

Application Note

**KGD-802-B Redundant Ring Support
with KTI's Auto Multi-Ring Technology**

2013.3.28

For industrial applications, multiple switches are often connected like a cascaded chain due to topology limitation. In such configuration, a backup (redundant) mechanism with fast response is often required to keep the network operating when any cable fault or even device fault occur.

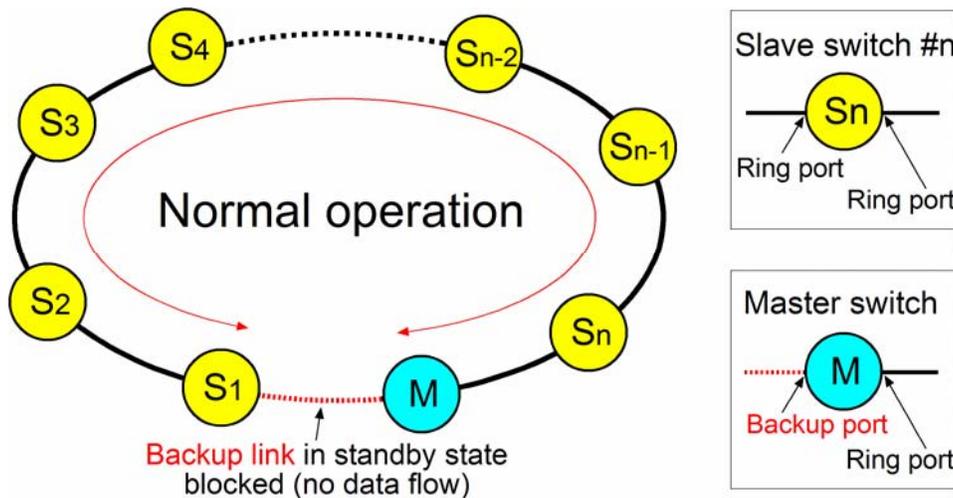
KGD-802-B switch is featured with KTI's Auto Multi-Ring Technology to support redundant ring connections.

Features of KTI's Auto Multi-Ring

- One switch is capable to support four redundant rings concurrently
- Supports up to 30 switches in one ring
- When enabled, the ring function operates immediately even when switch just powered up.
- Supports network redundancy for cable link failures and switch device failures
- Fast response time to recover ring network operation as faults are detected
- Helpful web page to monitor ring details and status
- Ring operation is back to standby state automatically after faults are fixed and ring is repaired
- One switch can support both Auto Multi-Ring and Spanning Tree protocol concurrently.

Term Definitions

To describe how the function works, the following terms are defined:



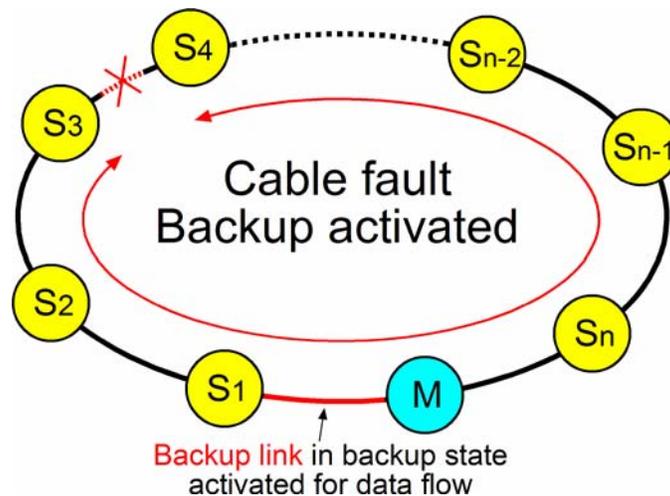
Slave switches: All switches except the master switch in a ring configuration. Two ring ports are

