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26 Quick Reference

26.1 General

The quick references are comprised of information, tables, and charts that are contained within the manual. They are placed in this chapter without the accompanied explanation text for experienced signal designers to have quick reference to common design standards.

26.2 Basic Wiring Guidelines

An AC positive (“hot” = “+”) wire and an AC negative (“Neutral” = “-”) wire is required to complete the circuit for each piece of equipment (from the equipment to the power source).

Basic Wiring Guidelines for Individual Conductors			
Note: current standard is to use control cables			
120V Wiring shall be sized for a maximum 3% voltage drop			
120 Volt AC	Signal System Neutral: Poles Over 4" in Diameter	One #8 THWN (-)	Used to complete the circuit for indications in vehicle or pedestrian signals mounted on large signal poles.
	Signal System Neutral: Pedestals 4" in Diameter	One #12 THWN (-)	Used to complete the circuit for indications in vehicle or pedestrian signals mounted on pedestals.
	Vehicle Signals	Three #14 THWN (+)	Typically one wire for each indication color: Red, Yellow, & Green. Certain signal head types require a different number wires. (Note: see signal system neutral)
	Pedestrian Signals	Two #14 THWN (+)	One wire for each indication: walk & flashing don't walk. (Note: See signal system neutral)
	Luminaires	Two #10 XHHW* (120V = + & -) (240V = + & +)	From service cabinet to each luminaire (no daisy chaining). Never routed through the controller cabinet.
	Photoelectric Cells	Three #12 THWN* (+ & -)	From the service cabinet, for the luminaire circuit. Never routed through the controller cabinet.
	Part-Time Restriction Signs	Two #12 THWN* (+ & -)	For each sign.
Low Voltage DC	Power Supply	Two #6 XHHW* (+ & -)	From service cabinet to controller cabinet.
	Pedestrian Pushbuttons	One #14 THWN (+)	For each pedestrian phase.
	Pushbutton Common	One #14 THWN (-)	Used to complete the circuit for pedestrian pushbutton.
	Interconnect	One 6 twisted pair cable (n/a)	Unspliced from controller cabinet to controller cabinet. NOTE: no longer used for new installations or maintained for existing installations.

*Common wire is inclusive to wire count.

26.3 Loop Detector Information

Loop Detector Placement		
Location	Posted Speed (MPH)	Detector Spacing (ft.) from stop bar to center of detection
Mainline Note: If mainline has a shared thru-left turn lane, install stop bar detection in the lane at 5' & 15' in addition to the detection shown for mainline based on posted speed.	25	140
	30	180
	35	110/220
	40	160/320
	45	160/320
	50	190/380
	55	225/450
Right Turn Lane (mainline) Note: not applicable to unsignalized slip lanes		140 (115 if lane is short)
Side Street & Left Turns		5/15/75
Interchange Ramps	Low volume &/or low exit speed	5/15/75/150
	High volume &/or high exit speed	5/15/110/220
Bike Lane (mainline)	15	50
Bike Lane (side street)	10	5/50
Mainline Temporary Bridge (one lane/two-way)		5/15/100 & 65 for bypass loop in opposing lane

*Note: Regions may have a minimum value that is larger than the statewide minimum standard. Verify with Region Traffic and Region Electrical.

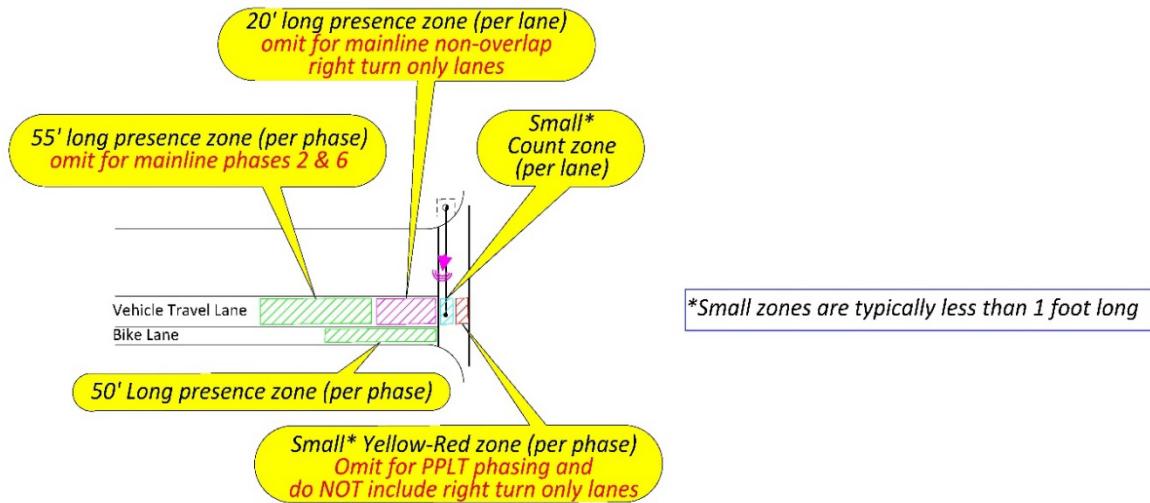
Loop Feeder Cables Allowed in Conduit	
# of Loop Feeders	Conduit Size*
1-5	1 1/2"
6-9	2"
10-13	2 1/2"
14-21	3"

