

NEMA TS 2-2003 (R2008)

Traffic Controller Assemblies with NTCIP Requirements - Version 02.06



NEMA Standards Publication TS 2-2003 (R2008)

*Traffic Controller Assemblies
with NTCIP Requirements
Version 02.06*

Published by:

National Electrical Manufacturers Association
1300 North 17th Street, Suite 1752
Rosslyn, Virginia 22209

www.nema.org

© Copyright 2012 by the National Electrical Manufacturers Association. All rights including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention or the Protection of Literary and Artistic Works, and the International and Pan American Copyright Conventions.

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

The National Electrical Manufacturers Association (NEMA) standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While NEMA administers the process and establishes rules to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

NEMA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. NEMA disclaims and makes no guaranty or warranty, expressed or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety-related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

CONTENTS

	Page
Foreword	xv
Scope	xvi
History	xix
TS 2-1998 Update	xxi
TS 2-2003 Update	xxii

Section 1 DEFINITIONS

1.1 Control Equipment	1
1.1.1 Auxiliary Equipment	1
1.1.2 Barrier	1
1.1.3 Cabinet	1
1.1.4 Call	1
1.1.4.1 Serviceable Conflicting Call	1
1.1.5 Check	1
1.1.6 Connector	1
1.1.6.1 Not Used Connections	1
1.1.6.2 Reserved Connections	2
1.1.6.3 Spare Connections	2
1.1.7 Controller Assembly	2
1.1.7.1 Flasher Controller Assembly	2
1.1.7.2 Full-Traffic-Actuated Controller Assembly	2
1.1.7.3 Isolated Controller Assembly	2
1.1.7.4 Master Controller Assembly	2
1.1.7.5 Master-Secondary Controller Assembly	2
1.1.7.6 Occupancy Controller Assembly	2
1.1.7.7 Pedestrian-Actuated Controller Assembly	2
1.1.7.8 Pretimed Controller Assembly	2
1.1.7.9 Secondary Controller Assembly (Slave)	2
1.1.7.10 Semi-Traffic-Actuated Controller Assembly	3
1.1.7.11 Traffic-Actuated Controller Assembly	3
1.1.8 Controller Unit	3
1.1.8.1 Digital Controller Unit	3
1.1.8.2 Multi-Ring Controller Unit	3
1.1.8.3 Single-Ring Controller Unit	3
1.1.9 Coordination	3
1.1.10 Coordinator	3
1.1.11 Cycle	3
1.1.11.1 Cycle Length	3
1.1.12 Density	3
1.1.13 Detector	3
1.1.14 Device	3
1.1.14.1 Electromechanical Device	3
1.1.14.2 Electronic Device	3
1.1.14.3 Solid-State Device	4
1.1.15 Dial	4
1.1.16 Dwell	4
1.1.17 Extension, Unit	4
1.1.18 Entry	4
1.1.18.1 Dual Entry	4
1.1.18.2 Single Entry	4

1.1.19 Flasher	4
1.1.20 Force Off	4
1.1.21 Gap Reduction	4
1.1.22 Hold	4
1.1.23 Interconnect	4
1.1.24 Interval	4
1.1.24.1 Minimum Green Interval	4
1.1.24.2 Pedestrian Clearance Interval	4
1.1.24.3 Red Clearance Interval	4
1.1.24.4 Sequence, Interval	5
1.1.24.5 Yellow Change Interval	5
1.1.25 Manual	5
1.1.25.1 Manual Operation	5
1.1.25.2 Manual Pushbutton	5
1.1.26 Maximum Green	5
1.1.27 Memory	5
1.1.27.1 Detector Memory	5
1.1.27.2 Nonlocking Memory	5
1.1.27.3 Non-Volatile Memory	5
1.1.27.4 Volatile Memory	5
1.1.27.5 Random Access Memory (RAM)	5
1.1.27.6 Read Only Memory (ROM)	5
1.1.27.7 Programmable Read Only Memory (PROM)	5
1.1.27.8 Programmable Read Only Memory (EPROM)	5
1.1.28 Malfunction Management Unit	5
1.1.29 Modular Design	6
1.1.30 Offset	6
1.1.31 Omit, Phase (Special Skip, Force Skip)	6
1.1.32 Overlap	6
1.1.33 Passage Time	6
1.1.34 Pattern	6
1.1.35 Phase	6
1.1.35.1 Traffic Phase	6
1.1.35.2 Conflicting Phases	6
1.1.35.3 Nonconflicting Phases	6
1.1.35.4 Pedestrian Phase	6
1.1.35.5 Phase Sequence	6
1.1.35.6 Parent Phase	6
1.1.35.7 Vehicle Phase	6
1.1.36 Portion	6
1.1.36.1 Extensible Portion	6
1.1.36.2 Initial Portion	7
1.1.36.3 Interval Portion	7
1.1.37 Preemption	7
1.1.38 Preemptor, Traffic Controller	7
1.1.39 Preferred Sequence	7
1.1.40 Progression	7
1.1.41 Red Indication, Minimum (Red Revert)	7
1.1.42 Rest	7
1.1.43 Ring	7
1.1.44 Split	7
1.1.45 Suppressors	7
1.1.45.1 Suppressor, Radio Interference	7
1.1.45.2 Suppressor, Transient	8
1.1.46 Switch	8

