IEC 62439-6

Edition 1.0 2010-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Industrial communication networks – High availability automation networks – Part 6: Distributed Redundancy Protocol (DRP)

Réseaux industriels de communication – Réseaux de haute disponibilité pour l'automation – Partie 6: Protocole de redondance distribuée (DRP)

IEC 62439-6:2010

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,…).
It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Liens utiles:

Recherche de publications CEI - www.iec.ch/searchpub

La recherche avancée vous permet de trouver des publications CEI en utilisant différents critères (numéro de référence, texte, comité d'études,…).
Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

Just Published CEI - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications de la CEI. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

IEC 62439-6

Edition 1.0 2010-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Industrial communication networks – High availability automation networks – Part 6: Distributed Redundancy Protocol (DRP)

Réseaux industriels de communication – Réseaux de haute disponibilité pour l'automation – Partie 6: Protocole de redondance distribuée (DRP)

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX XB

ICS 25.040, 35.040

ISBN 978-2-83220-533-4

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

Part 6: Distributed Redundancy Protocol (DRP)

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

International Standard 62439-6 has been prepared by subcommittee 65C: Industrial Networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This standard cancels and replaces IEC 62439 published in 2008. This first edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 62439 (2008):

– adding a calculation method for RSTP (rapid spanning tree protocol, IEEE 802.1Q),
– adding two new redundancy protocols: HSR (High-availability Seamless Redundancy) and DRP (Distributed Redundancy Protocol),
– moving former Clauses 1 to 4 (introduction, definitions, general aspects) and the Annexes (taxonomy, availability calculation) to IEC 62439-1, which serves now as a base for the other documents,
– moving Clause 5 (MRP) to IEC 62439-2 with minor editorial changes,
– moving Clause 6 (PRP) was to IEC 62439-3 with minor editorial changes,

- moving Clause 7 (CRP) was to IEC 62439-4 with minor editorial changes, and
- moving Clause 8 (BRP) was to IEC 62439-5 with minor editorial changes,
- adding a method to calculate the maximum recovery time of RSTP in a restricted configuration (ring) to IEC 62439-1 as Clause 8,
- adding specifications of the HSR (High-availability Seamless Redundancy) protocol, which shares the principles of PRP to IEC 62439-3 as Clause 5, and
- introducing the DRP protocol as IEC 62439-6.

This bilingual version (2012-12) corresponds to the English version, published in 2010-02.

The text of this standard is based on the following documents:

FDIS	Report on voting
65C/583/FDIS	65C/589/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This International Standard is to be read in conjunction with IEC 62439-1:2010, *Industrial communication networks – High availability automation networks – Part 1: General concepts and calculation methods.*

A list of the IEC 62439 series can be found, under the general title *Industrial communication networks – High availability automation networks*, on the IEC website.

This publication has been drafted in accordance with ISO/IEC Directives, Part 2.

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

INTRODUCTION

The IEC 62439 series specifies relevant principles for high availability networks that meet the requirements for industrial automation networks.

In the fault-free state of the network, the protocols of the IEC 62439 series provide ISO/IEC 8802-3 (IEEE 802.3) compatible, reliable data communication, and preserve determinism of real-time data communication. In cases of fault, removal, and insertion of a component, they provide deterministic recovery times.

These protocols retain fully the typical Ethernet communication capabilities as used in the office world, so that the software involved remains applicable.

The market is in need of several network solutions, each with different performance characteristics and functional capabilities, matching diverse application requirements. These solutions support different redundancy topologies and mechanisms which are introduced in IEC 62439-1 and specified in the other Parts of the IEC 62439 series. IEC 62439-1 also distinguishes between the different solutions, giving guidance to the user.

The IEC 62439 series follows the general structure and terms of IEC 61158 series.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning about the communication procedure and fault detection and recovery for DRP given in 5.2 and 5.3.

IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

SUPCON Group Co., Ltd & Zhejiang University

Hangzhou

China

Beijing Kyland Technology Co. LTD

No 95 Building

Southeast Corner of Xisanqi Bridge

Haidian

Beijing

China

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

ISO (www.iso.org/patents) and IEC (http://www.iec.ch/tctools/patent_decl.htm) maintain on-line data bases of patents relevant to their standards. Users are encouraged to consult the data bases for the most up to date information concerning patents.

