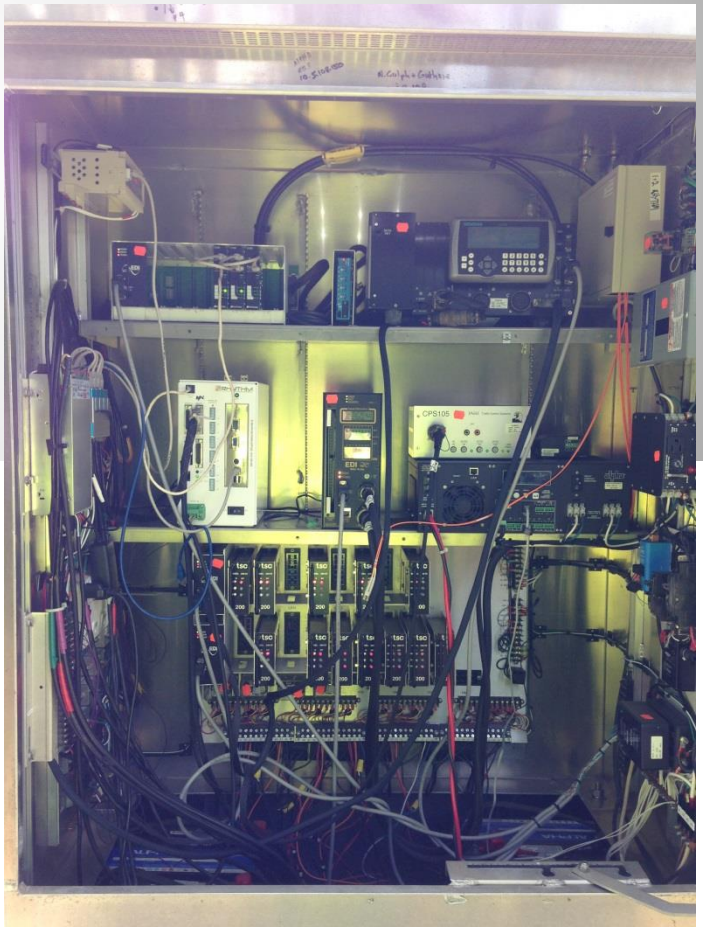
PennState College of Engineering

TRANSPORTATION ENGINEERING AND SAFETY CONFERENCE

Traffic Signal Troubleshooting

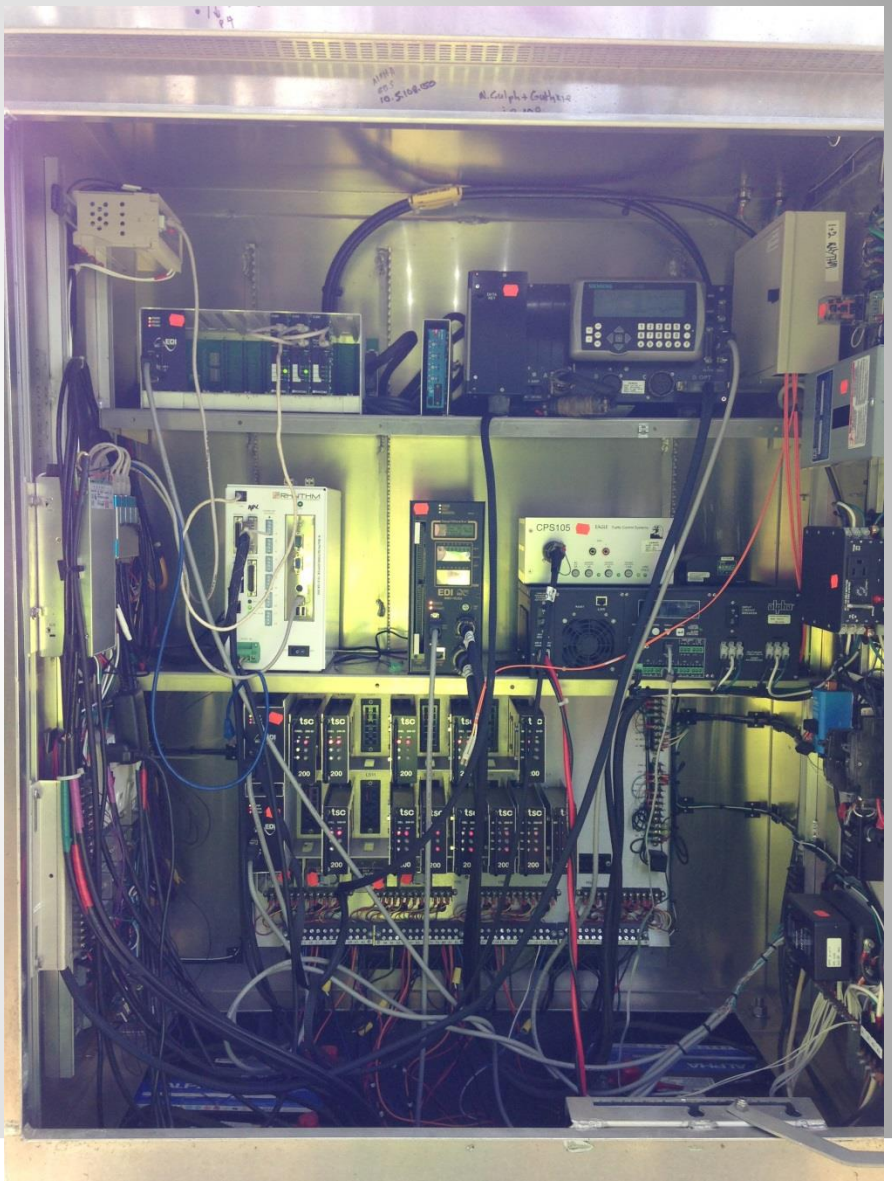


Charles DeVitis
Upper Merion Township
Traffic Signal Supervisor

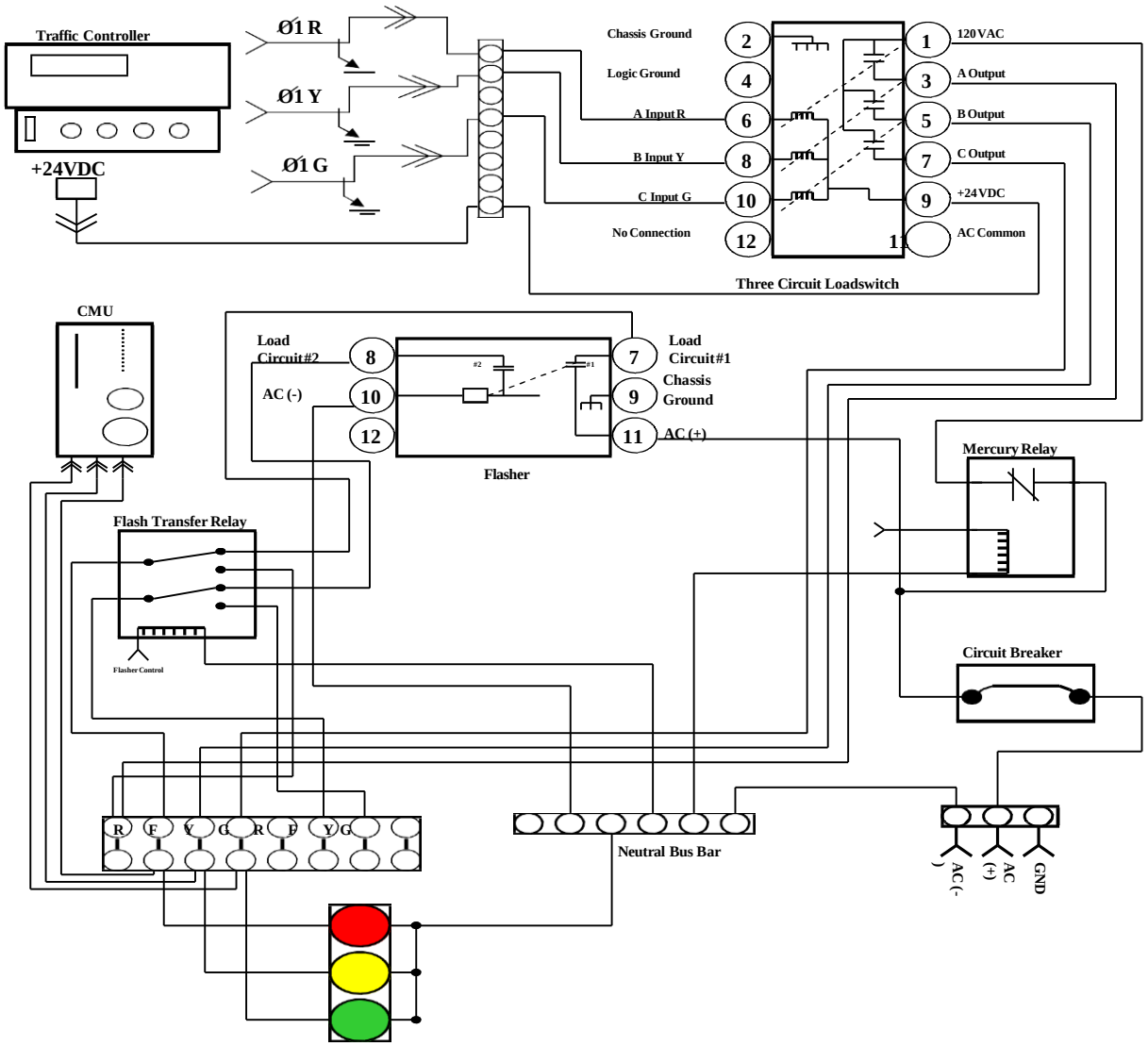
December 6th 2018

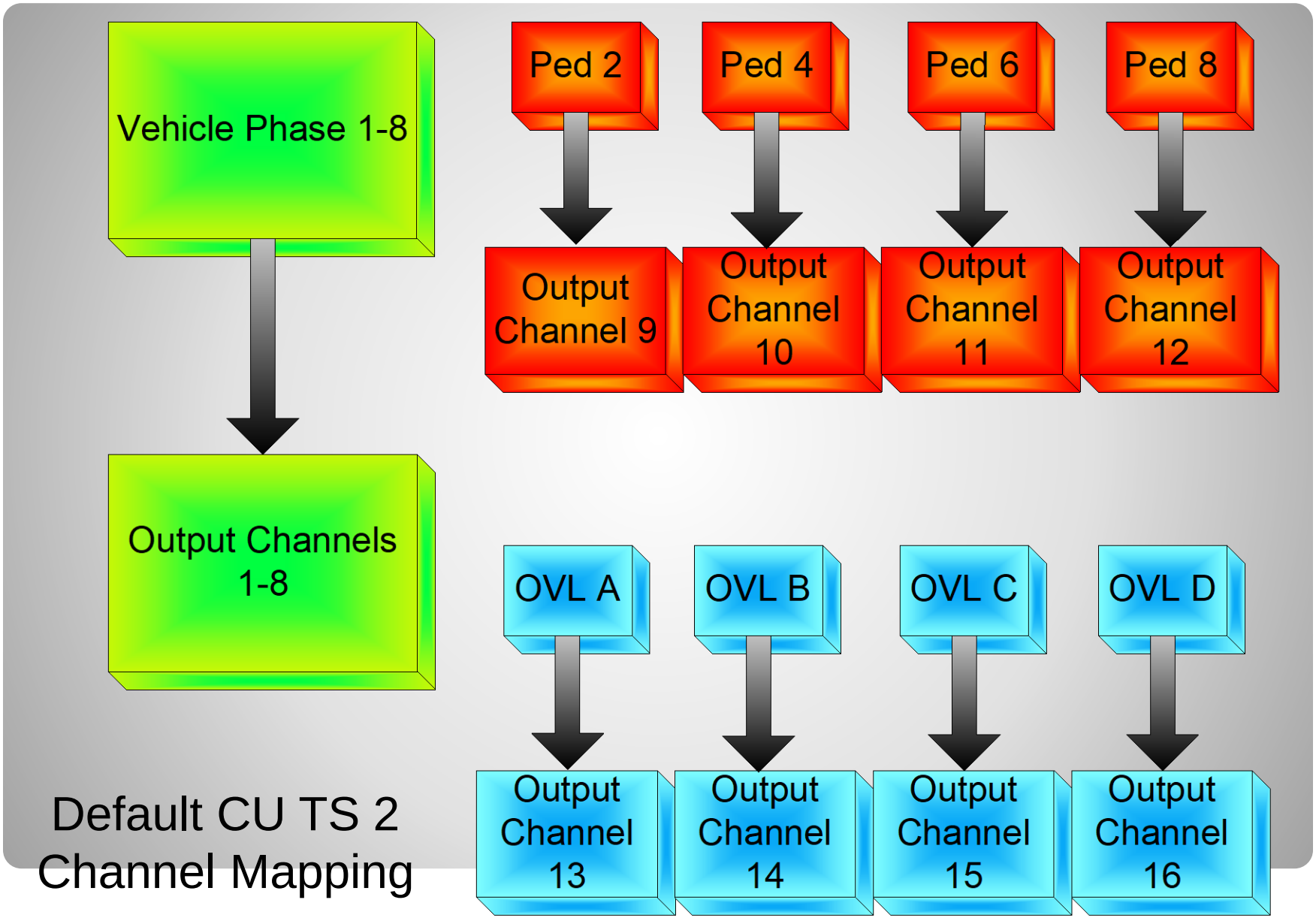
What does the Signal Tech really need to know.

Controllers
Conflict Monitors
Battery Back Up Systems
Fiber Optics
Networking and Switches
Adaptive Systems
Central Systems
Preemption
Load Switches
BIU’s
Power Supplies
And Many More



Simplified Controller Cabinet Wiring Diagram





Default CU TS 2 Channel Mapping

NEMA SIGNAL PHASING

Ring 1	1	2	3	4
Ring 2	5	6	7	8

Sequential Phases in a Ring are not permitted to be on at same time. In Ring One Phases 1,2,3 and 4 should not be programmed to be on at same time.
Same applies to Ring Two for Phases 5,6,7 and 8

Ring 1	1	2	3	4
Ring 2	5	6	7	8

Phases that are permitted to be on at same time will be one from Ring One and the Phase below it in Ring Two or on the diagonal and not crossing the Barrier.