Loop Wire Entrance
Sand Pocket

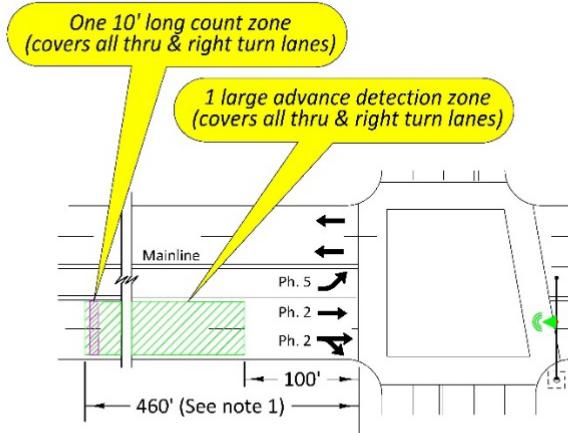
Loop Wires Allowed in Loop Wire Entrance Conduit	
Number of Loops (one loop has 2 loop wires entering the loop wire entrance conduit)	Loop Wire Entrance Conduit Size
1-2 Preformed Loops	2"
3-4 Preformed Loops	2 1/2"
1-4 Standard Loops	2"
5-8 Standard Loops	2 1/2"

Note: If more than 4 preformed loops or more than 8 standard loops need to enter at one location, install multiple loop wire entrances.

26.4 Non-Invasive Detection Information



STANDARD PRESENCE DETECTION (Near-Range Unit)



STANDARD ADVANCE DETECTION (Far-Range Unit)

Notes:

1. Detection that starts 100' from the stop bar and extends a minimum of 460' from the stop bar is acceptable for all posted speeds. However, the standard far-range unit is likely to start detection prior to 100' and is capable of reaching 600'. The alternative far-range unit is capable of reaching 900' if necessary (verify with Region Traffic).
2. If MaxAdapt is used (Verify with Region Traffic), add a Near-Range Unit to provide advance Count Detection Zones as shown below

26.5 Input File Info

26.5.1 Input File for 332S

I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14
J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11	J12	J13	J14
Ø 1 C1-56 MT1 MT13 C1-60 Ø 1	Ø 1 C11-16 MT29 MT30 C11-20 Ø 1	Ø 2 C1-39 MT2 MT3 C1-43 Ø 2	Ø 2 C1-63 MT4 MT5 C1-76 Ø 2	Ø 2 C1-47 MT6 MT31 C11-10 Ø 2	Ø 3 C1-58 MT7 MT14 C1-62 Ø 3	Ø 3 C11-18 MT32 MT33 C11-22 Ø 3	Ø 4 C1-41 MT8 MT9 C1-45 Ø 4	Ø 4 C1-49 MT11 MT34 C1-78 Ø 4	SPARE C11-23 — C11-25 SPARE	SPARE C11-24 — C11-26 SPARE	2 PED C1-67 — C1-69 4 PED	6 PED C1-68 — C1-70 8 PED	
Ø 5 C1-55 MT15 MT27 C1-59 Ø 5	Ø 5 C11-15 MT35 MT36 C11-19 Ø 5	Ø 6 C1-40 MT16 MT17 C1-44 Ø 6	Ø 6 C1-64 MT18 MT19 C1-77 Ø 6	Ø 6 C1-48 MT20 MT37 C11-11 Ø 6	Ø 7 C1-57 MT21 MT28 C1-61 Ø 7	Ø 7 C11-17 MT38 MT39 C11-21 Ø 7	Ø 8 C1-42 MT22 MT23 C1-46 Ø 8	Ø 8 C1-66 MT24 MT25 C1-79 Ø 8	SPARE C1-54 — C1-75 GPS	PCOI C1-51 — C1-52 VCOI	EVA C1-71 — C1-73 EVC	EVB C1-72 — C1-74 EVD	

INPUT FILE I & J (FRONT VIEW)

(NOT TO SCALE)

DEFAULT STANDARD FOR VIDEO DETECTION EQUIPMENT LAYOUT

"I" File	Upper	1	2	3	4	5	6	7	8	9	10	11	12	#	Slot Number
		4 I/O: T	VIP: T	2 I/O: T	4 I/O: T	VIP: T	2 I/O: T	V.R.C.M.	Equip.	Video Equipment					

"J" File	Upper	1	2	3	4	5	6	7	8	9	10	11	12		
		4 I/O: T	VIP: T	2 I/O: T	4 I/O: T	VIP: T	2 I/O: T								

Definitions:

VIP = Video Image Processor
2 I/O = 2 channel Input/Output Module
4 I/O = 4 channel Input/Output Module
T = camera
V.R.C.M. = Video Remote Communications Module

