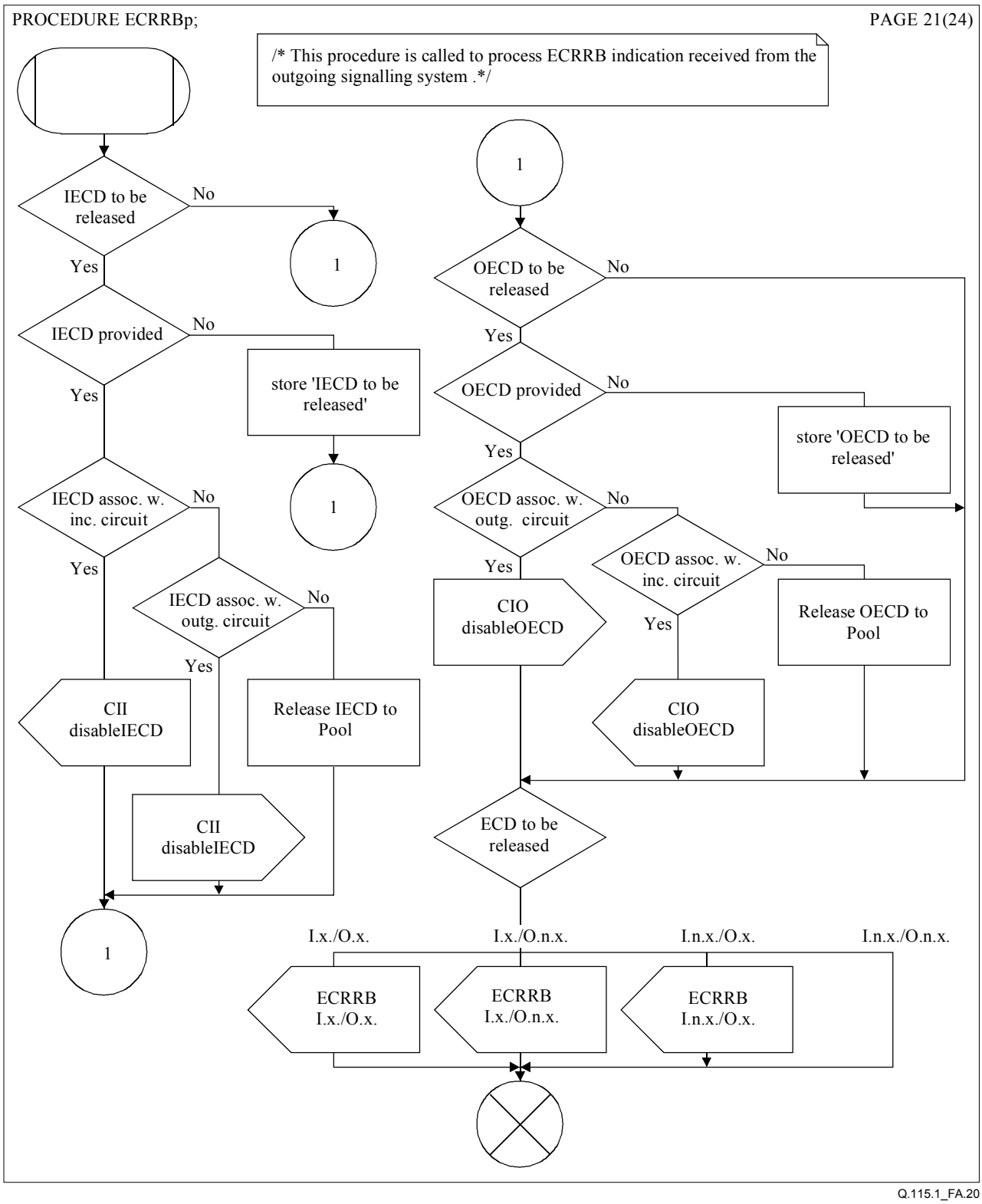


Figure A.20/Q.115.1 – Echo control procedure for the release of an ECD (backward)