Usually Phases 2+6 are Main Street and Phases 4+8 are side street.
Phases 1+5 are Main streets turn Lanes and Phases 3+7 are side streets turn lanes.

Ring 1	1	2	3	4
Ring 2	5	6	7	8

Here is an example of how the turns lanes are defined.
Phase 2 turning phase is Phase 5, as you can see the turn lanes are diagonal from the parent phase.

NEMA SIGNAL PHASING 16 Channels

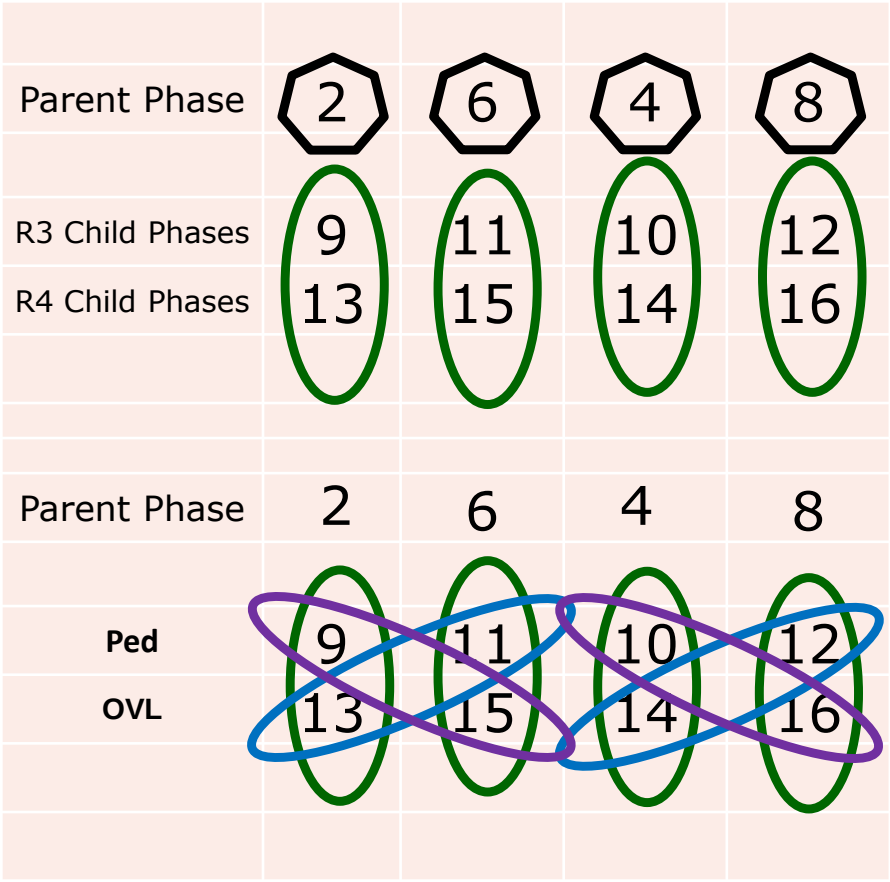
Ring 1	1	2	3	4
Ring 2	5	6	7	8
Ring 3	9	10	11	12
Ring 4	13	14	15	16
Ring 3	9	10	11	12
Ring 4	13	14	15	16

Now we previously learned about a 2 ring NEMA Phasing, the same will apply if we add a 3rd and 4th ring to the cabinet. Seen mainly in TS 2 Cabinets. If used for Vehicle Phasing. Ped and Overlap we will handle a little differently

Ring Three consist of the following: Phases 9 through 12 are for Pedestrian Movements

Ring Four consist of the following: Phases 13 through 16 are for Overlaps A through D

Again we carry over what we learned on permissive phases from Rings 1 and 2. Can not cross the Barrier and sequential phases can not be on at same time.