INDUSTRIAL COMMUNICATION NETWORKS – HIGH AVAILABILITY AUTOMATION NETWORKS –

Part 6: Distributed Redundancy Protocol (DRP)

1 Scope

The IEC 62439 series is applicable to high-availability automation networks based on the ISO/IEC 8802-3 (IEEE 802.3) (Ethernet) technology.

This part of the IEC 62439 series specifies a recovery protocol based on a ring topology, designed to react deterministically on a single failure of an inter-switch link or switch in the network. Each switch has equal management role in the network. Double rings are supported.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-191, *International Electrotechnical Vocabulary – Chapter 191: Dependability and quality of service*

IEC 61158 (all parts), *Industrial communication networks – Fieldbus specifications*

IEC 61588:2009, *Precision clock synchronization protocol for networked measurement and control systems* (IEEE 1588)

IEC 62439-1:2010, *Industrial communication networks – High availability automation networks – Part 1: General concepts and calculation methods*

ISO/IEC/TR 8802-1, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 1: Overview of Local Area Network Standards Technologies de* (IEEE 802.1)

ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

IEEE 802.1D:2004, *IEEE standard for local Local and metropolitan area networks Media Access Control (MAC) Bridges*

IEEE 802.1Q, *IEEE standards for local and metropolitan area network. Virtual bridged local area networks*

3 Terms, definitions, abbreviations, acronyms, and conventions

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-191, as well as in IEC 62439-1, apply, in addition to the following.

3.1.1
active ring port
ring port which is connected in the ring network and works in Blocking or Forwarding state

3.1.2
cycle
shortest time interval after which the communication traffic pattern repeats itself

3.1.3
standby ring port
ring port which is connected in the ring network and works in the Disabled state

3.1.4
time offset
time difference from a specially designated time

3.2 Abbreviations and acronyms

For the purposes of this document, the abbreviations and acronyms given in IEC 62439-1, apply.

3.3 Conventions

This document follows the conventions defined in IEC 62439-1.

4 Overview

4.1 Principles

The Distributed Redundancy Protocol (DRP) defines a high availability network solution based on ISO/IEC 8802-3 (IEEE 802.3) and the functions of ISO/IEC/TR 8802-1 (IEEE 802.1) for communication link redundancy.

DRP provides a framework for describing the operational behaviour of the switches in a ring topology to detect a single network failure (such as an inter-switch link failure or a ring switch failure) and recover from it within a deterministic recovery time.

A DRP network has a ring topology with multiple switch nodes, each of which may be a switch or a switching end node. Each node requires an integrated switch with at least two ports (ring ports) connected to the ring, and which is able to detect and recover from failures in accordance with the DRP protocol.

Each node has equal management role in a DRP ring network. It means that each node observes and controls the ring topology by multicasting a ring test frame RingCheck and an inter-switch link test frame LinkCheck cyclically, and reacts on network faults. The LinkCheck test frame provides the mechanism to detect the failure of a switch node.

In a DRP network, each switch node is synchronized using IEC 61588 (IEEE 1588) with either boundary clock or transparent clock according to the application.

NOTE Typically, boundary clock is used according to IEC 61588 (IEEE 1588). In larger-scale application, the transparent clock should be used for better time synchronization.

Optionally, DRP supports double ring topology redundancy. In this case, each switch node shall have at least two pairs of ring ports: one pair of active ring ports and one pair of standby ring ports.

The DRP defines a service entity and a protocol entity, as well as a set of management frames. The service entity specifies the externally visible services for application layer and systems management. The communication model for DRP is shown in Figure 1.