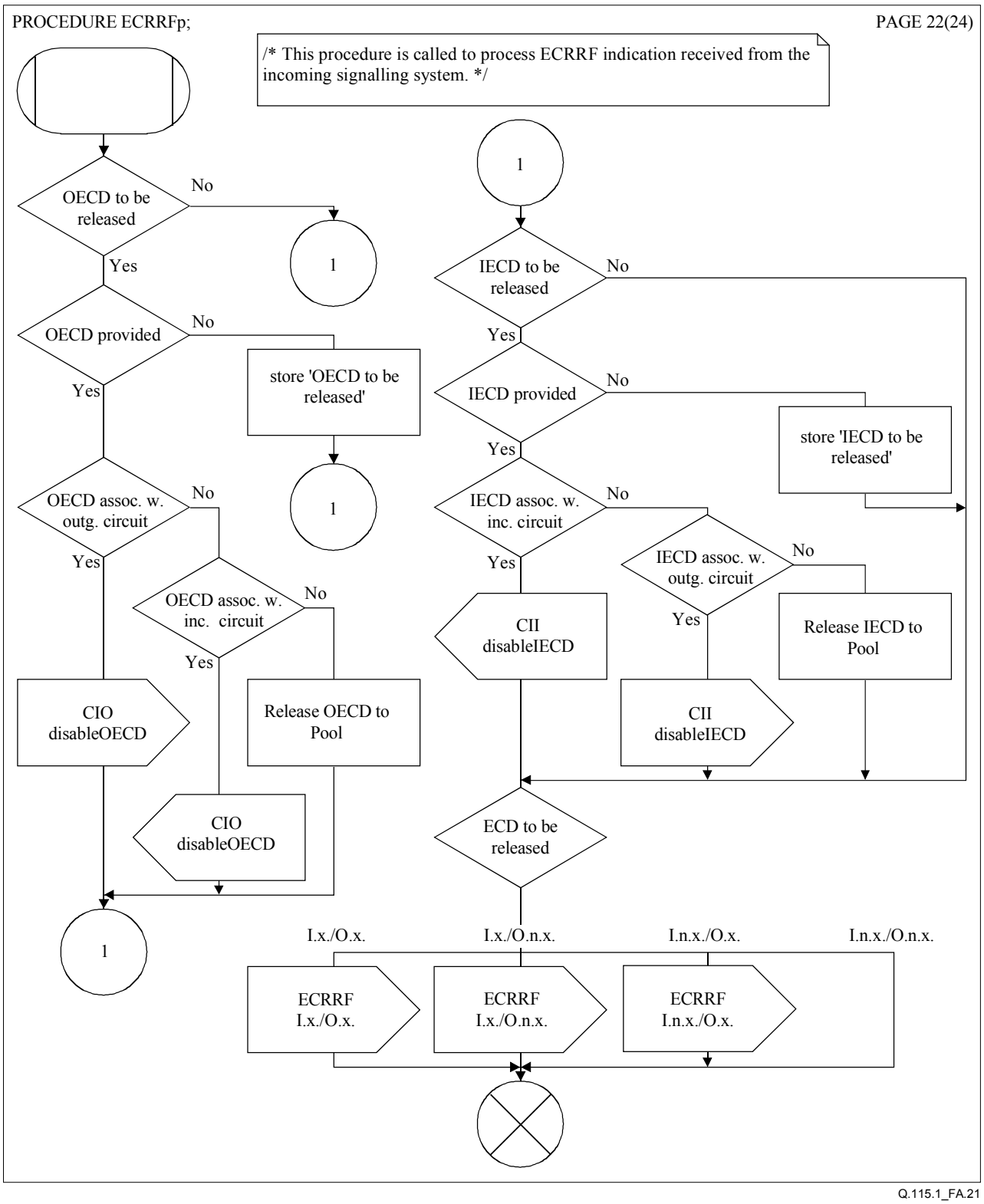


Figure A.21/Q.115.1 – Echo control procedure for the release of an ECD (forward)