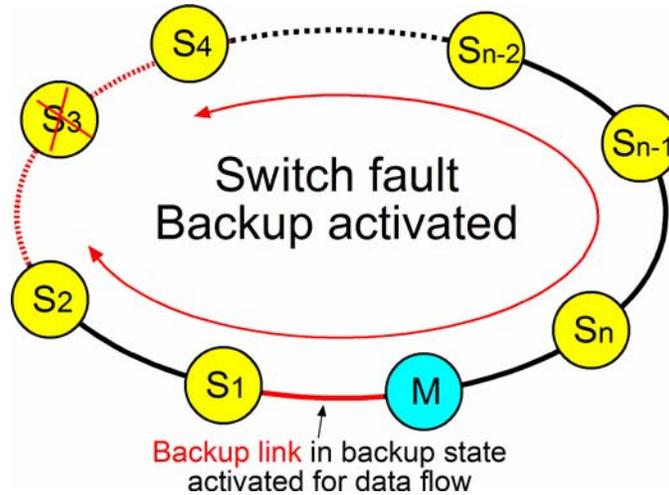
configured for ring connection.

- Master switch:** The switch unit which monitors the ring configuration and controls the backup link in a ring. One ring port and one backup port are configured.
- Ring members** The switches cascaded in a ring topology.
- Ring ports:** The ports used for connecting switches in a ring.
- Backup port:** The port specified in the master switch which is connected to a physical cable but is disabled in operation and under standby state. It is enabled and activated by the master switch immediately to support ring communication when a fault is detected in a ring configuration.
- Ring group ID:** Each ring configuration must have a unique ID for identification when multiple rings are configured in a network. A switch can support multiple rings concurrently.

How Redundant Ring Operates

The ring master monitors the ring connection continuously. As any fault is reported, the master switch activates (enables) the backup link under “**Standby State**” immediately to provide a backup path, recover the communication channel and keep the ring operating. The fault may be caused by ring cable disconnection as shown in the following figure below:





Other possible fault could be a switch failed due to function failure or power problem as shown above. As fault notification is received by the master, the backup link enters into “Backup State” from standby state,.

KTI Auto Multi-Ring function can support not only one fault case but also multiple faults cases at same time and give much faster response time than typical Spanning Tree Protocol. Other faults happening outside this scope is beyond the capability of this technology.

Web Configuration

The switch provides a user friendly management interface to configure the ring network. It also provides a helpful function to examine the status of all configured rings. One switch uses two ports to support one ring connection. The configuration below shows the switch connects three redundant rings and it is designated as the master for Ring 1 and Ring 3.

Multi Ring Configuration (v0.1.0)

Group	Ring Port 1	Backup Port	Ring Port 2	Backup Port	ID
Ring Group 1	Port 1	<input checked="" type="checkbox"/>	Port 2	<input type="checkbox"/>	2
Ring Group 2	Port 3	<input type="checkbox"/>	Port 4	<input checked="" type="checkbox"/>	3
Ring Group 3	Port 5	<input checked="" type="checkbox"/>	Port 6	<input type="checkbox"/>	4
Ring Group 4	--	<input type="checkbox"/>	--	<input type="checkbox"/>	0

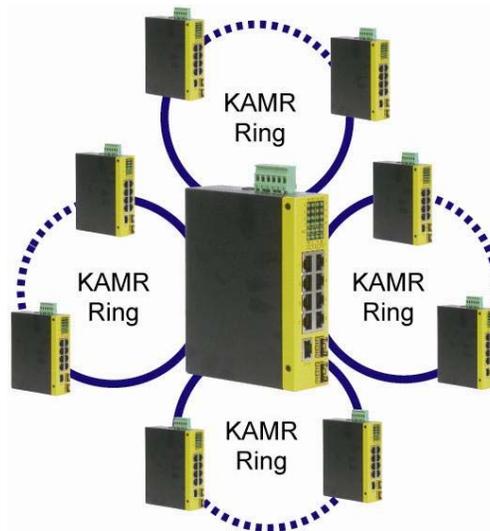
Apply Refresh

Repairing the Network & Standby Recovery

When the backup link is activated to support continuous ring operation, the failed section in the ring is blocked and isolated for physical examination and repairing by network trouble shooting engineers. After failure is repaired, the master switch monitors the health of the ring until all elements are verified to recover back to normal condition. The ring can enter into “Standby State” (on guard) again. All the operation is performed automatically.