26.5.2 Input File for 332

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 E,C MT1 C1-56	2 E,C C1-39 MT2 C1-43	2 E,C C1-63 MT4 C1-76	2 C MT6 C1-47	3 E,C MT7 C1-58	4 E,C C1-41 MT8 C1-45	4 E,C C1-65 MT10 C1-78	4 C C1-49	1 E,C C1-60 MT13 C1-62	2 Ped C1-67	6 Ped C1-68 C1-69			
1 E,C C1-43 2 E,C	2 E,C C1-39 MT2 C1-43	2 E,C C1-63 MT4 C1-76	2 C MT6 C1-47	3 E,C MT7 C1-58	4 E,C C1-41 MT8 C1-45	4 E,C C1-65 MT10 C1-78	4 C C1-49	1 E,C C1-60 MT13 C1-62	2 Ped C1-67	6 Ped C1-68 C1-69	4 Ped C1-70	8 Ped	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
5 E,C MT15 C1-55	6 E,C C1-40 MT16 C1-44	6 E,C C1-64 MT18 C1-77	6 C MT20 C1-48	7 E,C MT21 C1-57	8 E,C C1-42 MT22 C1-46	8 E,C C1-66 MT24 C1-79	8 C MT26 C1-50	5 E,C C1-59 MT27 C1-61	C1-54 C1-75	EVA C1-71 C1-73	EVB C1-72 C1-74		
5 E,C C1-44 6 E,C	6 E,C C1-40 MT16 C1-44	6 E,C C1-64 MT18 C1-77	6 C MT20 C1-48	7 E,C MT21 C1-57	8 E,C C1-42 MT22 C1-46	8 E,C C1-66 MT24 C1-79	8 C MT26 C1-50	5 E,C C1-59 MT27 C1-61	C1-54 C1-75	EVA C1-71 C1-73	EVB C1-72 C1-74		

Channel 1
Input File "I"
Channel 2

Channel 1
Input File "J"
Channel 2

DEFAULT STANDARD FOR VIDEO DETECTION EQUIPMENT LAYOUT

"I" File	Upper	1	2	3	4	5	6	7	8	9	10	11	
		2 I/O: T Ph. 2	VIP: T Ph. 2 Ph. 2		4 I/O: T Ph.5 Ph.5		VIP: T Ph. 4 Ph. 4		4 I/O: T Ph.4 Ph. 7		V.R.C.M.		
		Lower	Ph. 2	Ph. 2	Ph. 2	Ph. 2	Ph. 4	Ph. 4	Ph. 4	Ph. 4	Ph. 7		
"J" File	Upper	1	2	3	4	5	6	7	8	9	10	11	
		2 I/O: T Ph. 6	VIP: T Ph. 6 Ph. 6		4 I/O: T Ph.1 Ph.1		VIP: T Ph. 8 Ph. 8		4 I/O: T Ph.8 Ph. 3				
		Lower	Ph. 6	Ph. 6	Ph. 6	Ph. 6	Ph. 8	Ph. 8	Ph. 8	Ph. 3			

Note: video layout phase assignment is different than the default standard phase assignment shown above.

Definitions:

VIP = Video Image Processor
2 I/O = 2 channel Input/Output Module
4 I/O = 4 channel Input/Output Module
T = camera
V.R.C.M. = Video Remote Communications Module

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26.5.3 Input File for 336

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 E,C	2 E,C	3 E,C	4 E,C	5 E,C	6 E,C	7 E,C	8 E,C	2 E,C	4 E,C	EVA	EVB	2 Ped	6 Ped
CI-56 MT1 MT13 CI-60	CI-39 MT2 MT3 CI-43	CI-58 MT7 MT14 CI-62	CI-41 MT8 MT9 CI-45	CI-55 MT15 MT27 CI-59	CI-40 MT16 MT17 CI-44	CI-57 MT21 MT28 CI-61	CI-42 MT22 MT23 CI-46	CI-63 MT4 MT18 CI-64	CI-65 MT10 MT24 CI-66	CI-71 — CI-73	CI-72 — CI-74	CI-67 — CI-69	CI-68 — CI-70
1 E,C	2 E,C	3 E,C	4 E,C	5 E,C	6 E,C	7 E,C	8 E,C	6 E,C	8 E,C	EVC	EVD	4 Ped	8 Ped

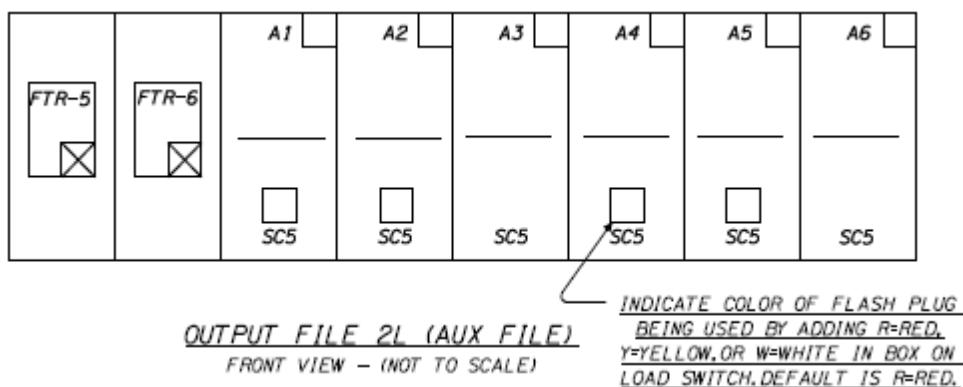
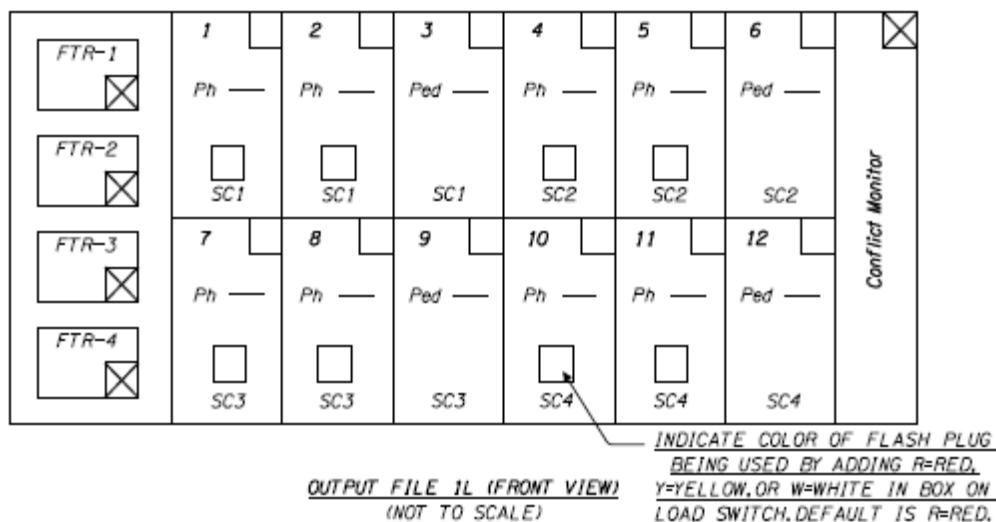
Channel 1