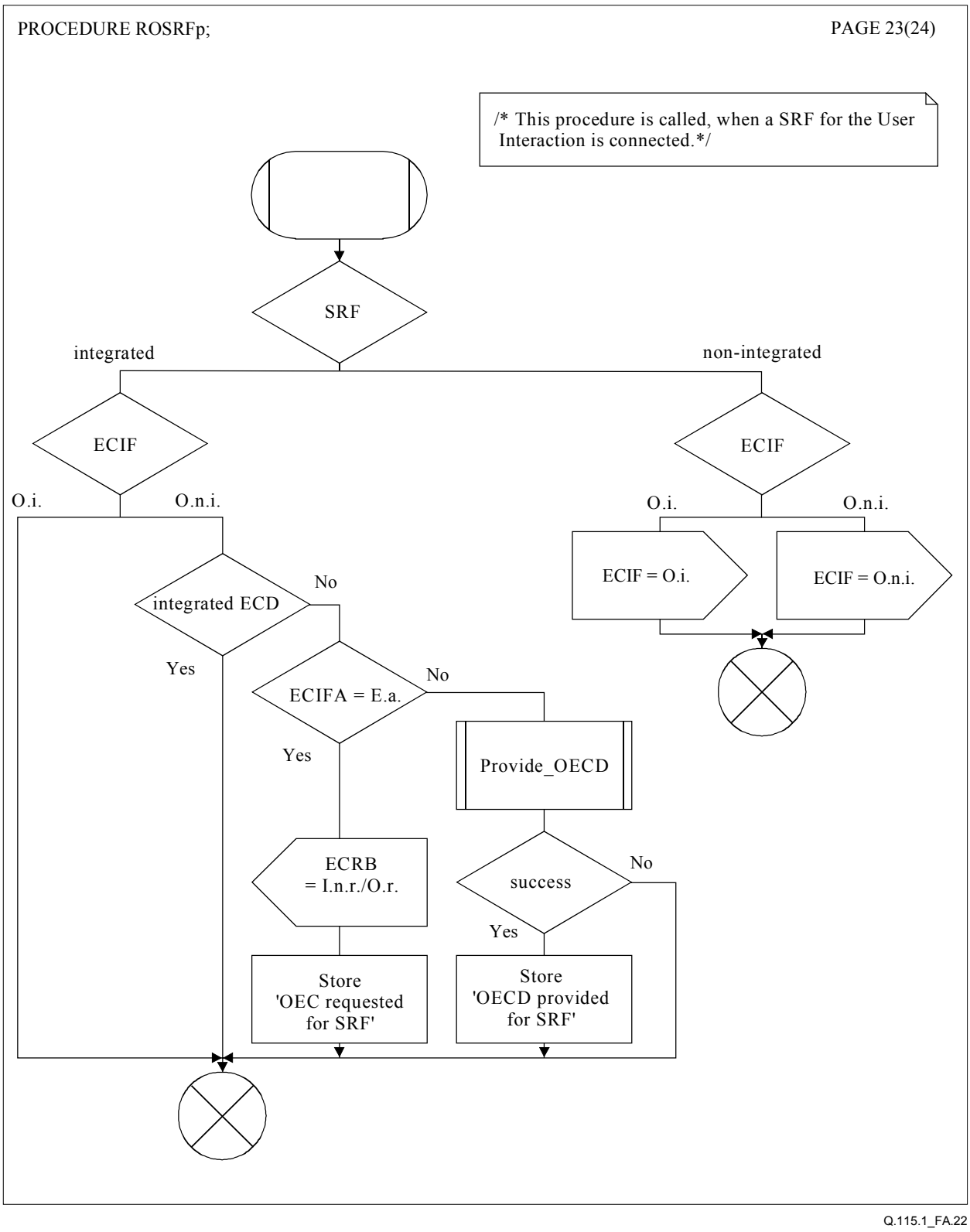
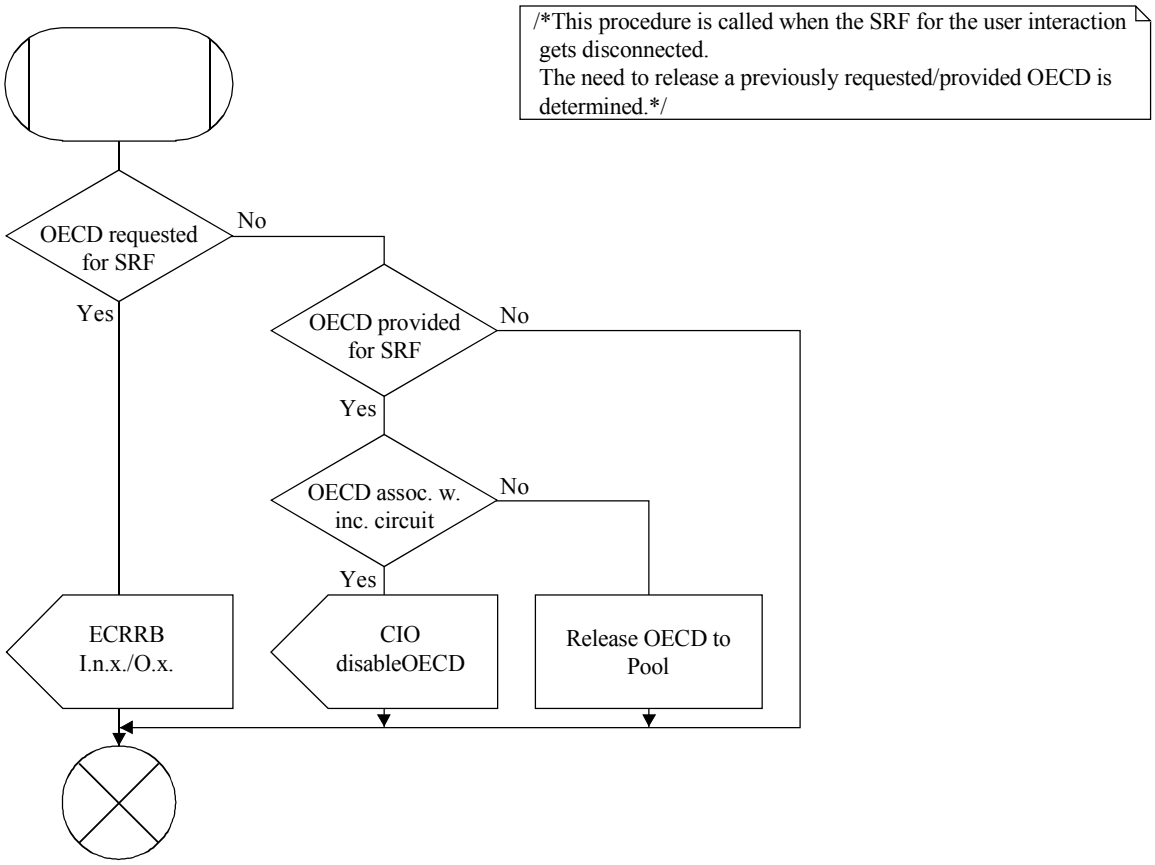