1.1.46.1 Auto/Manual Switch	8
1.1.46.2 Flash Control Switch	8
1.1.46.3 Power Line Switch (Disconnect Switch)	8
1.1.46.4 Recall Switch	8
1.1.46.5 Signal Load Switch	8
1.1.46.6 Signal Shut-Down Switch	8
1.1.47 Time Base Control	8
1.1.48 Terminals, Field	8
1.1.49 Timing	8
1.1.49.1 Analog Timing	8
1.1.49.2 Concurrent Timing	8
1.1.49.3 Digital Timing	8
1.1.49.4 Timing Plan	8
1.1.50 Yield	8
1.2 Detectors	8
1.2.1 Actuation	8
1.2.2 Antenna	9
1.2.3 Call	9
1.2.4 Detection	9
1.2.4.1 Advisory Detection	9
1.2.4.2 Passage Detection	9
1.2.4.3 Presence Detection	9
1.2.5 Detector	9
1.2.5.1 Bidirectional Detector	9
1.2.5.2 Calling Detector	9
1.2.5.3 Classification Detector	9
1.2.5.4 Directional Detector	9
1.2.5.5 Extension Detector	9
1.2.5.6 Infrared Detector	9
1.2.5.7 Light-Sensitive Detector	9
1.2.5.8 Loop Detector	9
1.2.5.9 Magnetic Detector	10
1.2.5.10 Magnetometer Detector	10
1.2.5.11 Nondirectional Detector	10
1.2.5.12 Pedestrian Detector	10
1.2.5.13 Pneumatic Detector	10
1.2.5.14 Pressure-Sensitive Detector	10
1.2.5.15 Radar Detector	10
1.2.5.16 System Detector	10
1.2.5.17 Side-Fire Detector	10
1.2.5.18 Sound-Sensitive Vehicle Detector	10
1.2.5.19 Ultrasonic Detector	10
1.2.6 Detector Mode	10
1.2.7 Inductive Loop Detector System	10
1.2.8 Inductive Loop Detector Unit	11
1.2.9 Lead-in Cable	11
1.2.10 Output	11
1.2.10.1 Extension Output	11
1.2.10.2 Delayed Output	11
1.2.11 Probe	11
1.2.12 Sensor	11
1.2.13 Vehicle Detector System	11
1.2.14 Zone of Detection (Sensing Zone)	11
1.3 Signal	11
1.4 Cross-Reference Definitions	12

Section 2 ENVIRONMENTAL REQUIREMENTS

2.1 Environmental and Operating Standards	13
2.1.1 Definitions of Major Units of the Controller Assembly	13
2.1.2 Operating Voltage	13
2.1.3 Operating Frequency	13
2.1.4 Power Interruption.....	13
2.1.4.1 Field Terminal Outputs	13
2.1.5 Temperature and Humidity	14
2.1.5.1 Ambient Temperature	14
2.1.5.2 Humidity	14
2.1.6 Transients, Power Service	14
2.1.6.1 High-Repetition Noise Transients	14
2.1.6.2 Low-Repetition High-Energy Transients.....	15
2.1.7 Transients, Input-Output Terminals	15
2.1.8 Nondestruct Transient Immunity.....	15
2.1.9 Vibration	15
2.1.10 Shock	15
2.2 Controller Unit Tests	15
2.2.1 Timing Accuracy	16
2.2.1.1 Deviation.....	16
2.2.1.2 Setability and Repeatability	16
2.2.2 Timing	16
2.2.3 Vibration	16
2.2.4 Shock	16
2.2.5 Test Facilities	16
2.2.6 Test Unit	16
2.2.7 Test Procedure: Transients, Temperature, Voltage, and Humidity	16
2.2.7.1 Test A: Placement in Environment Chamber and Check-Out of Hook-Up.....	16
2.2.7.2 Test B: Transient Tests (Power Service).....	17
2.2.7.3 Test C: Low-Temperature Low-Voltage Tests.....	19
2.2.7.4 Test D: Low-Temperature High-Voltage Tests.....	20
2.2.7.5 Test E: High-Temperature High-Voltage Tests	20
2.2.7.6 Test F: High-Temperature Low-Voltage Tests	21
2.2.7.7 Test G: Test Termination	21
2.2.7.8 Test H: Appraisal of Equipment Under Test.....	21
2.2.8 Vibration Test.....	22
2.2.8.1 Purpose of Test	22
2.2.8.2 Test Equipment Requirements	22
2.2.8.3 Resonant Search	22
2.2.8.4 Endurance Test	23
2.2.8.5 Disposition of Equipment Under Test	23
2.2.9 Shock (Impact) Test.....	23
2.2.9.1 Purpose of Test	23
2.2.9.2 Test Equipment Requirements	23
2.2.9.3 Test Procedure	25
2.2.9.4 Disposition of Test Unit.....	25
2.2.10 Power Interruption Tests.....	25
2.2.10.1 500-Millisecond Power Interruption	25
2.2.10.2 1000-Millisecond Power Interruption	25
2.2.11 Timing Accuracy Tests	26
2.2.11.1 Setability	26
2.2.11.2 Repeatability	26
2.3 Malfunction Management Unit Tests	26