Now I will confuse everyone because with Rings 3 and 4 they are slightly different and I will use a new diagram to explain.

Phases 2,4,6 and 8 are Parent Phases from Rings 1 and 2 and this diagram shows their Child Phases.

In this Example we show you the new permissive pairs of rings 3 and 4's Child Phases and how they are associated with the Parent phases of rings 1 and 2.
Phase 2 vehicle + Phase 9 ped + Phase 13 overlap A
Phase 6 vehicle + Phase 11 ped + Phase 15 overlap C
Phase 4 vehicle + Phase 10 ped + Phase 14 overlap B
Phase 8 vehicle + Phase 12 ped + Phase 16 overlap D

Monitor Cheat Sheet & Trouble Shooting Guide

CONFLICT

Signal Indication Burned Out Shorted or Open
Field Wiring Output side of load Switch
shorted Bad transfer Flash relay

RED FAIL

Bad Load Switch, EPAC, BIU in TS2

CVM/WATCHDOG

Controller found the fault, Police Flash Switch, TS2 Check Frame Faults

24V-2 & 24V-1

This is a NON Latching Fault (can be set to latching)
The signal will return to normal operation when 24 vdc is restored Power Supply in TS2
Controller in TS1
Main Power under 90 Volts AC
If running on Generator bad output power

CLEARANCE FAIL

Min Yellow and Red
Time was cut short for Yellow or Red Clearance times
Controller programming
Preemption programming an overlap for right turn signal

PORT 1 FAIL

TS 2 only faults SDLC Cables, BIU, Controller

DIG/PGM CARD

Program card ajar, Monitor Broke

FIELD CHECK

In combination with Conflict helps determine exact signal indication fault

FAIL DUAL

2 different Signal indications on at the same time same phase
Load Switch Field Wires

INDICATION

TS 1 (conflict monitor) Green and Yellow Light bulb on at same time TS 2 ONLY a RED out will trigger this with FIELD CHECK Status enabled Bad transfer Flash relay

LOCAL FLASH Police door Epac incorrect Time of Day

KNOWN GENERATOR PROBLEMS

If output power is too high or too low the signal will go in and out of flash
If the frequency of the generators sine wave shifts above or below +/- 2 Hertz The MMU and Conflict Monitor will keep the signal in flash
RED ENABLE or RED FAIL will be the fault on MMU and RE RE will be on if using the LCD conflict monitors TS-1

Have the police bring out another generator and write down the number on the generator so we can have it removed from service

Monitor Cheat Sheet & Trouble Shooting Guide

TROUBLE SHOOTING COMPLAINTS from Others/Police CHECK
POLICE DOOR SWITCHES FIRST
Make sure the FLASH SWITCH is in its proper position

Signal in Flash but I also see the green lit
CHECK Mercury Relay then Flash Transfer relays

TS 2 ONLY

Additional info on a TS 2 cabinet not covered in this manual but covered in our other Trouble shooting seminar

PLEASE CHECK THE ALARM PAGES Screens 9-4 & 9-8 & 9-3
USE ECOM SOFTWARE OR EPAC SCREEN 9 – 8 check the MMU ALARM REPORT
This will be able to rule out NON LATCHING FAULTS example loss of 24vdc

START UP FLASH w/PREEMPT
Bad BIU or preempt input
First check screen 1-8 enter frame 138 check bits 22 & 23
Second same as above but check frame 139 check bits 24 thru 27 if a "1" is present the BIU or Preempt card is causing the problem
If replacing the BIU or turning off the Preemption card does not work check that there is no ramp or firehouse or rail road preemption causing this problem remove wires from backboard or unplug "D" connector
LAST replace Controller

TS 2 DIAG FLASH – NO EXIT A series of repetitive faults that require you to power down and recycle power to the signal. These faults happen 3 times in a 24 hour period.

This is caused by a FRAME FAULT check the equipment that is attached to the SDLC cables FRAME FAULTS 128 thru 131 are all related to the MMU
FRAME FAULTS 138 thru 141 are all related to the TERMINAL & FACILITIES BIU's FRAME FAULTS 148 thru 155 are all related to the Detector racks or Camera Processor

In the Seimens Epac Book on page 111 is the Diagnostics section and will explain in detail Also in the book on page 101 is the LOCAL ALARMS explained

TS 1

Active status of the intersection
Active status of the ABC connectors output
These 2 screens will show you what color R, Y, G is on for its corresponding phase
When STOP TIME is on because of a fault you can now narrow down what signal colors are giving you a conflict or dual indication

Monitor Cheat Sheet & Trouble Shooting Guide

ON ALL TIMING COMPLAINTS check in this order

TIME OF DAY remember MILITARY TIME is used DETECTORS &

CAMERAS for faults or miss aligned camera
- **Check Locking Non Locking**
- **Put the phase into MAX RECALL if NO CALL is being generated *VERY RARE***
- **Check next paragraph for help on changing vehicle recalls**

PHASE DATA make sure it corresponds to the Signal Permit Density times
- **Pedestrian times Vehicle and Ped Recalls**
  - **Phases 2 and 6 are usually are set for MIN RECALL**
  - **All other phases are set at No recall unless loop is broken then Max Recall Broken**
  - **Pedestrian Button MIN RECALL NEVER MAX RECALL**
    - **Max Recall messes up volume density**

Protected Turns Phases
- **Have a dedicated 3 Section head for this movement We want**
  - **LOCKING memory**

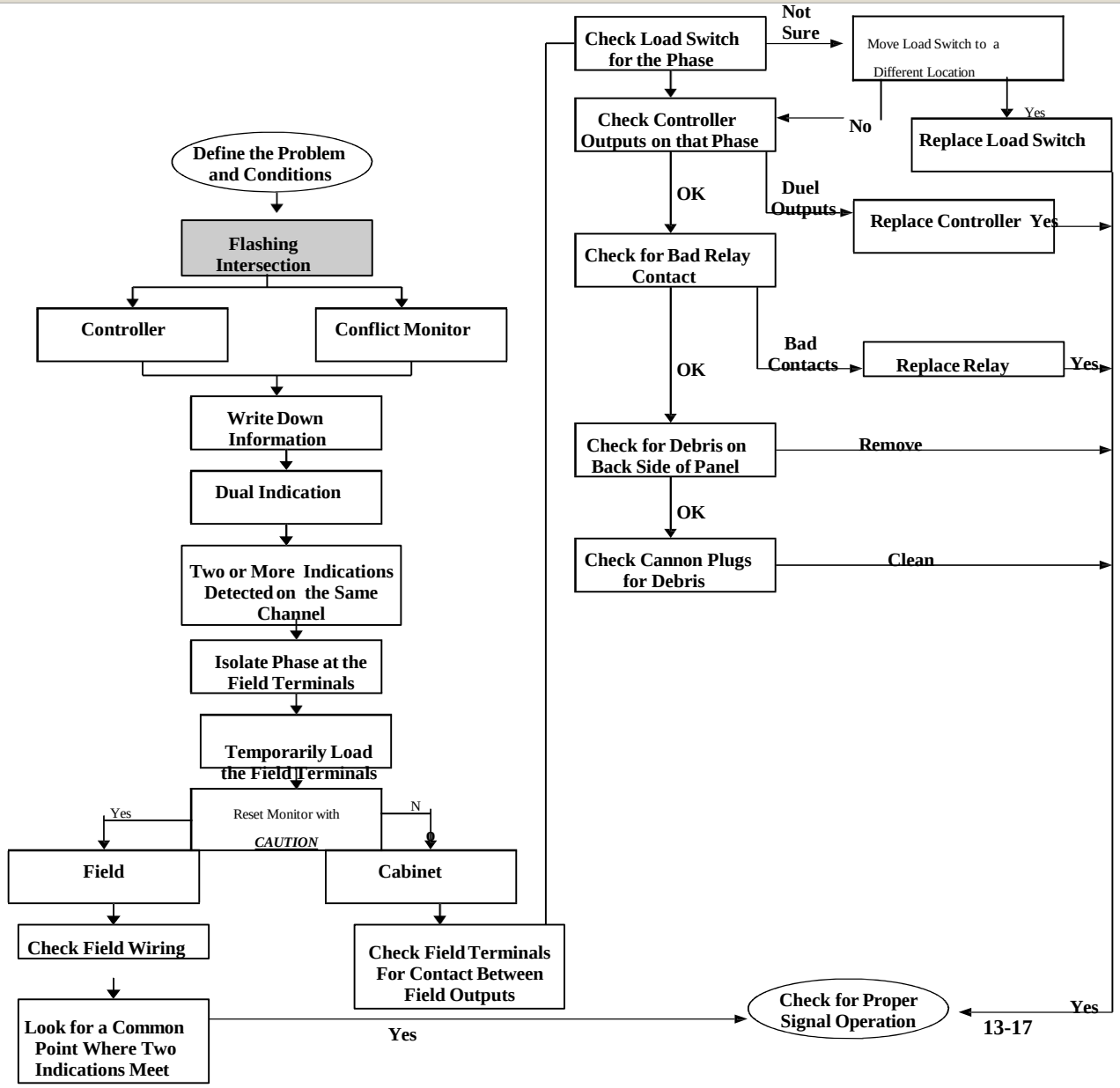
Protected Permissive Turn Phases
- **Have a 5 section head dedicated for this movement example Phases 1+6**
  - **We want NON-LOCKING memory Example the TURNING movement usually phases 1 or 5 and 3 + 7**