Configuration for Multiple Rings

For large network, more than one ring connections are very common. KTI Auto Multi-Ring Technology implementation can support up to four ring connections within a switch concurrently. It means that the switch can be the member of up to four independent rings concurrently.



Each ring must be configured a unique ID for identification. A switch can be the master switch of one ring, but a slave switch of another ring.

Multi Ring Status

Multi Ring Group Status

Group	Ring Status	Members	ID
Ring Group 1	STANDBY	3	2
Ring Group 2	STANDBY	3	3
Ring Group 3	STANDBY	5	4
Ring Group 4	--	--	--

Refresh

Local Port Status

Port	Link Status	Protocol	Ring ID
1	1000FDX	Ring (Backup Port)	2
2	1000FDX	Ring	2
3	1000FDX	Ring	3
4	1000FDX	Ring (Backup Port)	3
5	1000FDX	Ring (Backup Port)	4
6	1000FDX	Ring	4
7	1000FDX	RSTP	--
8	1000FDX	RSTP	--

Above web page example shows the rings to which the switch belongs. The switch is the member of Ring 1, Ring 2 and Ring 3 at the same time. The status of each ring includes ring status, the number of members and ID. The web UI also shows the port status in same page for easy user monitoring.

A ring may be in one of the following states by system auto detection:

[**STANDBY**] – The ring is normal and with no failure. The backup link is under standby and not activated.

[**BACKUP**] – Failure occurred somewhere in the ring and the master switch has activated the backup link to support continuous operation of the ring. The ring failure should be repaired immediately by the persons who are in charge.

[**Master Failed**] – Possible failure occurred on the master unit itself. No backup support is available. This is a critical situation and should be repaired immediately.

[**Backup Port Failed**] – Possible failure occurred on the backup link. No backup support is available. This is a critical situation and should be repaired immediately.

The web UI also provides feature to display the detailed information of one ring group as shown below:

Multi Ring List - Ring Group 3

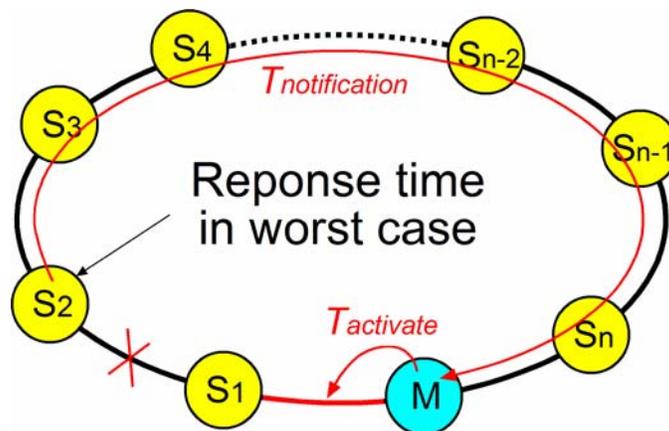
Mac Address	IP Address	Device Name	Port Number	Port Type	Port Status	Ring ID
00-40-F6-EB-4B-B9	192.168.2.204	Control Room	5	Backup	Link	4
			6		Link	
00-40-F6-EB-4C-25	192.168.2.208	Office 3F-4	1		Link	4
			2		Link	
00-40-F6-EB-4E-F5	192.168.2.207	Office 3F-3	1		Link	4
			2		Link	
00-40-F6-EB-4B-CB	192.168.2.205	Office 3F-1	5		Link	4
			6		Link	
00-40-F6-EB-4E-89	192.168.2.206	Office 3F-2	7		Link	4
			8		Link	

Refresh Back

This example shows switch member information and status of Ring 3.

