

CSX BOYLES YARD SIU DEVELOPMENT

.

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# Overview and Purpose

This purpose of this document is to describe the SIU application developed by Vossloh for the CSX Boyles Yard Project in order that all the features, limitations, logic, and requirements are understood.

It is intended that this application will become standard for both Boyles yard and other CSX yard projects in the future.

**Background**

CSX has standardized on the SIU application ‘CSX DTMF REV E’ in previous yards and projects. This application was developed over several years and incorporated both CSX requested functionality and changes necessary to adequately address different application requirements.

Currently, the majority of CSX yards that are controlled by the ‘RailMaster’ and ‘YardMaster’ applications utilize ‘CSX DTMF REV E’.

Beginning with the Boyles Yard Project, CSX requested that Vossloh incorporate a feature previously provided by Railcomm whereby the ‘Normal’ and ‘Reverse’ LED position indicators flash if a ‘Route’[[1]](#footnote-1) is set over them. It was also requested that the flashing be synchronized across all the switches.

Additionally, CSX requested that Vossloh develop and provide a method to interface the main and remote cases of a crossover to eliminate the discrete conductors currently utilized.

**Requirements**

It is understood that the requirements are (beginning with ‘CSX DTMF REV E’):

1. The green and yellow indicators will display “steady on” when in normal and reverse correspondence, respectively.
2. The green and yellow indicators will flash when a route is set over them.
3. The flashing will be synchronized.
4. CSX would prefer to not have an additional board or device (the Railcomm solution) in order to implement the flashing solution.
5. CSX would prefer to only have one application that applies to single switches, and crossover switches.
6. Flashing (whether a switch should flash or display steady) will be controlled by the office application (‘RailMaster’).
7. Implement a two wire interface between the master and remote switches in a crossover.

# Synchronized Flashing and WLL Design

## FLASHING

**Design Constraints**

In order to synchronize flashing four criteria must be met:

1. All devices must receive a synchronizing timestamp at the same time
2. All devices must provide stable time services that are identical.
3. The granularity of the time service must be equal or greater than the minimum duration of any event being timed.
4. The time service must have the ability to be reset.

Native time services within the SIU application framework are not suitable for synchronized flashing. The SIU provides two timer functions for applications:

1. Programable timers (8): Granularity 1 second.
2. FLASH function (1): Granularity 1 millisecond

The programable timers do not have the granularity necessary to provide synchronized flashing. The Flash function does have the necessary granularity but lacks the ability to be reset. Additionally, while the granularity appears to be 1 millisecond the implementation of application only allows processing of the flash timer once every pass of the application logic as described below. Further, the flash timer does not have the ability to be reset.

The design of the SIU executive relies on procedural processing of services and application logic rather than interrupts. While interrupts are commonly used and help to guarantee the processing of a service (such as a timer) quickly, they suffer from creating a non-deterministic system. For pseudo real time applications this can cause variable behavior that is undesirable. The SIU utilizes a processing loop similar to that shown below.

|  |
| --- |
| BEGIN LOOP |
| PROCESS TIMERS |
| PROCESS ETHERNET |
| PROCESS BUSS |
| PROCESS SERIAL COMMUNICATION |
| PROCESS INPUTS |
| **PROCESS APPLICATION LOGIC** |
| PROCESS OUTPUTS |
| PROCESS LOGGING |
| END LOOP |

**Implementation**

In addition to providing eight timers to the application logic, the SIU provides eight programmable counters. By utilizing counters it is possible to count every two passes of the programming loop. As long as the code base in each SIU is the same this is deterministic and adequately stable. The current code base operates at approximately 13 milliseconds per pass.

The main flashing function utilizes two counters that count the ON time and OFF time. When a synch message is received these counters are reset to zero.

**NOTE:** The frequency of the synchronization message is configured in the RailMaster System. When a synch message is received the counters are reset to zero. This has the affect of restarting the counters and will be visible as a stutter in the flashing if enabled. This can be mitigated by adjusting the frequency of the synch message.

In order to keep ALL SIU’s synchronized they must utilize the same application code. This requires that there is one application for:

* Single Switches
* Crossover Master
* Crossover Remote

Selection of application type is set on the SIU configuration page.

**NOTE:** Single switches do not utilize a WLL. This creates a slight difference in the timing of the processing loop. While single switches (and crossovers) are stable and able to stay synchronized with respect to each other for long periods of time, crossovers and single switches drift with respect to each other. Testing indicates that synchronizing once a minute is adequate to keep all devices synchronized.