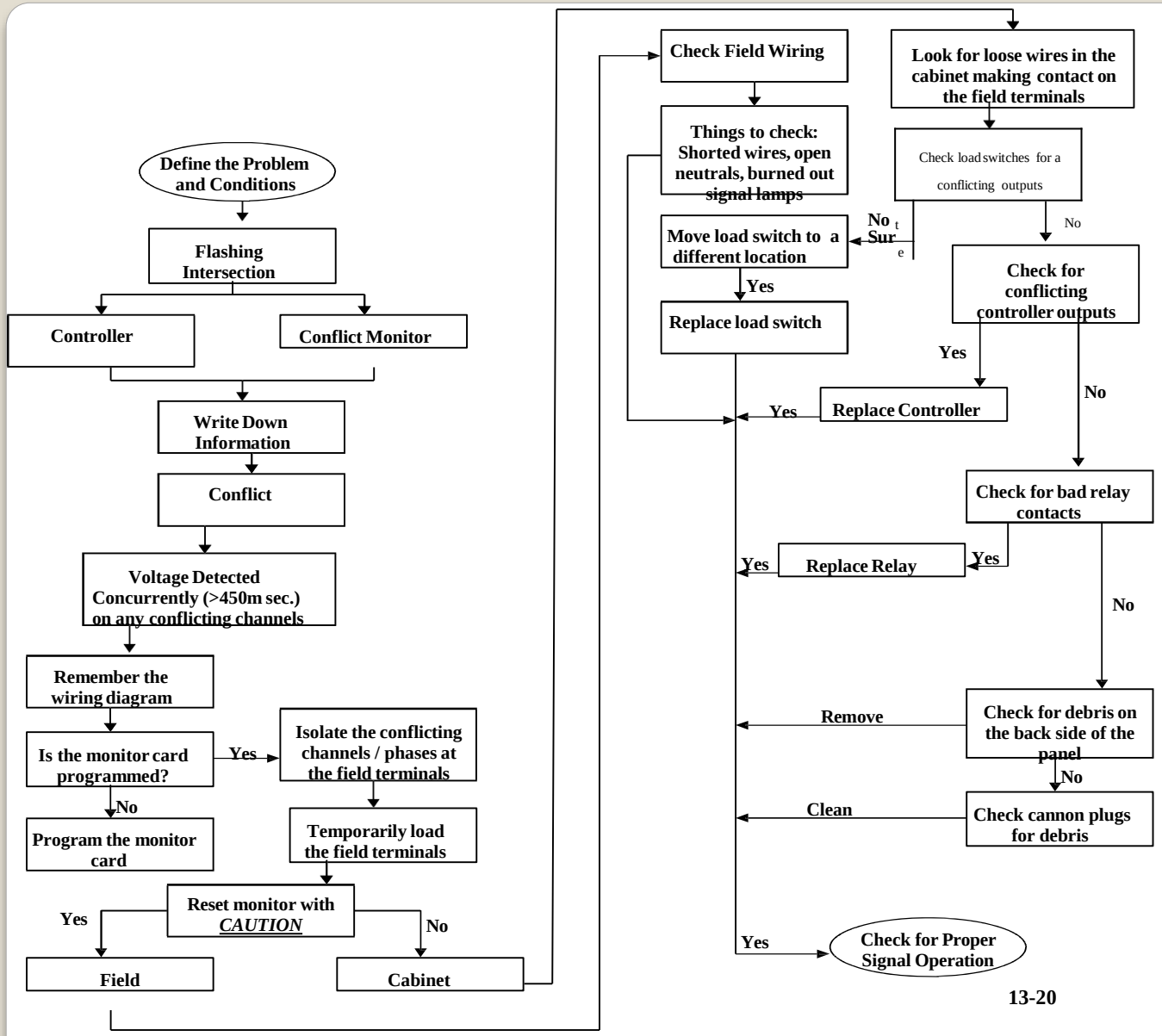
Side Streets Phases 4 & 8
- **Non Locking Memory unless Signal plan calls for Locking**
- **No Recalls should be under these phases unless Signal Plan calls for a recall**

A logical thought process

7 Step Isolation Procedure

1. **Observe intersection operation**
2. **Identify the problem or problems**
3. **Determine the general areas that could create the observed symptoms**
4. **Make tests or take steps to isolate the actual area causing the problem**
5. **Make tests to determine the device that is causing the problem**
6. **Replace the defective device or otherwise correct the problem**
7. **After corrective measures are completed, thoroughly observe intersection operation to ensure that all problems have been corrected.**


Define the Problem and Conditions
Flashing Intersection
Controller
Conflict Monitor
Write Down Information
Dual Indication
Two or More Indications Detected on the Same Channel
Isolate Phase at the Field Terminals
Temporarily Load the Field Terminals
Reset Monitor with CAUTION
Yes
N
Field
Cabinet
Check Field Wiring
Check Field Terminals For Contact Between Field Outputs
Look for a Common Point Where Two Indications Meet
Yes
Check Load Switch for the Phase
Not Sure
Move Load Switch to a Different Location
Yes
Replace Load Switch
No
Check Controller Outputs on that Phase
OK
Duel Outputs
Replace Controller Yes
Check for Bad Relay Contact
OK
Bad Contacts
Replace Relay
Yes
Check for Debris on Back Side of Panel
Remove
OK
Check Cannon Plugs for Debris
Clean
Check for Proper Signal Operation
Yes


Define the Problem and Conditions
Flashing Intersection
Controller
Conflict Monitor
Write Down Information
Conflict
Voltage Detected Concurrently (>450m sec.) on any conflicting channels
Remember the wiring diagram
Is the monitor card programmed?
Yes
No
Program the monitor card
Isolate the conflicting channels / phases at the field terminals
Temporarily load the field terminals
Reset monitor with CAUTION
Yes
No
Field
Cabinet
Check Field Wiring
Things to check: Shorted wires, open neutrals, burned out signal lamps
Move load switch to a different location
No
Sure
Yes
Replace load switch
Look for loose wires in the cabinet making contact on the field terminals
Check load switches for a conflicting outputs
No
Check for conflicting controller outputs
Yes
Replace Controller
Yes
No
Check for bad relay contacts
Yes
Replace Relay
Yes
No
Check for debris on the back side of the panel
Remove
No
Check cannon plugs for debris
Clean
Yes
Check for Proper Signal Operation