INPUT FILE

Channel 2

26.6 332S and 332 Cabinet Limitations – Output File

1. 18 switch packs
2. 16 are conflict monitored
 - a. Switch packs A3 and A6 are not monitored
 - b. 2018 monitor can be used in extreme cases for all 18 switch packs
3. 12 have the ability to cabinet flash via flash plugs
 - a. Switch packs 3, 6, 9, 12, A3, and A6 go dark in cabinet flash



26.7 332S and 332 Cabinet Limitations – Input File

1. 28 vehicle inputs for a 332 using 9 slots and 2 input files

a. Slots 10, I11, and 14 have no inputs

- Slots 1, 4, 5, and 8 have one input per slot (not two)
- 4 ped
- 4 EV
- 2 rail – indirect via 4 C1 pins using a 252 Isolator
- 0 spares

2. 40 vehicle inputs for a 332S using 10 slots and 2 input files

a. All 14 slots are populated with C1 and C11 pins

- 4 ped
- 4 EV
- 2 rail – direct via 2 C1 pins using inverting a 255 Isolator
- 1 GPS
- 5 spares

332 cabinet

1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 E,C C1-56 VD1	2 E,C C1-39 VD10	2 E,C C1-63 VD11	2 C C1-47 VD13	3 E,C C1-58 VD15	4 E,C C1-41 VD16	4 C C1-65 VD17	4 C C1-49 VD18	1 E,C C1-60 VD4	2 Ped C1-67	6 Ped C1-68			
1 E,C C1-43 VD2	2 E,C C1-76 VD2	2 C C1-43 VD2	3 E,C C1-58 VD3	4 E,C C1-45 VD4	4 E,C C1-45 VD5	4 E,C C1-78 VD6	4 C C1-43 VD7	3 E,C C1-62 VD8	C1-69	C1-70			
									4 Ped C1-67	8 Ped C1-68			
1	2	3	4	5	6	7	8	9	10	11	12	13	14
5 E,C C1-55 VD5	6 E,C C1-63 VD19	6 E,C C1-64 VD20	6 C C1-48 VD23	7 E,C C1-57 VD7	8 E,C C1-42 VD24	8 E,C C1-66 VD25	8 C C1-79 VD27	5 E,C C1-59 VD6	12 Ped C1-54	EV A C1-71	EV B C1-72		
5 E,C C1-44 VD6	6 E,C C1-77 VD22	6 E C1-77	6 C C1-48	7 E,C C1-57	8 E,C C1-46	8 E,C C1-79	8 E C1-79	6 E,C C1-61 VD8	C1-75	C1-73	C1-74		

332S cabinet

I1	I2	I3	I4	I5	I6	I7	I8	I9	I10	I11	I12	I13	I14
Φ 1 C1-56 VD1	Φ 1 C1-16 VD29	Φ 2 C1-39 VD30	Φ 2 C1-63 VD10	Φ 2 C1-47 VD11	Φ 3 C1-58 VD31	Φ 3 C1-18 VD32	Φ 4 C1-65 VD15	Φ 4 C1-49 VD17	SPARE C11-23	SPARE C11-24	2 PED C1-67	6 PED C1-68	
Φ 1 C1-60 VD2	Φ 1 C1-20	Φ 1 C1-43	Φ 2 C1-76	Φ 2 C1-10	Φ 3 C1-62	Φ 3 C1-22	Φ 4 C1-45	Φ 4 C1-4	C11-12	C11-25	C11-26	C1-69	C1-70
												4 PED C1-67	8 PED C1-68
J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11	J12	J13	J14
Φ 5 C1-55 VD5	Φ 5 C1-15 VD35	Φ 6 C1-40 VD19	Φ 6 C1-64 VD21	Φ 6 C1-48 VD23	Φ 7 C1-57 VD7	Φ 7 C1-17 VD38	Φ 8 C1-42 VD24	Φ 8 C1-66 VD26	SPARE C1-54	PCOI C1-51	EVA C1-71	EV B C1-72	
Φ 5 C1-59 VD6	Φ 5 C1-19	Φ 6 C1-44	Φ 6 C1-77	Φ 6 C1-11	Φ 7 C1-61	Φ 7 C1-21	Φ 8 C1-46	Φ 8 C1-79	C11-13	C1-75	C1-52 GPS VCOI	C1-73 EVC	C1-74 EVD