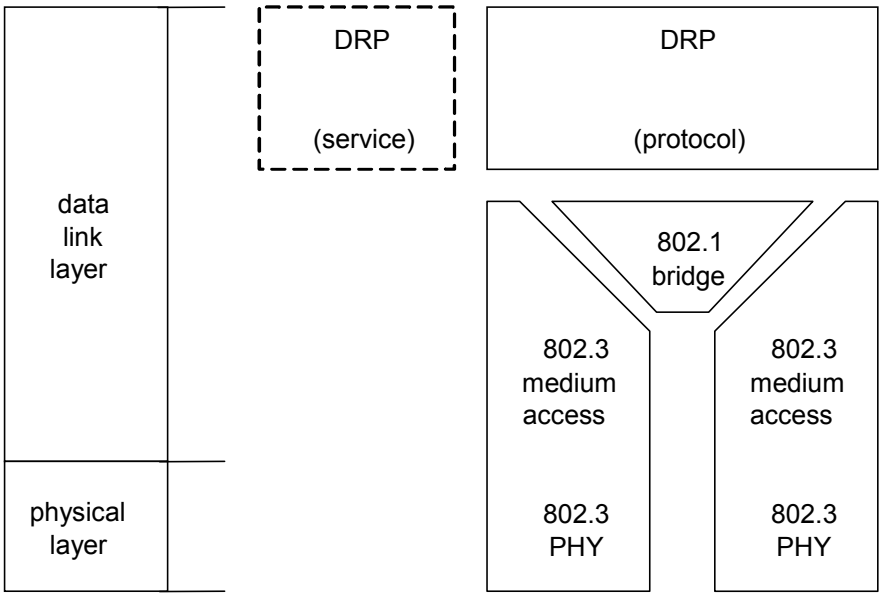


Figure 1 – DRP communication model

4.2 Ring ports

Each switch node shall have at least two ring ports connected to the ring network.

Some switch nodes in addition to the ring ports can have one or more non ring ports including leaf link ports. In such cases, the DRP frames (for example RingCheck, LinkCheck, LinkAlarm, LinkChange, DeviceAnnunciation and RingChange) shall not be forwarded to non-ring ports.

The ring ports which support DRP protocol shall have three states as follows:

a) Disabled

- All frames shall be dropped.

b) Blocking

All frames shall be dropped except the following:

- DRP frames, such as RingCheck frame, LinkCheck frame, LinkAlarm frame, LinkChange frame, DeviceAnnunciation frame, RingChange frame.
- Frames specified in IEEE 802.1D (2004) Table 7-10 to pass ports in “Discarding” state (e.g. LLDP, IEC 61588 (IEEE 1588) PTP).
- Frames only produced or consumed by the higher layer entities of this node and never forwarded.

c) Forwarding:

All frames shall be passed through according to the forwarding behaviour of IEEE 802.1D.

4.3 DRP switch node

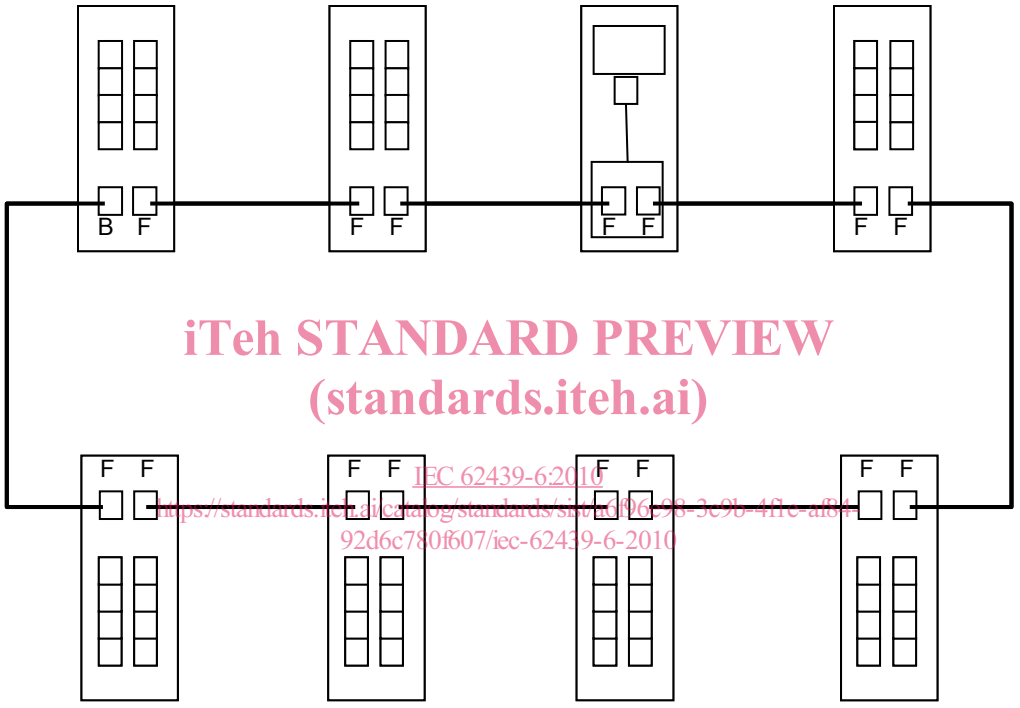
The communication roles of all switch nodes are equal in the DRP ring. Each switch node may be a switch or a switching end node.