KTI's Auto Multi-Ring Function Performance

The following figure illustrates the worst case that the KAMR ring has the longest response time when a cable fault occurred between Slave 1 and Slave 2:



To calculate the worst response time, several time parameters are defined as follows:

T_{mfd} : Time for switch S2 to detect port link fault after a cable disconnection. This time differs for different media interfaces and devices. For 10/100/1000M twisted-pair, the time is about 750ms ~ 1000ms (defined by IEEE 802.3 standard). By KTI's measurement, typical is 120ms and maximum is 200ms for 1000BASE-X fiber interface. For 1000BASE-T twisted-pair media, typical time is around 300ms up to 550ms.

$T_{notification}$ Time required for fault notification from S1 to arrive Master. It depends on the number of switches the notification passed through. Theoretically, the time is:

$$T_{notification} = T_{latency} * n$$

n: the number of switches the notification passed through before arriving master

T_{latency} : The latency of a notification passing a switch. It is 2.5ms typical for KGD-802-B.

The maximum number of the switches allowed including the master in a KAMR ring is 30.

Therefore, *n* is 28 and $T_{notification} = 2.5ms \times 28 = 70ms$ in the worst case.

<i>T_{activate}</i>	Time required for the Master switch to enable and activate the backup link for ring recover operation. The time also includes some MAC table reconfiguration. For KGD-802-B, the time is 10ms max.
<i>T_{response}</i>	Response time summed up when S1 switch detected a link fault until Master activated backup link to recover the ring operation. $T_{response} = T_{notification} + T_{activate} = 70ms + 10ms = 80ms$ in worst case.
<i>T_{repair}</i>	Time physical repairing the ring fault. During the time, the master switch keeps monitoring the ring status.
<i>T_{standby}</i>	Time for the master switch to block the backup link as it detected whole ring is repaired completely. The master switch recovers the ring back to standby again (on guard). The time is 50 ms typically.

Response Time with KTI Auto Multi-Ring Technology

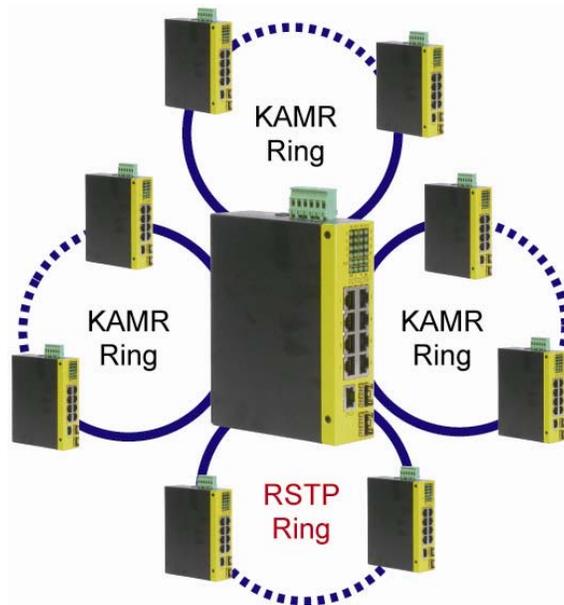
For KGD-802-B, the typical response time of Auto Multi-Ring function when a cable fault is detected until ring operation is recovered: **80ms**

This time figure varied not much even when the number of members in a ring is increased.

This time figure varied not much even when multiple rings are configured.

Important Notes for Applications

1. One switch can support up to four KAMR rings.
2. Only one backup port is configured among the members in a redundant ring.
3. One switched port can not belong to more than one KAMR ring.
4. KAMR supports up to 30 members in a ring.
5. A switched port can not be configured as KAMR ring port and RSTP port at the same time.
6. One switch can support both KAMR and RSTP concurrently via different ports. In the following figure, the central switch is the member of three KAMR rings and it also is a member of one RSTP ring.



7. KAMR function is not compatible with other similar functions available in different brands of switches.
8. The faults to be monitored are cable connections between ring ports and the switch members in a ring. Other faults beyond these are not supported.
9. The cabling of the backup link should be protected securely and has NO RISK for any failure.
10. When the backup link is activated, the faults should be investigated and repaired immediately.

The following figure illustrates a configuration that three redundant rings and one RSTP ring hook on a main redundant ring. Some switches support two redundant rings concurrently.