INPUT FILE I & J (FRONT VIEW)

26.8 332S and 332 Cabinet Limitations – Conflict Monitor

1. 16 channels with 32 outputs of conflict monitoring (green & yellow)
 - a. Monitor all green, flashing yellow arrow, and walk indications
 - b. Do not monitor solid yellows (exception: solid yellow cannot be separated from the flashing yellow arrow when using a center flash signal head and therefore will be monitored)
2. Flashing yellow arrow
 - a. Use the overlap green outputs

Example

- 3 section FYA signal head on Phase 1 (center flash)
 - Use R & G outputs on switch pack 1 (phase 1)
 - Monitor G on channel 1
 - Use G output on switch pack A1 (OLA) for FYA and solid YA
 - Monitor FYA/YA on channel 9

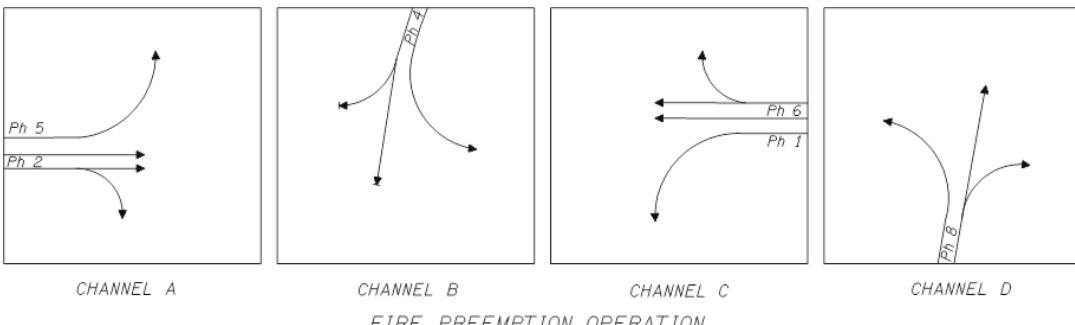
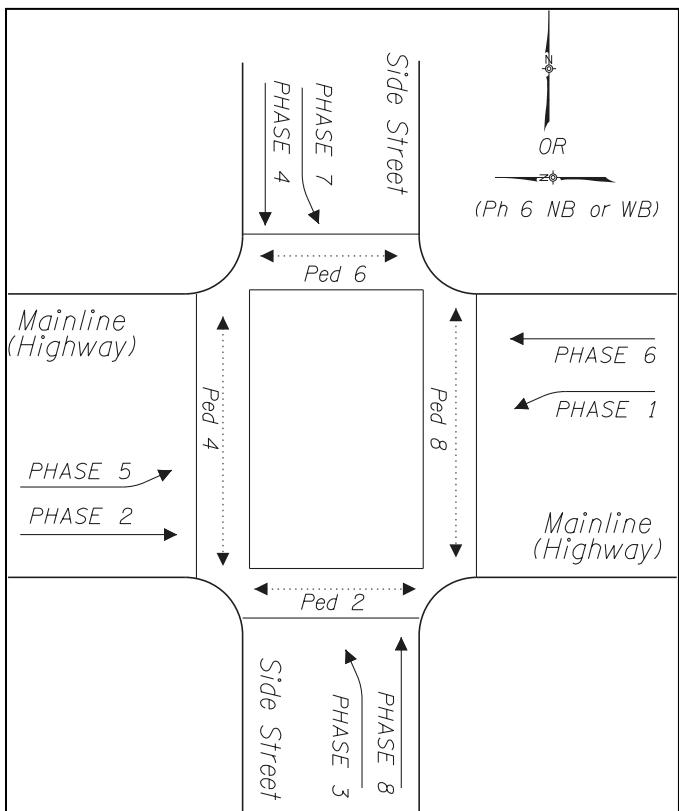
CONFLICT MONITOR – TYPICAL CONNECTOR PIN ASSIGNMENTS		
Term	Function	Pin
130	SP2-G	1
115	SP3-W	2
135	SP8-Y	3
103	SP5-G	4
106	SP6-W	5
108	SP-11Y	6
133	SP7-G	7
114	SP3-Y	8
126	SP1-Y	9
124	SP10-G	10
105	SP6-Y	11
117	SP4-Y	12
A123	ASP1-G	13
–	NC	14
–	T&B	15
–	T&B	16
–	NC	17
–	T&B	18
–	NC	19
TB01-9	EQ Gnd	20
TB01-10	AC-	21
C4-37	Watch Dog	22
TB02-1	+24VDC	23
LRColl	Interlock	24
TB02-2	Interlock	25
–	NC	26
–	NC	27
TB01-11	Norm. Closed	28

CHANNEL ASSIGNMENTS (TYPICAL)		
Ch	PH	
1	1	
2	2	
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	OLA, Ø1FYA/YA	
10	ØLB, Ø3FYA/YA	
11	OLC, Ø5FYA/YA	
12	OLD, Ø7FYA/YA	
13	2PED	
14	4PED	
15	6PED	
16	8PED	
T&B – Tied & Bundled		