Figure A.22/Q.115.1 – Echo control procedure for the request of an OECD (IN)



Q.115.1_FA.23

Figure A.23/Q.115.1 – Echo control procedure for the release of an OECD (IN)

Appendix I

Transmission of echo control information elements via signalling systems

Figures I.1 to I.7 provide examples of how the exchange signalling functions interact with the echo control logic described in this Recommendation. The signalling blocks are responsible for deriving ECIFA and ECIBA information from signalling indicators, or from default route data.

NOTE – The interaction between echo control logic and BICC is the same as for ISUP'2000. This is also true for other ITU-T ISUP versions starting with ISUP'92, as they all have the same signalling capability to transfer echo control related information.

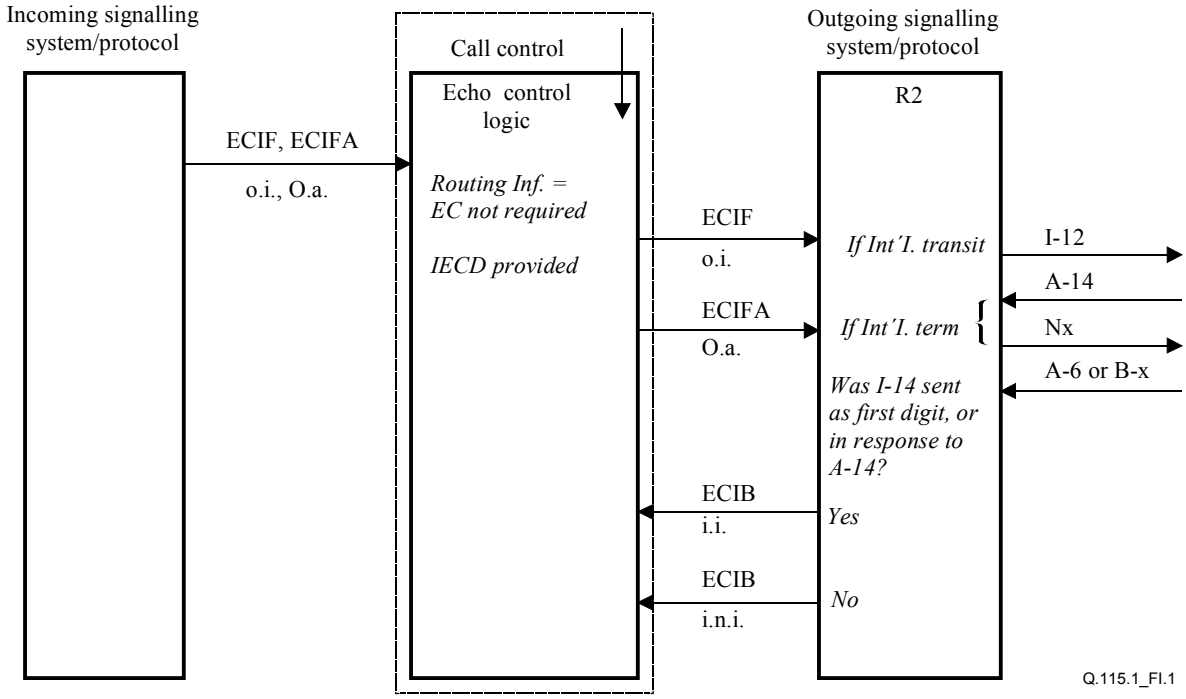


Figure I.1/Q.115.1 – Interactions between echo control logic and ITU-T signalling system R2