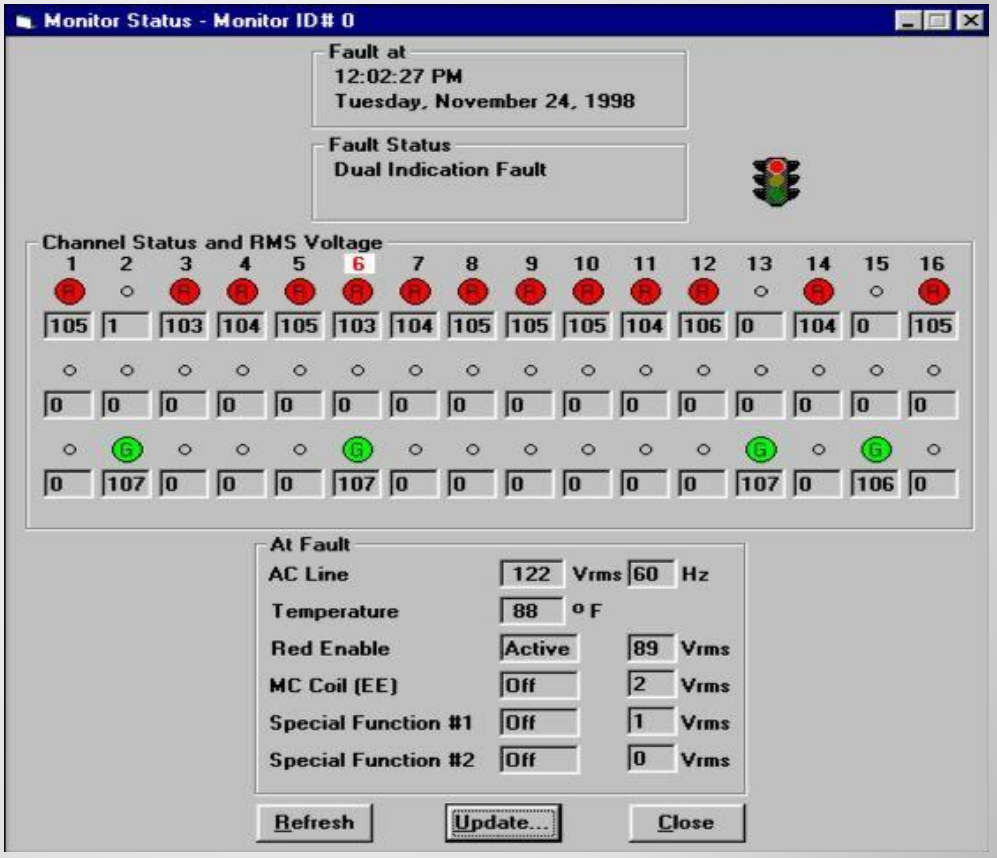
ECom Signal Software

For use with Eberle Design brand of Conflict Monitors

Display Real- Time Status

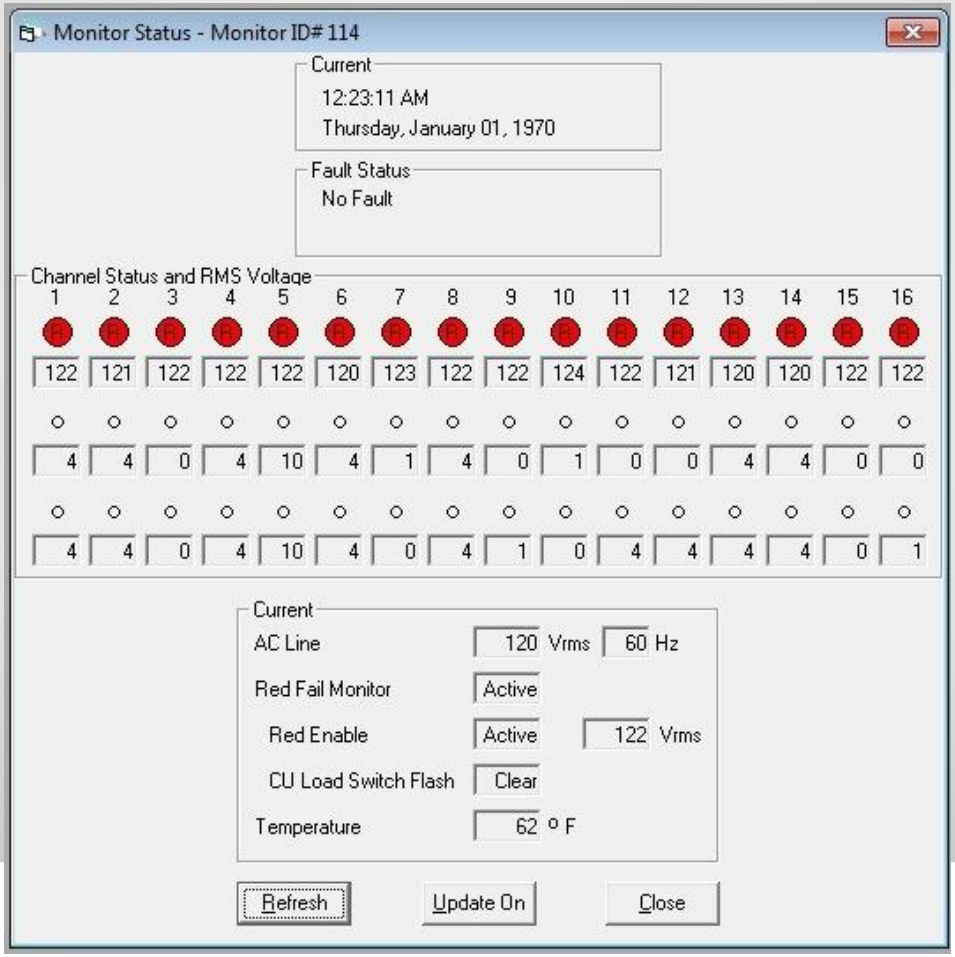
Why guess when you can know?

- Real time status shows all signal states, field terminal voltages, and cabinet control voltages.
- Current fault type and fault status is displayed with time and date stamp.
- Channels involved in the fault are directly indicated.