CONFLICT MONITOR

CONFLICT MONITOR DIODE CARD							
CHANNEL ASSIGNMENT							
Ch.1	Ch.5	Ch.9	Ch.13	Ch.2	Ch.6	Ch.10	Ch.14
Ch.3	Ch.7	Ch.11	Ch.15	Ch.4	Ch.8	Ch.12	Ch.16
YELLOW INHIBIT JUMPERS							
1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
DIODES – Diode Removed Makes Movement Allowable (Diode IN4148)							
1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9
1-3	2-4	3-5	4-6	5-7	6-8	7-9	8-10
1-4	2-5	3-6	4-7	5-8	6-9	7-10	8-11
1-5	2-6	3-7	4-8	5-9	6-10	7-11	8-12
1-6	2-7	3-8	4-9	5-10	6-11	7-12	8-13
1-7	2-8	3-9	4-10	5-11	6-12	7-13	8-14
1-8	2-9	3-10	4-11	5-12	6-13	7-14	8-15
1-9	2-10	3-11	4-12	5-13	6-14	7-15	8-16
1-10	2-11	3-12	4-13	5-14	6-15	7-16	9-16
1-11	2-12	3-13	4-14	5-15	6-16	10-16	9-15
1-12	2-13	3-14	4-15	5-16	11-16	10-15	9-14
1-13	2-14	3-15	4-16	12-16	11-15	10-14	9-13
1-14	2-15	3-16	13-16	12-15	11-14	10-13	9-12
1-15	2-16	14-16	13-15	12-14	11-13	10-12	9-11
1-16	15-16	14-15	13-14	12-13	11-12	10-11	9-10

26.9 Phasing Standards



26.10 Signal Pole & Signal Head Information

Signal Head Placement/Spacing Dimensions	
From the stop line to signal face	45' minimum
From the stop line to signal face	180' or greater requires a near-side head
Spacing of heads for the same phase	8' minimum, 10' desirable
Spacing of heads to adjacent phase	6'-12' desirable
Spacing of heads (except Type 4L head) to adjacent sign	3' minimum
Spacing of Type 4L head to adjacent sign	4' minimum

Signal Pole Placement	
18" minimum from face of curb to any equipment mounted on pole.	
5' recommended minimum from face of curb	
6' recommended minimum from EP	
5' recommended minimum clearance on all sides of a raised island	

Mast Arms		
Mast Arm Length	Std. Dwg. TM650	Pole Type W/Illum.
	Pole Type	
15'	SM1	SM1L
20'	SM2	SM2L
25'	SM2	SM2L
30'	SM3	SM3L
35'	SM3	SM3L
40'	SM4	SM4L
45'	SM4	SM4L
50'	SM5	SM5L
55'	SM5	SM5L
Std. Dwg. TM655		
60'	N/A	SM6L
65'	N/A	SM6L
70'	N/A	SM7L
75'	N/A	SM7L

26.11 Sign Information

SIGN NUMBERS & SIZE (signs beginning with an "O" are Oregon specific)	SIGN TYPES			RECOMMENDED OR REQUIRED
	Aluminum	Part Time Restriction	RECOMMENDED OR REQUIRED	
R6-2L 30"x36"	ONE WAY 	(AL 1L)		Required for one-way streets. One way signs can be installed on the mast arm (R6-2L) OR ground mounted (R6-1L). See MUTCD 2B.40(P10)
R6-2R 30"x36"	ONE WAY 	(AL 1R)		Required for one-way streets. One way signs can be installed on the mast arm (R6-2R) OR ground mounted (R6-1R). See MUTCD 2B.40(P10)
R10-11A 30"x36"	NO TURN ON RED 	(AL 3)		Region Traffic Engineer Operational Approval Required
OR3-12 30"x36"	U TURN PERMITTED 	(AL 3U)		State Traffic-Roadway Engineer Operational Approval Required
R5-2 30"x30"		(AL 3T)		State Traffic-Roadway Engineer Operational Approval Required (typically used in conjunction with U-turn permitted sign)
OR3-5TD 30"x36"		(AL 4)		
R3-6L 30"x36"		(AL 4L)		
R3-6R 30"x36"		(AL 4R)		
OR3-5TT 30"x36"		(AL 4T)		
R3-5L 30"x36"		(AL 5L)		Required for a trap lane (where a through lane becomes a mandatory turn lane at the intersection) if the trap lane does not have a signal head with arrow indications
R3-5R 30"x36"		(AL 5R)		Required for a trap lane (where a through lane becomes a mandatory turn lane at the intersection) if the trap lane does not have a signal head with arrow indications
R3-5A 30"x36"		(AL 5T)		
R3-3 36"x36"	NO TURNS 	(AL 6)		Use of appropriate lane use signs is preferred over R3-3
R3-2 36"x36"		(AL 6L)	(PR 6L)	Use of appropriate lane use signs is preferred over R3-2. PTR version used for RxR applications
R3-1 36"x36"		(AL 6R)	(PR 6R)	Use of appropriate lane use signs is preferred over R3-1. PTR version used for RxR applications
R5-1 36"x36"		(AL 7)		
R10-28 24"x30"	ONE VEHICLE PER GREEN 	(AL 8)		For overhead mounting
OR20-1 24"x12"	ONE VEHICLE PER GREEN 	(AL 8S)		
R10-6 24"x36"		(AL 9)		
R10-12 30"x36"		(AL 11)		Required with a Type 4L signal head. Recommended when a permissive left turn phase has an exclusive left turn lane or a Type 7 signal is used. Optional otherwise.
R10-15a 30"x30"		(AL 12)		Required with a Type 5 signal head
W3-8 36"x36"		(AL 16)		
OR20-5 24"x30"	FORM 2 LANES WHEN METERED 	(AL 17)		
W3-4 36"x36"		(AL 18)		
W16-13p 24"x18"	WHEN FLASHING 	(AL 19)		
R3-7a 24"x12"	EXCEPT BUSES 	(AL 20)		