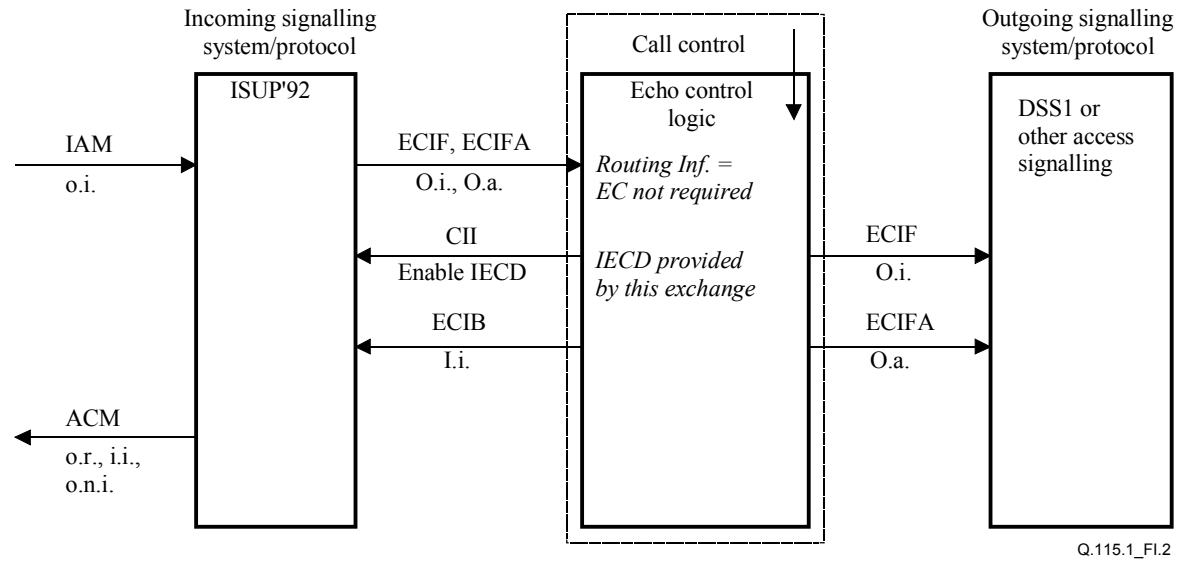
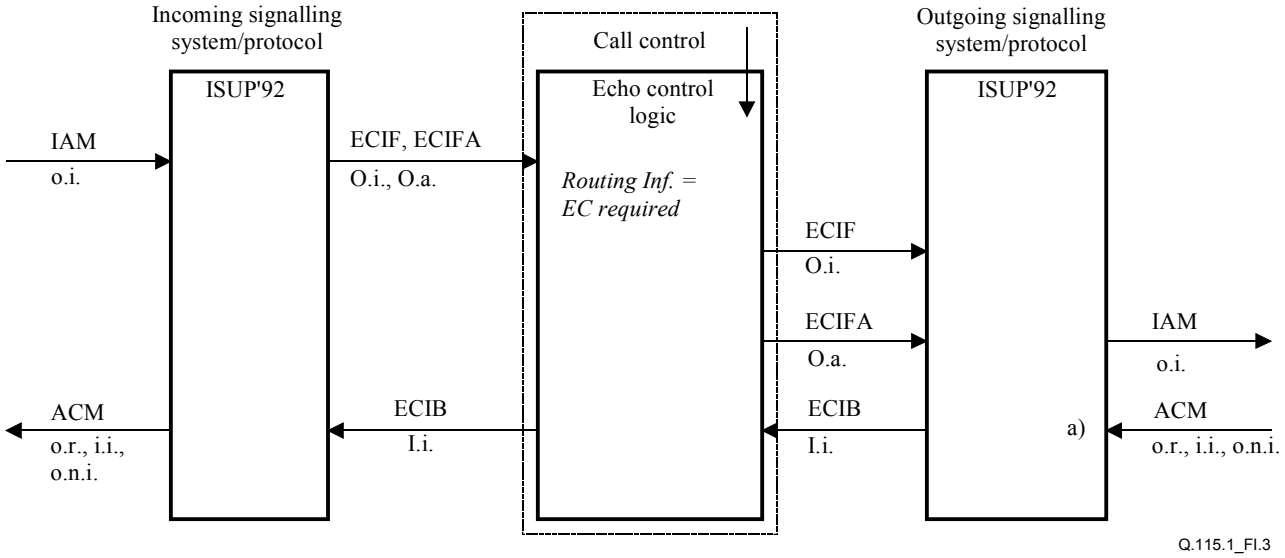
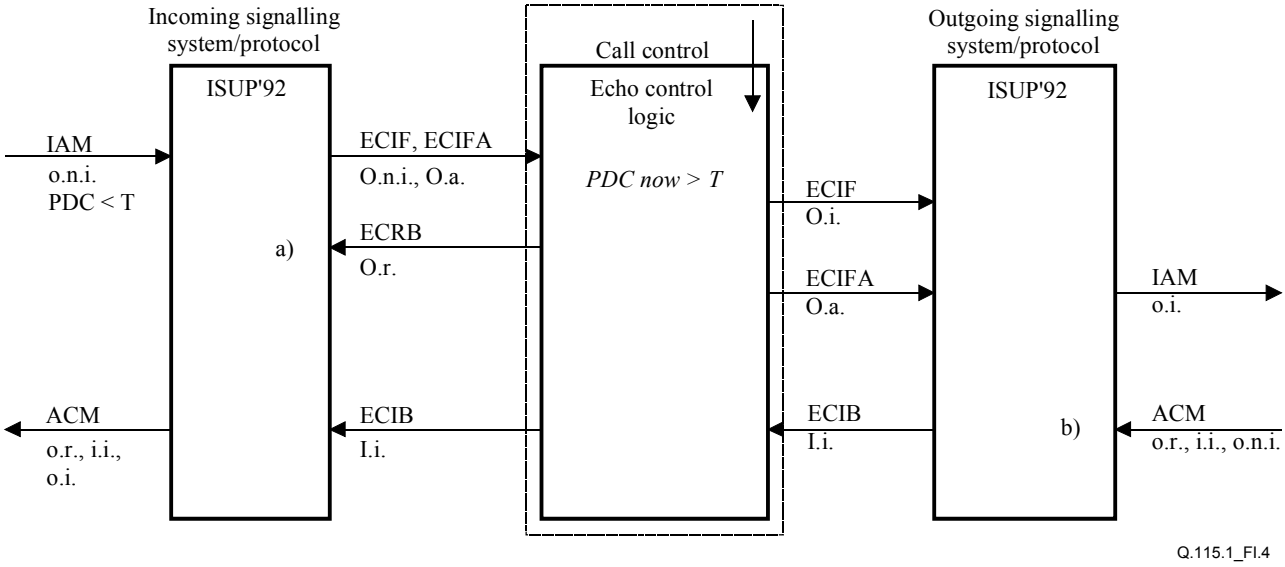