Each switch node has the equal right to periodically multicast ring fault detection frame RingCheck and inter-switch link fault detection frame LinkCheck in both directions of the ring at the scheduled time.

4.4 Single ring topology redundancy

Each switch node shall have two ring ports connected to the ring network, which are called active ports (as shown in Figure 2).

In a DRP single ring network, only one active ring port operates in the Blocking state while all other ring ports operate in the Forwarding state. That is, only one switch node sets one of its active ring ports into the Blocking state, the other active ring port of this node is set into the Forwarding state. All other switch nodes set the two active ring ports into the Forwarding state.



IEC 392/10

Figure 2 – Single ring topology redundancy

4.5 Double ring topology redundancy

As shown in Figure 3, each switch node shall have at least two pairs of ring ports connected to the ring network. One pair of ring ports is active (for example the ports in Ring1) while the other pair of ring ports is standby (for example the ports in Ring2).

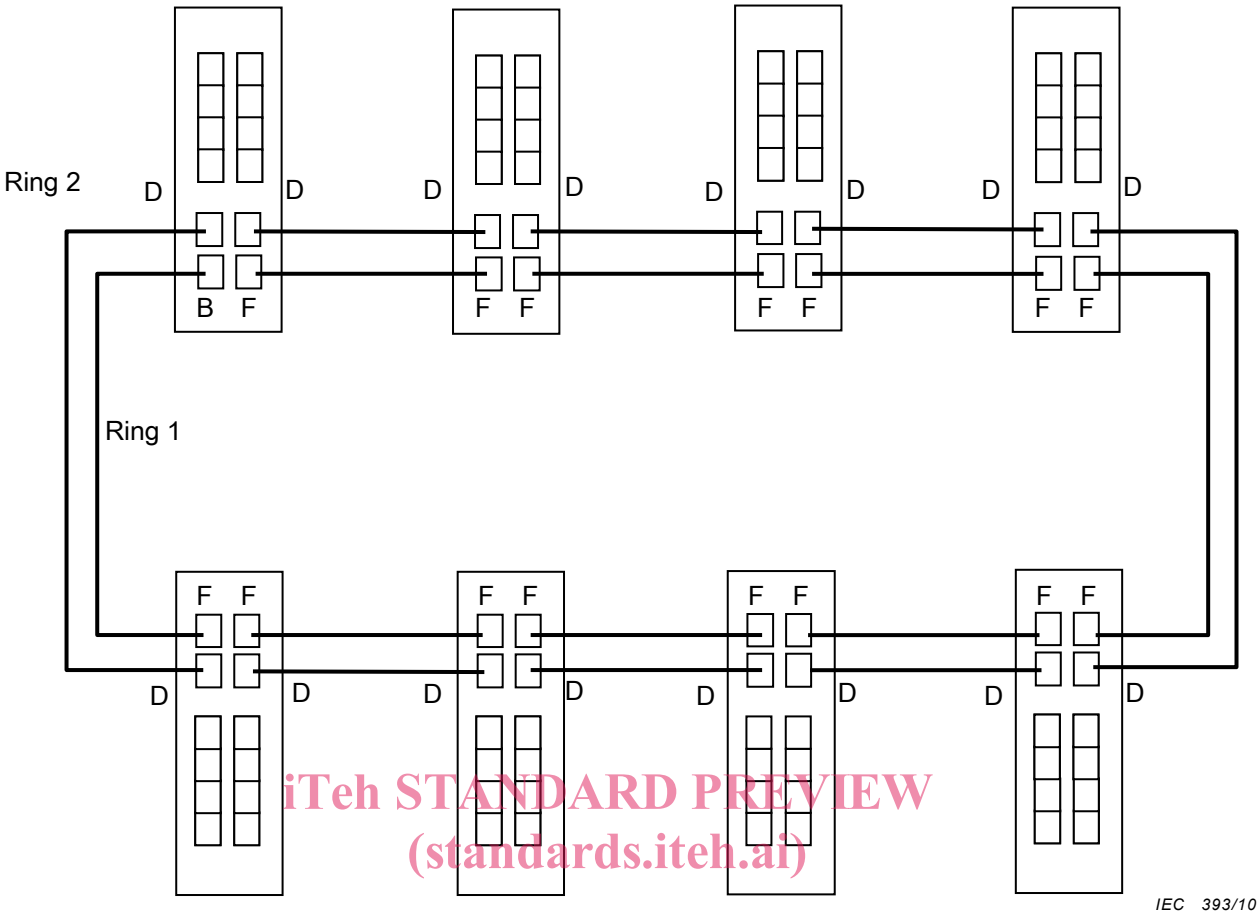


Figure 3 – Double ring topology redundancy

In a DRP double ring network, only one switch node sets one of its active ring ports into Blocking state, the other active ring port into the Forwarding state and the two standby ring ports into the Disabled state.

4.6 Configuration

4.6.1 Overview

Before the switch node is connected in a DRP network, it shall be configured using configuration software using the DRP Write service. The configuration shall include manufacturer configuration, communication configuration, and application configuration.

4.6.2 Manufacturer configuration

Manufacturer configuration includes the preset of DeviceID, ManufacturerName, DRPVersion, SoftwareVersion, HardwareVersion, Device MAC Address.

Manufacturer configuration information shall be downloaded in a DRP device only when it is manufactured, and it may be uploaded using the Read service.

4.6.3 Communication configuration