2.3.1 Test Facilities	26
2.3.2 Standard Setup	26
2.3.3 Ground Isolation Test	27
2.3.4 1500 pF Input Test	27
2.3.5 Conflict Low Voltage Test	27
2.3.6 Conflict High Voltage Test	27
2.3.7 Red Input Test	27
2.3.8 Minimum Yellow Change/Red Clearance Interval	28
2.3.9 Port 1 Timeout	28
2.3.10 DC Voltage Monitoring	28
2.3.11 MMU Power Failure	29
2.3.12 Permissive Programming	29
2.3.13 Continuous Reset	29
2.3.14 Transient Tests	29
2.4 Terminal and Facilities Tests	30
2.5 Load Switch Tests	30
2.5.1 Test Procedure for PIV and DV/DT Testing	30
2.6 Flasher Tests	31
2.6.1 Test Procedure for PIV and DV/DT Testing	31
2.7 Flash Transfer Relay Tests	31
2.8 Loop Detector Unit Tests	32
2.8.1 Environmental Requirements	32
2.8.1.1 Voltage, DC Supply	32
2.8.1.2 Temperature and Humidity	32
2.8.1.3 Transients, DC Powered Units	32
2.8.1.4 Transients, Loop Detector Input Terminals	33
2.8.1.5 Vibration	33
2.8.1.6 Shock	35
2.9 Bus Interface Unit Tests	35
 Section 3 CONTROLLER UNITS	
3.1 Definitions	36
3.1.1 CRC (Cyclic Redundancy Check)	36
3.1.2 Load Switch Driver Group	36
3.2 Physical Standards	36
3.2.1 Dimensions	36
3.2.2 Design	36
3.2.3 Material and Construction of Rigid Printed Circuit Assemblies	36
3.2.3.1 Materials	36
3.2.3.2 Mating Surfaces	37
3.2.3.3 Component Identification	37
3.3 Interface Standards	37
3.3.1 Port 1 Physical and Protocol	37
3.3.1.1 Connector	37
3.3.1.2 Electrical Interface	38
3.3.1.3 Data and Clock Communications Protocol	39
3.3.1.4 Information Field Formats	42
3.3.1.5 Framing Timing	72
3.3.2 Port 2 Interface	75
3.3.2.1 Unit to Printer	75
3.3.2.2 Unit to Personal Computer	76
3.3.3 Port 3 System Interface	76
3.3.3.1 Connector	76
3.3.3.2 Interface	76
3.3.4 Type 1—Interface Standards	76