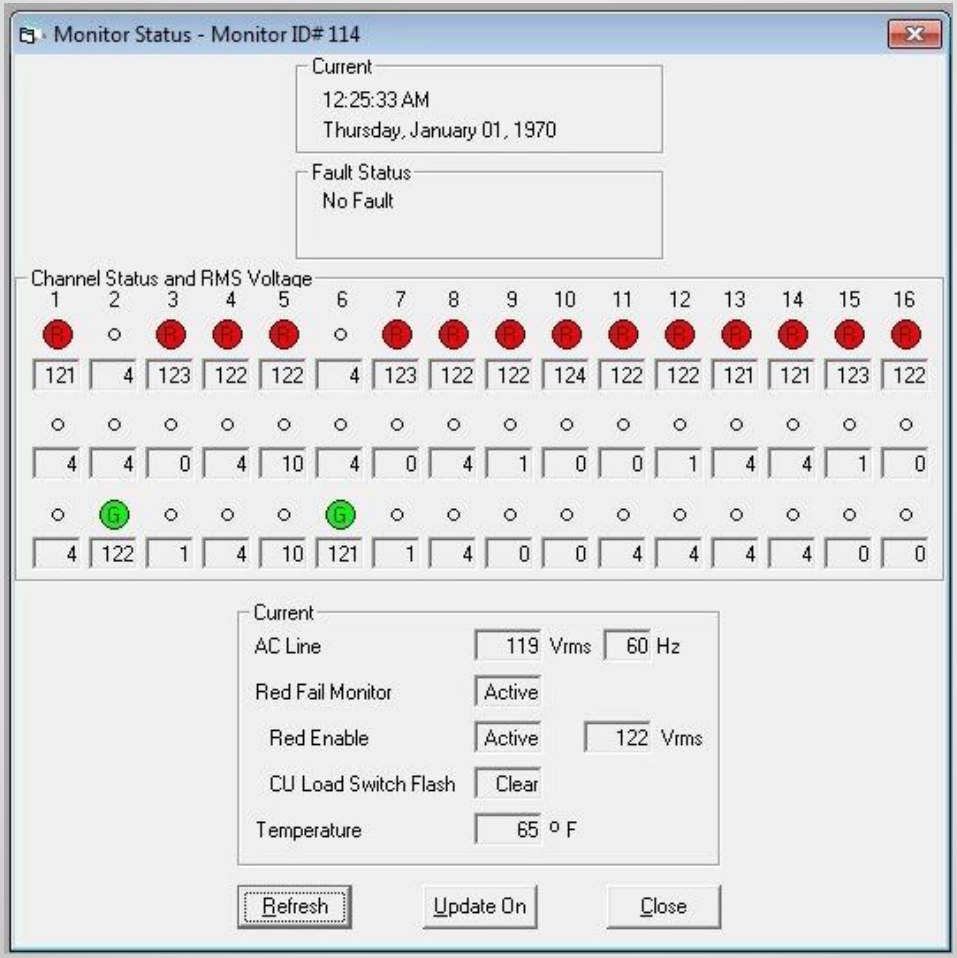


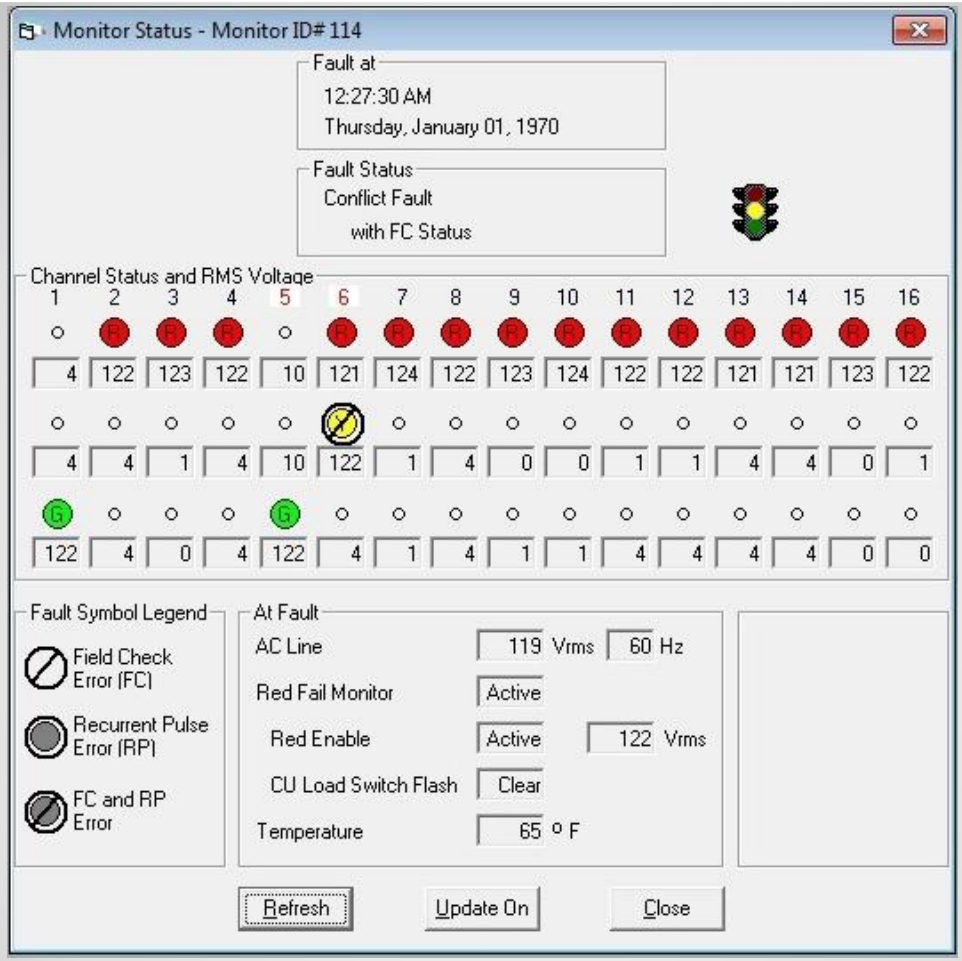
View a display that graphically displays signal On/Off states as well as the RMS voltage at each field terminal and at the AC Line input. It is like having a 48+ channel digital voltmeter connected to the cabinet 24 hours a day, 365 days a year. When a fault is detected the real-time status is latched as a snap-shot of the cabinet status at the time the fault was detected. The fault type is displayed with the time and date of the event. Channels involved with the fault are also directly identified.

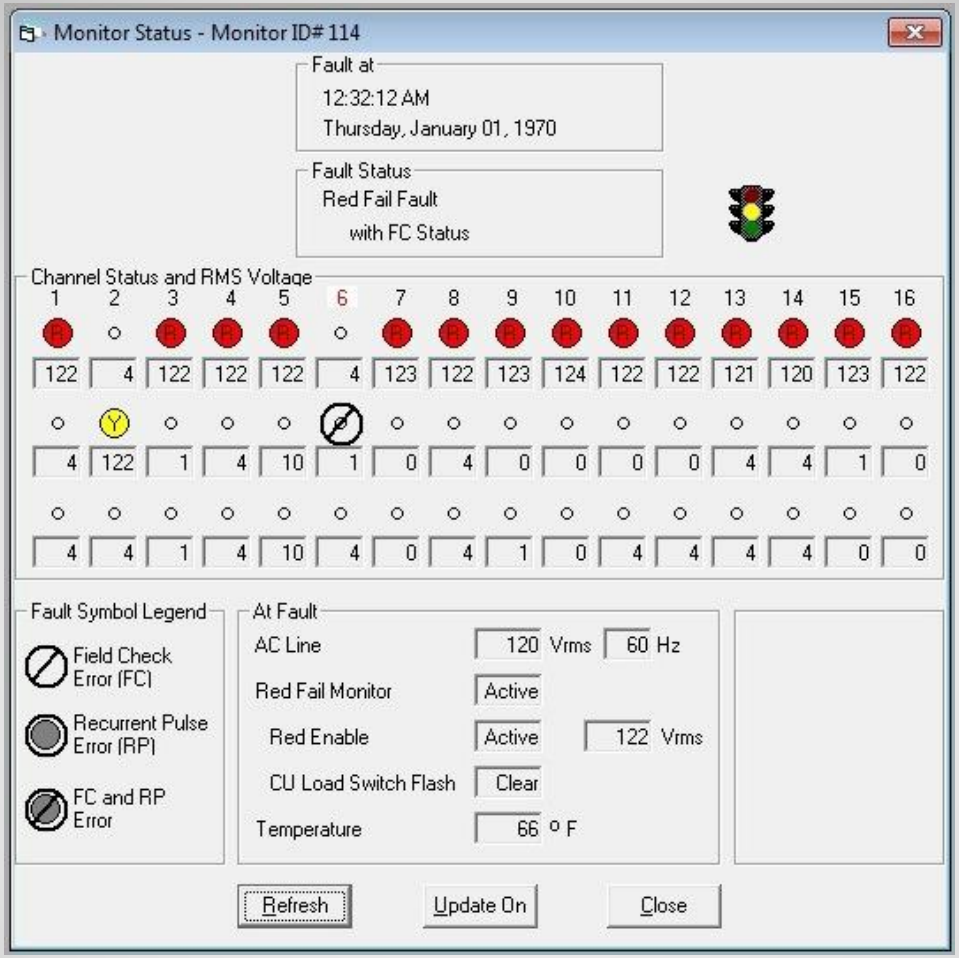
MMU acts like 48 individual Volt meters on every signal output



Phases 2 + 6 Normal Operation




Monitor Status - Monitor ID# 114
Fault at
12:27:30 AM
Thursday, January 01, 1970
Fault Status
Conflict Fault
with FC Status
Channel Status and RMS Voltage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
4 122 123 122 10 121 124 122 123 124 122 122 121 121 123 122
4 4 1 4 10 122 1 4 0 0 1 1 4 4 0 1
122 4 0 4 122 4 1 4 1 1 4 4 4 4 0 0
Fault Symbol Legend
Field Check Error (FC)
Recurrent Pulse Error (RP)
FC and RP Error
At Fault
AC Line 119 Vrms 60 Hz
Red Fail Monitor Active
Red Enable Active 122 Vrms
CU Load Switch Flash Clear
Temperature 65 ° F
Refresh
Update On
Close