Communication configuration includes the preset of states of standby ring ports, Cycle, Ring Check SendTimeOffset, Ring Check Time Limit, Link Check SendTimeOffset, Link Check Time Limit, SynchronizationClockType, DRPSequenceID, DRPDeviceNumber.

For a single ring network, each switch node shall initialize one active ring port in the Blocking state, and the other ring port in the Forwarding state as described in 4.7.

For a double ring network, the two standby ring ports shall be set to the Disabled state.

Communication configuration information shall be written into a switch node using a Write service. It can be read from a switch node using the Read service.

4.6.4 Application configuration

Application configuration includes the preset of DRP Domain ID, PD-Tag, VLAN ID, Ring1 Port1 ID, Ring1 Port2 ID, Ring2 Port1 ID, Ring2 Port2 ID, SynchronizationClockType.

Application configuration information shall be downloaded into the switch node using Write service. It can be uploaded using Read service.

4.7 Start up

When powered on, each switch node shall initialize one active ring port in the Blocking state and the other ring port in the Forwarding state. Each switch node shall be synchronized using IEC 61588 (IEEE 1588) protocol (see 6.6 and 9.3 in IEC 61588 (IEEE 1588)).

If a switch node has not received any RingCheck frame in Ring Check Time Limit, and this switch node is directly connected to the grandmaster clock outside of the ring as defined in IEC 61588 (IEEE 1588), the switch node shall set the value of DRPDeviceNumber and the value of DRPSequenceID to 0x01, and send the RingCheck frame immediately.

When the value of Cycle is 0xFFFF FFFF FFFF FFFF, the switch node shall not transmit any DRP frames. Otherwise, it shall send the DeviceAnnunciation and the LinkCheck frames according to the communication configuration.

When the DRP system reaches steady state, only the switch node with the smallest DRPSequenceID will keep one ring port in the Blocking state.

5 DRP communications

5.1 Overview

In a DRP redundant network, the communication time is divided into several Cycles, marked as Cycle as shown in Figure 4. Where $t_{\text{RingCheck}}$ is the time offset for sending the RingCheck frame while $t_{\text{LinkCheck}}$ is the time offset for sending the LinkCheck frame.