## WLL

**Design Constraints**

The WLL provides a dedicated RS485 link between the master and remote SIU’s for a crossover. In traditional Crossover applications the control and indication are accomplished by discrete wires and relays. Traditional Crossovers utilize only one SIU in the master.

The addition of a separate processor in the remote case introduces the following requirements and constraints:

1. Each SIU has to control its switch independently (logic is local).
2. Each SIU has to provide the other switch with data (occupancy, MOW, puchbuttons, etc)
3. Neither switch can operate if the WLL link is not present.
4. Failures should be self-revealing.

**Implementation**

The WLL provides a highspeed serial buss between a master and remote SIU. This buss transfers 16 bits bidirectionally:

|  |  |  |
| --- | --- | --- |
| **BIT** | **FROM MASTER** | **FROM REMOTE** |
| 1 | NORMAL CONTROL | NORMAL INDICATION |
| 2 | REVERSE CONTROL | REVERSE INDICATION |
| 3 | GREEN SIGNAL ON | TK1 INDICATION |
| 4 | YELLOW SIGNAL ON | TK2 INDICATION |
| 5 | RED SIGNAL ON | PB NORMAL |
| 6 | FLASH ROUTE | PB REVERSE |
| 7 | FLASH RED | MOW |
| 8 | SPARE | SPARE |
| 9 | SPARE (FUTURE SYNC) | SPARE (FUTURE SYNC) |
| 10 | LINK ALIVE | LINK ALIVE |
| 11 | SPARE | SPARE |
| 12 | SPARE | SPARE |
| 13 | SPARE | SPARE |
| 14 | SPARE | SPARE |
| 15 | SPARE | SPARE |
| 16 | SPARE | SPARE |

The master SIU determines if the switches can be thrown based on the state of the track circuits and the MOW’s. However, the remote case maintains its own switch control logic and will not throw if occupied or the MOW is disabled (locally),

Bit 10 is set to true always (outgoing). Each SIU must see this bit high (incoming) in order to operate. If this bit is low it is considered to be a system failure.

# SIU DISPLAY STATES

|  |  |  |  |
| --- | --- | --- | --- |
|  | ON TIME | OFF TIME | CONFIGURATION |
| STEADY | Constant | NA | FIXED |
| RTE\_FLASH | 500 ms | 500 ms | FIXED |
| OOC\_FLASH | 250 ms | 250 ms | CONFIGURABLE |
| FAIL\_FLASH | 50 ms | 2000 ms | FIXED |