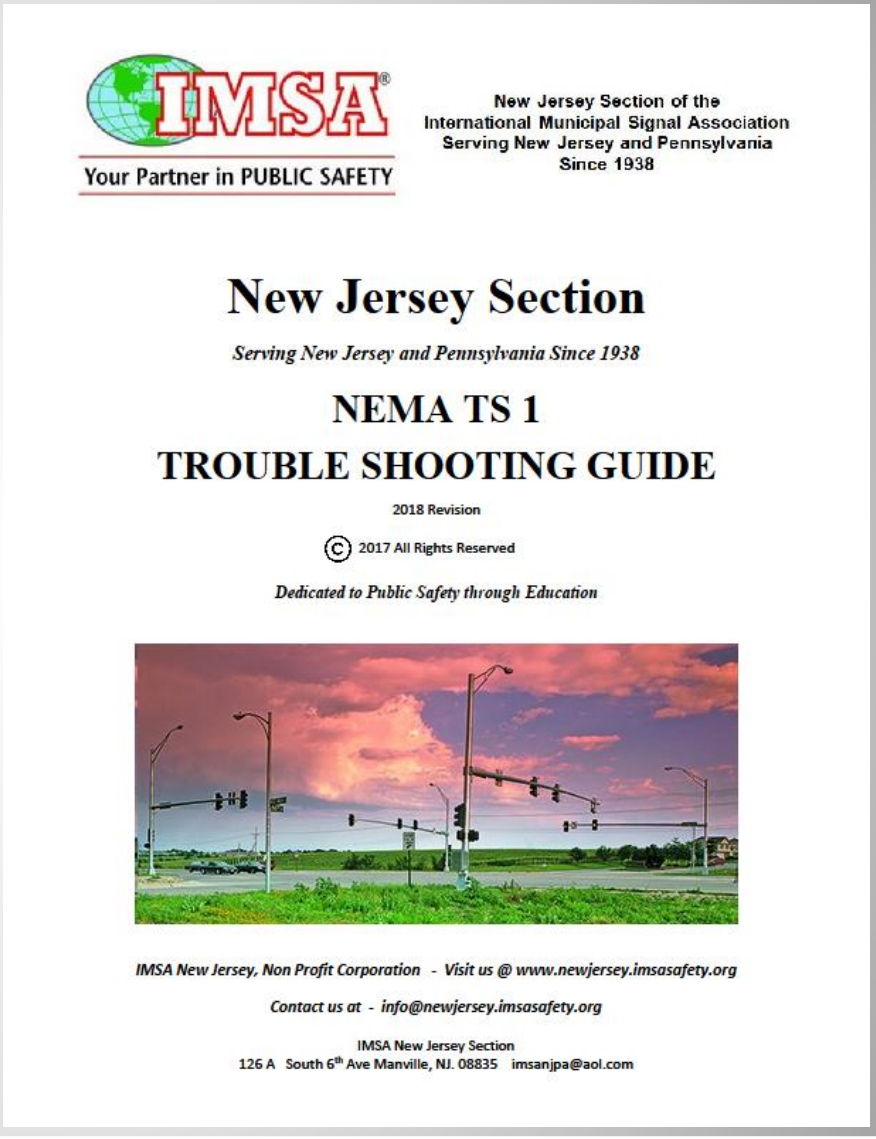

Monitor Status - Monitor ID# 114
Fault at
12:32:12 AM
Thursday, January 01, 1970
Fault Status
Red Fail Fault
with FC Status
Channel Status and RMS Voltage
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
122 4 122 122 122 4 123 122 123 124 122 122 121 120 123 122
4 122 1 4 10 1 0 4 0 0 0 0 4 4 1 0
4 4 1 4 10 4 0 4 1 0 4 4 4 4 0 0
Fault Symbol Legend
Field Check Error (FC)
Recurrent Pulse Error (RP)
FC and RP Error
At Fault
AC Line 120 Vrms 60 Hz
Red Fail Monitor Active
Red Enable Active 122 Vrms
CU Load Switch Flash Clear
Temperature 66 ° F
Refresh
Update On
Close

Where do Signal Technicians receive training ?

New Jersey Section of the IMSA

Passed down training within the Department

Local Signal Suppliers



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Your Partner in PUBLIC SAFETY

New Jersey Section of the
International Municipal Signal Association
Serving New Jersey and Pennsylvania
Since 1938

New Jersey Section

Serving New Jersey and Pennsylvania Since 1938

NEMA TS 1

TROUBLE SHOOTING GUIDE

2018 Revision

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Troubleshooting Tips

- Always remember, in a TS 2 facility, the CU and the MMU share responsibility in looking for problems, and either may initiate a flash condition if one is detected.

- The following three steps will usually provide enough information to diagnose most problems in a previously working facility
- Look at the Alarms log
  - Look at the MMU fault log
  - Look at the Ring Status for Rings 1 & 2

- If you are physically at the facility, the indicator LEDS on the MMU and BIUs frequently provide convenient information.

- The CU exerts control over the MMU using the CVM line (Controller Fault Monitor Output). Therefore, the MMU will usually not latch into a fault state for a serious problems first detected by the CU.

Troubleshooting Tips

Example CU Screens
STOPTIME

Ring status Ring 1 and Ring 2

```
RING 1    RING 2    PHS..12345678 90123456
YEL     4 YEL     4 O/N  .O...O.. ........
GAP OUT   GAP OUT   VEH  CCCCCCCC ........
                    PED  RRRRRRRR ........
                    H/O  ........ OOOOOOOO
                     LOCK OUT -
MAX OUT   MAX OUT        STOPTIME - 1/2
```

If the facility is in relay flash, but the load switch LEDs are lit and not flashing, then the MMU has most likely detected a problem before the CU and is holding the CU in stop time. The MMU may, or may not, be latched at this point, depending on what the problem was. The CU logs should have information about the nature of the problem.

Troubleshooting Tips

Example CU Screens

TS 2 DIAG FLSH – NO XIT

Ring status Ring 1 and Ring 2

```
EPAC RING TIMERS   SEQ: 00   F-PRIOR MENU
RING 1    RING 2   PHS..12345678 90123456
MGRN   11 MGRN   11 O/N  ...O...O ........
WALK    3 WALK    3 VEH  CCCCCCC. ........
                    PED  RRR.RRR. ........
                    H/O  ........ OOOOOOOO
PASS    4 PASS    2 TS2 DIAG FLSH - NO XIT
MAX1   31 MAX1   31
```

The controller has detected either a non-recoverable TS 2 error, or has had three occurrences of a fault for an individual T&F BIU. This will require a CU reset either by power cycling, or using the 3, 5, 9 screen. The MMU may, or may not, be latched, depending on the specific problem.

Troubleshooting Tips
Example CU Screens
BIU T&F cable disconnected

```
EPAC SYSTEM - LOCAL ALARMS REPORT
  MM/DD  HH:MM   -------STATUS-------
   4/ 1  15: 3  FRAME 138 FAULT



A-PRV B-NXT WINDOW  C-CLEAR F-PRIOR MENU
```

Frame 138 is associated with T&F BIU #1, so checking the BIU would be the first reasonable troubleshooting step.

Troubleshooting Tips

Example CU Screens

CU SDLC cable disconnected

```
Cable disconnected from CU
EPAC SYSTEM - LOCAL ALARMS REPORT
  MM/DD  HH:MM   -------STATUS-------
   4/ 1  15:12  FRAME 139 FAULT
   4/ 1  15:12  FRAME 128 FAULT
   4/ 1  15:12  DIAG: RESP FRAME FAIL
   4/ 1  15:12  FRAME 129 FAULT
   4/ 1  15:12  DIAG: RESP FRAME FAIL
   4/ 1  15:12  FRAME 138 FAULT
   4/ 1  15:12  FRAME 148 FAULT
   4/ 1  15:12  FRAME 149 FAULT
   4/ 1  15:12  FRAME 150 FAULT
   4/ 1  15:12  FRAME 151 FAULT
   4/ 1  15:12  FRAME 131 FAULT
   4/ 1  15:12  DIAG: RESP FRAME FAIL
   4/ 1  15:12  FRAME 152 FAULT
   4/ 1  15:12  FRAME 153 FAULT
A-PRV B-NXT WINDOW  C-CLEAR F-PRIOR MENU
```

A failure of this magnitude usually indicates an electrical problem with the SDLC bus, or a problem with the CU itself.