Figure I.2/Q.115.1 – Interactions between echo control logic and ISUP'92 (refer to Exchange 6 in Figure C.1/Q.764, 1993)



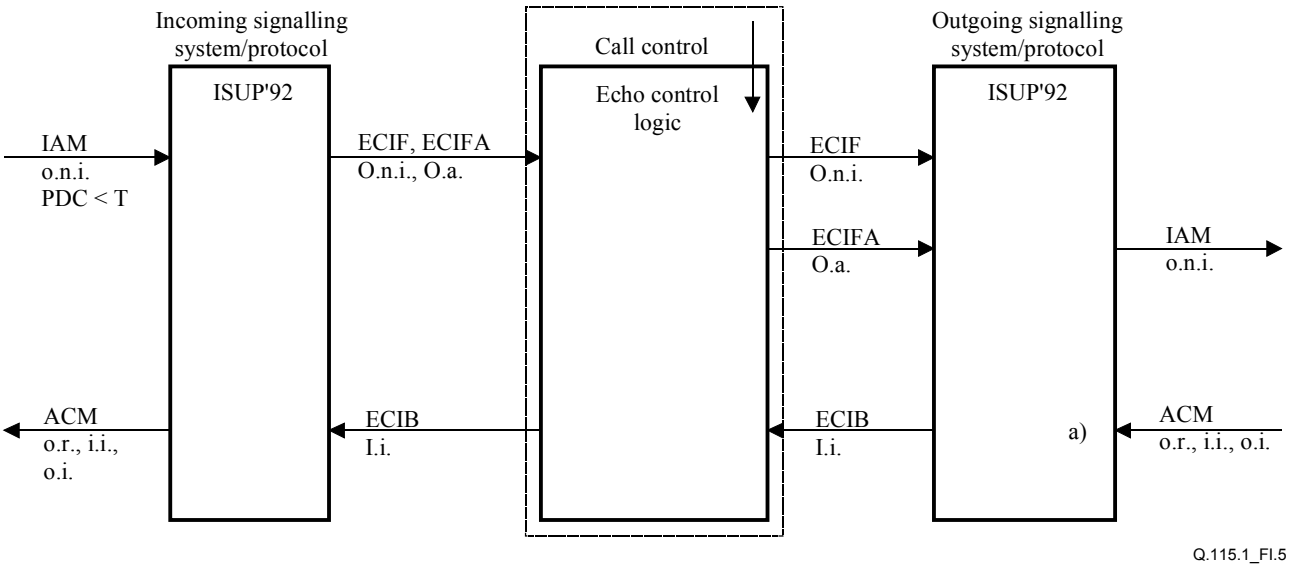
a) Do not pass the request for OECD to the Echo Control Logic if ECIFA = O.a.