SIGNS NO LONGER USED	
OR10-10L 30"x36"	LEFT TURN SIGNAL
OR10-10R 30"x36"	RIGHT TURN SIGNAL
OR17-1 30"x36"	"LEFT TURN YIELD TO ONCOMING TRAFFIC" sign replaced by R10-12
OR22-14 30"x36"	"RIGHT TURN YIELD TO PEDS ON GREEN ball symbol" sign replaced by OR10-15

26.12 Junction Box & Conduit Information

Minimum Junction Box Type/Size	
Type/Size	Location/use
JB-3T: Two (Tandem) 30"x17"x12" boxes	The same quadrant as the signal controller: first access point for all signal, detector, and interconnect circuits.
JB-2: Single 22"x12"x12" box	All quadrants without the signal controller: secondary access point for signal, detector, and/or interconnect circuits
JB-1: Single 17"x10"x12" box	All approach legs: detector and/or interconnect circuits

Type	Size	Total Conduit Diameters Allowed (Inches)	Remarks	Material
JB-1	17"x10"x12"	12	Non-traffic areas only	Concrete
JB-2	22"x12"x12"	18	Non-traffic areas only	Concrete
JB-3	30"x17"x12"	34	Non-traffic areas only	Concrete

Junction Box Spacing
300' maximum spacing. Check with the region electrical crew for the preferred spacing.

Conduit Requirements*	
Conduit crossing mainline or side street	2" minimum
Spare conduit from large signal pole to nearest junction box (if alternative detection is NOT used on project)	2"
Spare conduit from controller cabinet to nearest junction box	2"
Minimum conduit size allowed	1 1/2"
Maximum conduit size allowed	3"
Max wire fill for new conduits	70% of NEC maximum
Max wire fill for existing conduits	100% of NEC maximum

*Note: Regions may have a minimum value that is larger than the statewide minimum standard. Verify with region traffic and region electrical crew.

26.13 Electrical Crew Preferences

The electrical crew that will be maintaining the signal (ODOT or local agency) shall have a chance to review and comment on signal plans during the design phase. Send plan sheets directly to the electrical crew lead/manager or ensure that they are included on the plan distribution list for project milestone reviews. Use the following checklist as a guide for verifying the electrical crew preferences.

Electrical Crew Design Preferences to Verify		Section in Manual for More Information
1	Any existing equipment that should be removed and/or replaced	4.2
2	Equipment to salvage and location to stockpile	4.2, 10.2, & 19.4
3	Equipment that may be removed and relocated	4.2 & 10.5
4	Need for a maintenance pad	5.1.7
5	Vehicle and pedestrian signal material (aluminum or polycarbonate)	5.2.2 & 5.4.13
6	Utility clearances below ODOT default standard, but still meeting NESC requirements	5.5.4
7	Illumination mounting height, LED fixture, and fixture wattage	5.6 & 5.6.1
8	Need for battery back-up	5.9
9	Controller cabinet location	5.10.1
10	Junction box location and preferred spacing of junction boxes	5.12.2
11	Feasibility of reusing any existing wiring, splicing new conduit to existing conduit, or adjustments of existing junction boxes	5.12.4 & 5.13.5
12	Feasibility of adding new wire to existing conduit (conduit condition and wire fill)	5.13.1
13	Need for conduit sizes above the ODOT default standard	5.13.1
14	Need for any unique site specific bonding/grounding	5.14.4
15	Radar cable splice preference when there is no RTC on pole	6.8
16	Terminal cabinet orientation (when it cannot be placed at the default standard 180 degrees)	9.3.2
17	Flashing beacon power source of commercial or solar	12.4
18	Maintenance access to ramp meter detector units	13.6.1

26.14 Salvage Cost Estimate Equations (LPIF)

Salvage Cost Estimate Equations					
For each salvaged item, calculate and use the highest value of the 2 equations					
Depreciated Value Based on Service Life	Salvage Cost Estimate 1 = $\frac{\text{Service Life}^{(a)} - \text{Item Age}^{(b)}}{\text{Service Life}^{(a)}} \times \text{Cost of New Item}^{(c)} \times \text{Depreciation Factor}^{(d)}$				
Scrap Value Based on Material Recycling	Salvage Cost Estimate 2 ^(e) = $\frac{\text{Quantity of item}^{(f)} \times \text{Scrap Cost Per Quantity}^{(g)}}{\text{Per Quantity}^{(g)}}$				
<p>a: Use the following values (Contact the state traffic engineer for service life information of other items):</p> <ul style="list-style-type: none"> * 50 yrs for a large pole or steel structure * 10 yrs for a controller cabinet * 5 yrs for radar * 3 yrs for video detection <p>If the item age is greater than or equal to the service life, equation 1 = \$0</p> <p>b: Use as-built plans or maintenance history to determine the item age</p> <p>c: Use recent project cost data or signal cost estimating tools to determine the cost of a new item</p> <p>d: Use the following depreciation factors:</p> <ul style="list-style-type: none"> * 0.03 for 1st generation standard (e.g. truss arm, custom cabinet, radar/video model no longer sold, etc.) * 0.05 for 2nd generation standard (e.g., curved mast arm, 336 cabinet, etc.) * 0.10 for 3rd generation standard (e.g., 4-bolt base pole, 332 cabinet, etc.) * 0.30 for current standard (e.g. 8-bolt base pole, 332S cabinet, etc.) <p>e: Equation 2 is typically applicable for large poles (steel scrap value). All other traffic signal items that are commonly salvaged are of a material type or quantity that is not economical to seek scrap value.</p> <p>f: Use industry standard for recycling material (e.g. pounds of steel)</p> <p>g: Use recent industry data</p>					

26.15 Final Design/Drafting Checklist

Before submitting plans for design review/approval (see chapter 2), use the following checklist.