The New Tool for the Signal Technician

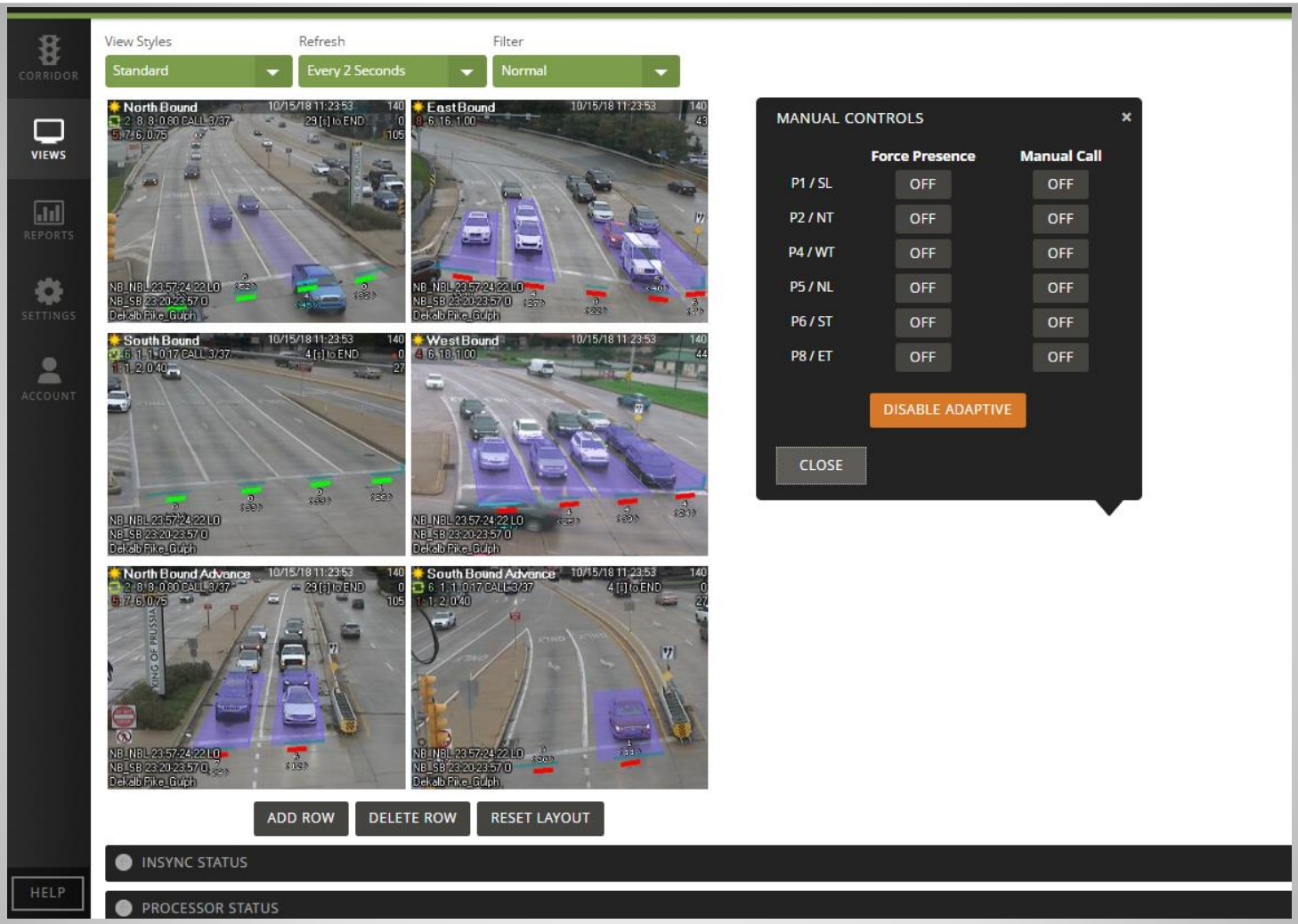
Managed Network Switch

Open all
- CNGE3FE7MS2
- System
  - System Information
  - IP Configuration
  - DHCP Server
  - TFTP Transaction
  - System Event Log
  - Fault Relay Alarm
  - SNTP
  - IP Security
  - User Authentication
  - Digital Input/Output
- Port
  - Port Statistics
  - Port Control
  - Port Trunk
  - Port Mirroring
  - Rate Limiting
- Protocol
  - VLAN
  - RSTP
  - SNMP
  - QoS
  - X-Ring+
  - LLDP
- Security
  - 802.1x/Radius
  - MAC Address Table
- Multicast
  - IGMP/MLD Snooping
  - Static Filtering
- Factory Default
- Save Configuration
- System Reboot

Port Statistics

Port	Type	Link	State	Tx Good Packet	Tx Bad Packet	Rx Good Packet	Rx Bad Packet	Tx Abort Packet	Packet Collision	Packet Dropped	RX Bcast Packet	RX Mcast Packet
Port.01	100TX	Up	Enable	94855562	0	13911246	0	0	0	0	404237	2740639
Port.02	100TX	Down	Enable	0	0	0	0	0	0	0	0	0
Port.03	100TX	Down	Enable	0	0	0	0	0	0	0	0	0
Port.04	100TX	Down	Enable	0	0	0	0	0	0	0	0	0
Port.05	100TX	Down	Enable	0	0	0	0	0	0	0	0	0
Port.06	100TX	Down	Enable	0	0	0	0	0	0	0	0	0
Port.07	1GTX/mGBIC	Down	Enable	0	0	0	0	0	0	0	0	0
Port.08	100TX	Down	Enable	0	0	0	0	0	0	0	0	0
Port.09	1GTX/mGBIC	Up	Enable	25269182	0	98003536	988	0	0	0	9894985	71440887
Port.10	1GTX/mGBIC	Up	Enable	93824071	0	15059956	0	0	0	0	433636	2809341

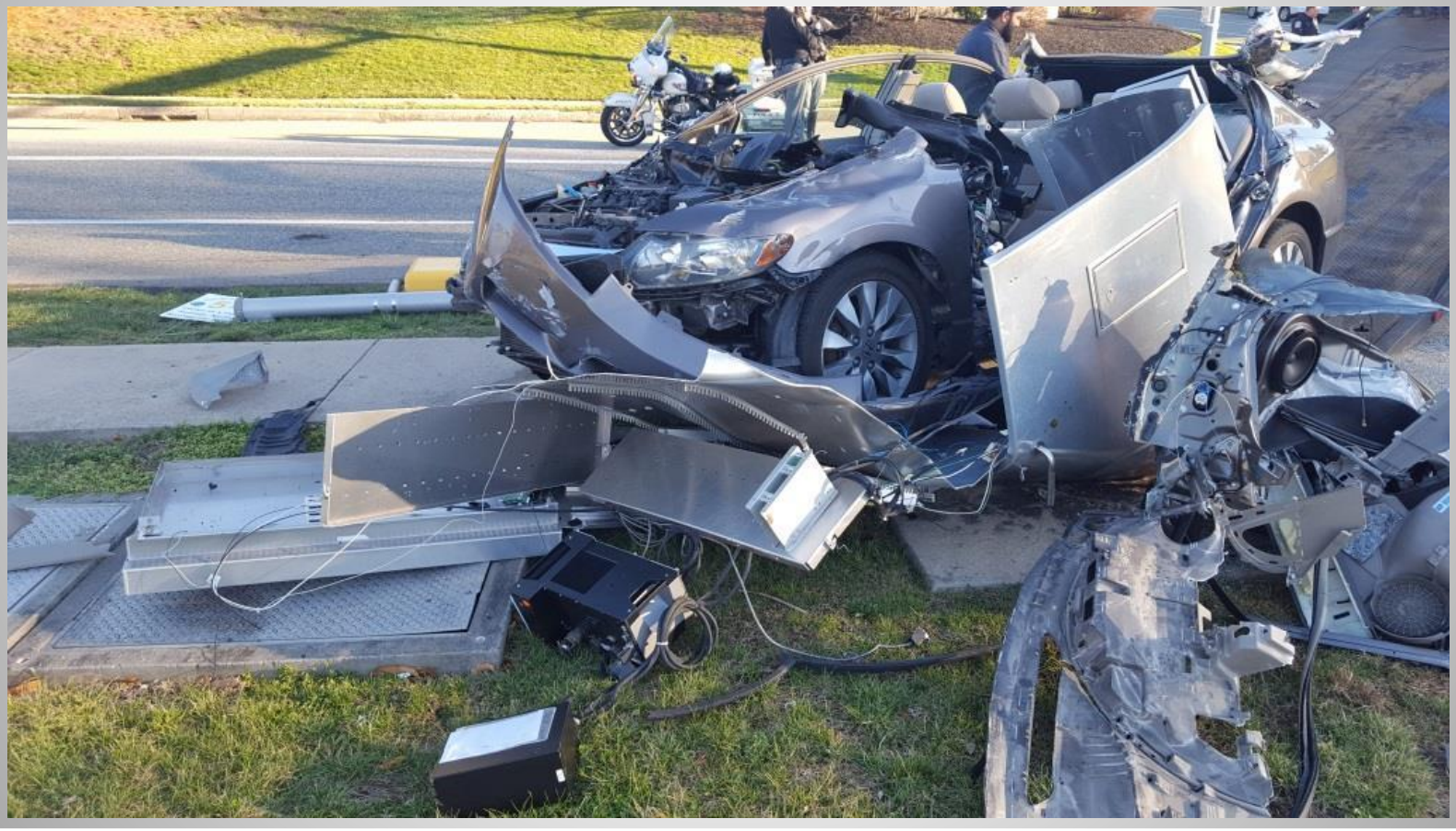
Clear Help



Traffic Adaptive Signals require knowledge of how to operate a computer and some advanced computer skills

Future for the Signal Tech

Complex signal repair



The End