Figure I.3/Q.115.1 – Interactions between echo control logic and ISUP'92 (refer to Exchange 5 in Figure C.1/Q.764, 1993)



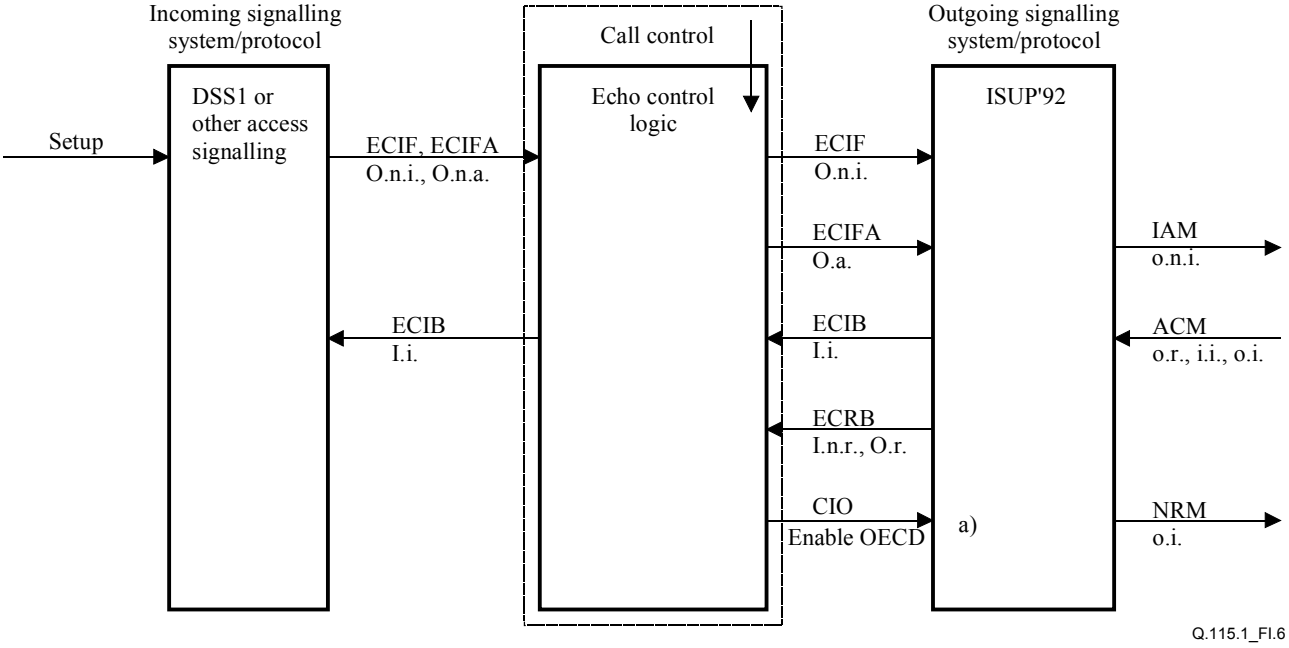
a) Send request for OECD in first backward message.
b) Do not pass the request for OECD to the echo control logic if ECIFA = O.a.

Figure I.4/Q.115.1 – Interactions between echo control logic and ISUP'92 (refer to Exchange 4 in Figure C.1/Q.764, 1993)