Signal Design/Drafting Checklist			For Information See:
APPROVALS			
	1	RTE/STE Operational approval(s) complete & plans match PSOD (phasing, crosswalk closures, fire preemption, etc.)	Section 3.1 and 5.7
	2	Loop detection is approved by the state traffic signal engineer and correctly detailed	Section 6.1.1
	3	LPIF documentation complete	Section 19.4
COORDINATION WITH OTHERS			
	4	Coordination with ITS unit on interconnect/communication plan is complete	Chapter 7
	5	Coordination with workzone designer is complete (temporary features, staggering a signal turn-on to avoid obstructing the view of existing signal indications, etc.)	Chapter 11
	6	Coordination with sign designer is complete (custom signs, determining bid items)	Section 5.3 & 5.3.2
	7	Coordination with geotech designer is complete (pole foundations)	Section 9.3.4
	8	Coordination with roadway designer and striping designer is complete (ADA ramps, turning templates, accesses, lane shifts, raised medians, stop bars, crosswalks, crosswalk closures, walkways for controller cabinet and BMCs as per TM482, etc.)	Section 5.1, 5.4, & 5.10.1
	9	Coordination with illumination designer is complete	Section 5.6
	10	Coordination with region utility specialist and utility is complete	Section 5.5.4
	11	Coordination with region mobility liaison is complete (overhead vertical clearance)	Section 5.5.2
	12	Coordination with region electrical crew maintaining the installation is complete	Section 2.9
	13	Coordination with region signal timer is complete (detection zone needs)	Chapter 6 & Chapter 20
BASIC DRAFTING – LAYOUT AND INFORMATION			
	14	M series plan sheets in correct order	Section 21.7.2
	15	All sheets are clear and easy to read (no inappropriate overlapping of features/bubble notes, unnecessary layers turned off, clutter minimized, etc.)	Chapter 21.2
	16	All sheets meet basic drafting layout and info requirements (sheet scale, upper right title info, sheet title, north arrow, stationing/scale bar, lane use arrows, street names, striping, right-of-way, etc.)	Multiple subsections in Section 21.7
	17	Current, standard symbology and bubble notes as per MicroStation workflow are used. Customization is limited to only what is necessary	Sections 21.4, 21.8.1, & 21.9
	18	All bubble note variables have been filled out correctly on the plan sheets	Section 21.9.1
	19	Reference bubble notes (EC, DC, IC, JB/SP, JB/DP, JB/IP, C, etc.) and cross reference text (see sheet MXX for legend) are used when necessary	Sections 21.3, 21.7.13 & 21.9.4
	20	All title block information is complete	Section 21.7.3
	21	List of applicable standard drawings is complete ("accompanied by dwgs. box")	Section 21.7.5
	22	All digital signature blocks for EOR and traffic engineering section approval are complete	Section 21.7.4
	23	Specifications, bid items, and cost estimate complete	Chapter 19
PLAN SHEET AND DESIGN ELEMENT SPECIFIC DRAFTING			
	24	Statewide goals, priority and implementation have been incorporated into project	Section 4.1.2
	25	All bubble notes used in the plan sheets are listed in the legend	Section 21.10.1
	26	All Phase rotation diagrams and fire preemption diagrams complete	Sections 3.3 & 3.4
	27	All poles and pedestals numbered	Section 21.8.3
	28	All illumination equipment location and detailing correct	Section 5.6
	29	All signal head type, phase, location, and detailing correct	Sections 5.2, 21.9.1 & 21.9.2
	30	All pedestrian signal heads and pushbutton location, phase and detailing correct	Section 5.4*
	31	All sign size, message, location, and detailing correct	Section 5.3
	32	All fire preemption equipment location and detailing correct	Section 5.7
	33	All non-invasive detection equipment location, type, mount and detailing is correct	Chapter 6
	34	Pole entrance chart complete	Section 21.10.8 & Chapter 9
	35	All service cabinet locations and detailing correct	Sections 5.8 & 5.11
	36	All controller cabinet location, orientation, and detailing correct	Section 5.10
	37	All Cabinet prints are complete (detection zones shown, etc.)	Chapter 20
	38	All Junction box location, size and detailing correct	Section 5.12*
	39	All Conduit routing, size, future/spare, and detailing is correct	Sections 5.13* & 21.8.2
	40	All wire/cable number, type, gauge and detailing is correct for ALL equipment	Section 5.14*
	41	Existing utility plan sheet complete	Section 21.10.7
	42	Railroad preemption plan sheet complete	Section 21.10.6 & Chapter 16
	43	All standard details necessary for project are incorporated into a DETAIL sheet	Section 9.5

*Also see application specific sections of the manual such as fire preemption, railroad, PTR signs, RRFB, etc.