NOTE: TIMES ARE APPROXIMATE

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **STATE** | | | |  | **OUTPUT** | | | |
| CORRESPONDENCE | OCCUPANCY | MOW | RT\_FLASH |  | GREEN | YELLOW | RED | BLUE |
|  |  |  |  |  |  |  |  |  |
| NORMAL | UP | UP | OFF |  | STEADY | OFF | OFF | OFF |
| NORMAL | DOWN | UP | OFF |  | STEADY | OFF | STEADY | OFF |
| NORMAL | UP | DOWN | OFF |  | STEADY | OFF | OFF | STEADY |
| NORMAL | DOWN | DOWN | OFF |  | STEADY | OFF | STEADY | STEADY |
| NORMAL | UP | UP | ON |  | **RTE\_FLASH** | OFF | OFF | OFF |
| NORMAL | DOWN | UP | ON |  | **RTE\_FLASH** | OFF | STEADY | OFF |
| NORMAL | UP | DOWN | ON |  | **RTE\_FLASH** | OFF | OFF | STEADY |
| NORMAL | DOWN | DOWN | ON |  | **RTE\_FLASH** | OFF | STEADY | STEADY |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **STATE** | | | |  | **OUTPUT** | | | |
| CORRESPONDENCE | OCCUPANCY | MOW | RT\_FLASH |  | GREEN | YELLOW | RED | BLUE |
|  |  |  |  |  |  |  |  |  |
| REVERSE | UP | UP | OFF |  | OFF | STEADY | OFF | OFF |
| REVERSE | DOWN | UP | OFF |  | OFF | STEADY | STEADY | OFF |
| REVERSE | UP | DOWN | OFF |  | OFF | STEADY | OFF | STEADY |
| REVERSE | DOWN | DOWN | OFF |  | OFF | STEADY | STEADY | STEADY |
| REVERSE | UP | UP | ON |  | OFF | **RTE\_FLASH** | OFF | OFF |
| REVERSE | DOWN | UP | ON |  | OFF | **RTE\_FLASH** | STEADY | OFF |
| REVERSE | UP | DOWN | ON |  | OFF | **RTE\_FLASH** | OFF | STEADY |
| REVERSE | DOWN | DOWN | ON |  | OFF | **RTE\_FLASH** | STEADY | STEADY |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **STATE** | | | |  | **OUTPUT** | | | |
| CORRESPONDENCE | OCCUPANCY | MOW | RT\_FLASH |  | GREEN | YELLOW | RED | BLUE |
|  |  |  |  |  |  |  |  |  |
| OOC | UP | UP | OFF |  | OFF | OFF | **OOC\_FLASH** | OFF |
| OOC | DOWN | UP | OFF |  | OFF | OFF | **OOC\_FLASH** | OFF |
| OOC | UP | DOWN | OFF |  | OFF | OFF | **OOC\_FLASH** | STEADY |
| OOC | DOWN | DOWN | OFF |  | OFF | OFF | **OOC\_FLASH** | STEADY |
| OOC | UP | UP | ON |  | OFF | OFF | **OOC\_FLASH** | OFF |
| OOC | DOWN | UP | ON |  | OFF | OFF | **OOC\_FLASH** | OFF |
| OOC | UP | DOWN | ON |  | OFF | OFF | **OOC\_FLASH** | STEADY |
| OOC | DOWN | DOWN | ON |  | OFF | OFF | **OOC\_FLASH** | STEADY |
|  |  |  |  |  |  |  |  |  |
| **FAIL** | NA | NA | NA |  | **FAIL\_FLASH** | **FAIL\_FLASH** | **FAIL\_FLASH** | **FAIL\_FLASH** |

|  |  |  |  |
| --- | --- | --- | --- |
| **FAIL:** | 1) STUCK PROX | NORMAL AND REVERSE PROX INDICATION AT SAME TIME |  |
|  | 2) CONGURATION | CONFIGURATION FOR SINGLE SW, MAIN, REMOTE NOT SET CORRECTLY |  |
|  |  | 1) MUST BE CONFIGURED BEFORE FIRST USE: One option must be set |  |
|  |  | 2) TWO OR MORE OPTIONS SET: Only one allowed |  |
|  | 3) WLL LINK FAILED | LINK BETWEEN MAIN AND REMOTE NOT OPERATIONAL |  |
|  |  |  |  |
| **FLASH\_STOP** |  | If communications are lost with RailMaster FLASHING WILL STOP 5 Minutes after last Sync | |
|  |  | command from office. Flashing will also stop with pushbutton operation at the switch. | |
|  |  | NOTE: Individual switches will continue to flash **until:** | |
|  |  | 1) Communication is reestablished, and flash is turned off. | |
|  |  | 2) Switch is controlled locally (pushbutton) | |
|  |  | 3) 5-minute timer expires | |

# SIU CONFIGURATION

## WIRING

|  |  |  |
| --- | --- | --- |
| **BIT** | **INPUT** | **OUTPUT** |
| 1 | NWK | GREEN |
| 2 | RWK | YELLOW |
| 3 | NWK-HT | RED |
| 4 | RWK HT | MOW (BLUE) |
| 5 | TK1 | SPARE |
| 6 | TK2 | HPU |
| 7 | TOGGLE | NOR |
| 8 | SPARE | REV |
| 9 | MOW | CUT LIGHT |
| 10 | PB NOR | OSTP (OCCUPANCY) |
| 11 | PB REV | SPARE |
| 12 | RT ADV | SPARE |

## SIU STATUS

**A screenshot of a cell phone

Description automatically generated**

## SIU PARAMETERS SINGLE SWITCH

A screenshot of a cell phone

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## SIU PARAMETERS MASTER

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## SIU PARAMETERS REMOTE

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Description automatically generated

1. The term route is not equivalent to a mainline route. No vitality, locking, timers, or directional stick (etc.) is implied or provided. When the control system sets a route, it lines a collection of switches in the desired position and displays the route green on the operators display. Controls from the operators display for individual switches are prevented while a route is set (office locking). Direct control by pushbutton is NOT prevented in order to allow train operators the ability to select a different track without having to cancel the route or return to the control screen. In all cases yard operating rules apply. [↑](#footnote-ref-1)