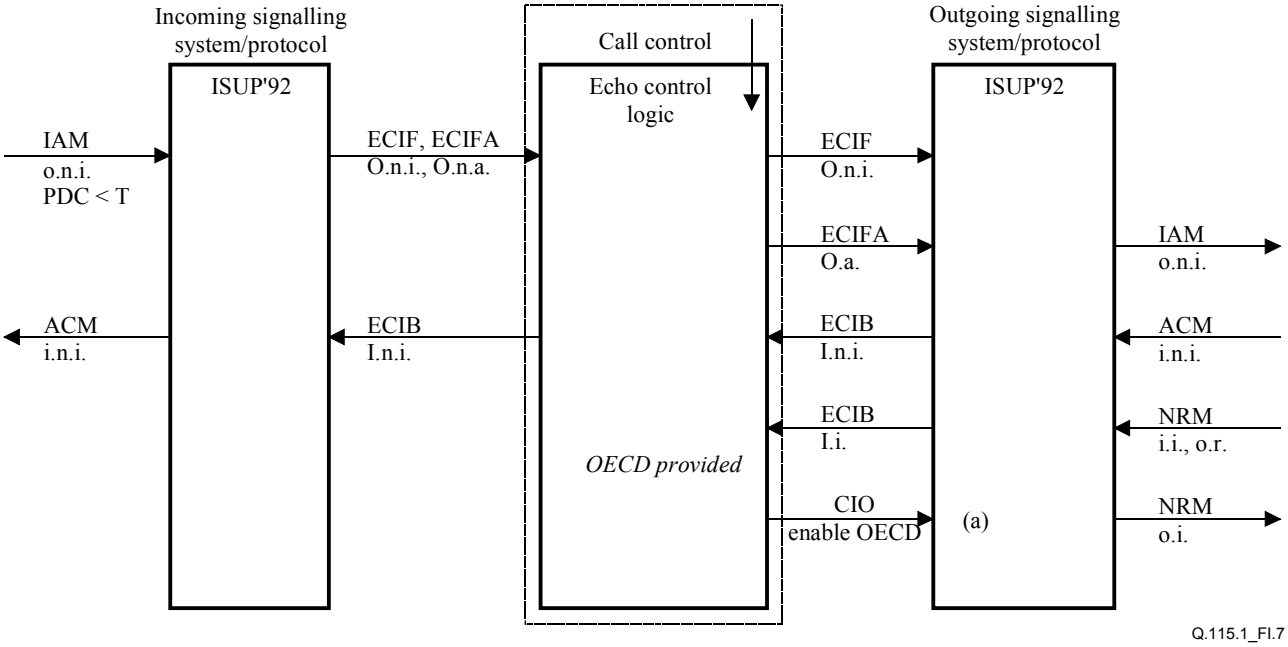
a) Do not pass the request for OECD to the echo control logic if ECIFA = O.a.

Figure I.5/Q.115.1 – Interactions between echo control logic and ISUP'92 (refer to Exchanges 2 and 3 in Figure C.1/Q.764, 1993)



a) The CIO = enable OECD information causes ISUP'92 to provide an OECD and send a forward NRM with o.i. indication to cancel T37 in succeeding ISUP'92 exchanges that do not use the echo control logic described in this Recommendation.

Figure I.6/Q.115.1 – Interactions between echo control logic and ISUP'92 (refer to Exchange 1 in Figure C.1/Q.764, 1993)



a) The CIO = enable OECD information causes ISUP'92 to provide an OECD and send a forward NRM with o.i. indication to cancel T37 in succeeding ISUP'92 exchanges that do not use the echo control logic described in this Recommendation.

Figure I.7/Q.115.1 – Interactions between echo control logic and ISUP'92 OECD provided in response to a request after ACM

Table I.1/Q.115.1 – Echo control information/request and the corresponding signalling information elements of international signalling systems/protocols

Signalling System		ITU-T R2	ITU-T No. 5	TUP	ISUP'88	ISUP'92
ECIF	No OECD in the connection	I-12 N1 (A-14)	–	IAM (OHES n.i.) GFI (OHES n.i.)	IAM (o.n.i.)	IAM/NRM (o.n.i.)
	OECD in the connection	I-14 I-14 (A-14)	–	IAM (OHES i.) GFI (OHES i.)	IAM (o.i.)	IAM/NRM (o.i.)
	OECD required from succ. exch.	I-11 I-14 (A-14)	–	–	–	–
ECIFA	No ECD available	–	–	–	–	–
	ECD available	–	–	–	–	–
ECIB	No IECD in the connection	–	–	ACM (i.n.i.)	ACM (i.n.i.)	ACM/CPG/CON/ NRM (i.n.i.)
	IECD in the connection	–	–	ACM (i.i.)	ACM (i.i.)	ACM/CPG/CON/ NRM (i.i.)
ECIBA	No ECD available	–	–	–	–	–
	ECD available	–	–	–	–	–

Table I.1/Q.115.1 – Echo control information/request and the corresponding signalling information elements of international signalling systems/protocols

Signalling System		ITU-T R2	ITU-T No. 5	TUP	ISUP'88	ISUP'92
ECRF	No IECD required	–	–	–	–	NRM (i.n.r.)
	IECD required	–	–	–	–	NRM (i.r.)
	No OECD required	–	–	–	–	NRM (o.n.r.)
	OECD required	–	–	–	–	NRM (o.r.)
ECRB	No IECD requested	–	–	–	–	NRM (i.n.r.)
	IECD requested	–	–	–	–	NRM (i.r.)
	No OECD requested	–	–	–	–	ACM/NRM (o.n.r.)
	OECD requested	–	–	GRQ (o.r.)	–	ACM/NRM (o.r.)

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