3.3.5 Type 2—Interface Standards	77
3.3.5.1 Electrical Limits of Input/Output Terminations	77
3.3.5.2 Pin Connections	78
3.3.6 NTCIP Requirements	81
3.4 Pretimed Control	84
3.4.1 Definitions	84
3.4.1.1 Signal Plan	84
3.4.2 General	84
3.4.2.1 Timing Plans	84
3.4.2.2 Intervals	85
3.4.2.3 Signal Plans	85
3.4.2.4 Offset	86
3.4.2.5 Sync Monitor	86
3.4.2.6 Manual Control	86
3.4.2.7 Free Mode	86
3.4.3 Initialization	87
3.4.4 Actuated Movements	87
3.4.4.1 Provision for Storing a Demand	87
3.4.4.2 Placement of Vehicle Recall	87
3.4.4.3 Placement of Pedestrian Recall	87
3.4.5 External Interface	87
3.4.5.1 Pin Connections	87
3.4.5.2 Inputs	89
3.4.5.3 Outputs	93
3.4.6 Priority of Input Functions	95
3.4.7 Indications	95
3.5 Actuated Control	96
3.5.1 Definitions	96
3.5.1.1 Ring	96
3.5.1.2 Barrier (Compatibility Line)	96
3.5.1.3 Multi-Ring Controller Unit	96
3.5.1.4 Single-Ring Controller Unit	97
3.5.1.5 Dual Entry	97
3.5.1.6 Single Entry	97
3.5.1.7 Pedestrian Recycle	97
3.5.1.8 Preferred Sequence	97
3.5.2 General	97
3.5.2.1 Pin Connections	98
3.5.3 Per Phase	101
3.5.3.1 Time Settings	101
3.5.3.2 Phase Intervals	101
3.5.3.3 Phase Selection Points	108
3.5.3.4 Provision for Storing a Demand	108
3.5.3.5 Placement of Maximum Recall	108
3.5.3.6 Placement of Minimum Recall	108
3.5.3.7 Placement of Pedestrian Recall	108
3.5.3.8 Placement of Call at Phase Termination	108
3.5.3.9 Conditional Service	108
3.5.3.10 Automatic Pedestrian Clearance	109
3.5.3.11 Inputs	109
3.5.3.12 Outputs	109
3.5.4 Per Ring	109
3.5.4.1 Inputs	110
3.5.4.2 Outputs	111
3.5.5 Per Unit	111

3.5.5.1 Initialization	112
3.5.5.2 Simultaneous Gap Out	112
3.5.5.3 Dual Entry	113
3.5.5.4 Alternate Sequences	113
3.5.5.5 Inputs	114
3.5.5.6 Outputs	118
3.5.5.7 Red Revert.....	119
3.5.6 Priority of Input Functions	118
3.5.7 Indications	118
3.5.8 Overlaps	119
3.6 Actuated Coordination	119
3.6.1 Definitions	119
3.6.1.1 Permissive	120
3.6.2 Operation	119
3.6.2.1 Timing Plans	120
3.6.2.2 Offset	121
3.6.2.3 Sync Monitor	121
3.6.2.4 Manual Control	121
3.6.2.5 Free Mode	121
3.6.3 Command Priority	121
3.6.4 External Interface.....	121
3.6.5 Indications	122
3.7 Preemption	122
3.7.1 Definitions	122
3.7.2 Operation	122
3.7.2.1 Input Priority.....	124
3.7.2.2 Memory.....	125
3.7.3 External Interface.....	124
3.7.4 Indications	124
3.8 Time Base	124
3.8.1 Definitions	124
3.8.1.1 Coordinated Universal Time	126
3.8.2 Operation	125
3.8.3 External Interface.....	125
3.8.4 Indications	125
3.9 Miscellaneous	126
3.9.1 Flash	126
3.9.1.1 Start-Up Flash.....	127
3.9.1.2 Automatic Flash	127
3.9.2 Dimming	127
3.9.3 Diagnostics	127
3.9.3.1 Automatic Diagnostics	128
3.10 Future	133
3.11 Programming	133
3.11.1 Entry	133
3.11.2 Display	133
3.11.3 Security	133
3.11.4 Backup	133
3.12 Power Interruption.....	134

Section 4 MALFUNCTION MANAGEMENT UNIT

4.1 Overview	135
4.1.1 Basic Capability	135
4.1.2 TS 1-1989 Compatibility	135
4.2 Physical	136

4.2.1 Accessibility	136
4.2.2 Material and Construction of Printed Circuit Assemblies.....	136
4.2.3 Environmental Requirements	136
4.2.4 Size	136
4.3 Interface Standards.....	136
4.3.1 Port 1 Connector.....	136
4.3.2 Pin Connections.....	136
4.3.2.1 Connectors	137
4.3.2.2 Pin Assignments	137
4.3.3 Inputs	140
4.3.3.1 AC Line	140
4.3.3.2 AC Neutral	140
4.3.3.3 Earth Ground	140
4.3.3.4 Logic Ground	140
4.3.3.5 +24V Monitor DC Inputs	140
4.3.3.6 Control Inputs	140
4.3.3.7 Cabinet Interlock.....	140
4.3.3.8 Field Terminals	141
4.3.3.9 Red Enable	141
4.3.3.10 Type Select Input.....	141
4.3.3.11 Local Flash Status	142
4.3.4 Outputs	142
4.3.4.1 Output Relay.....	142
4.3.4.2 Start-Delay Control	142
4.3.5 Display	142
4.3.6 Control and Programming.....	143
4.3.6.1 Minimum Flash Programming.....	144
4.3.6.2 Minimum Yellow Change Channel Disable Programming.....	144
4.3.6.3 Voltage Monitor Latch Programming	144
4.3.7 Compatibility Programming.....	144
4.3.7.1 Connector P1 Programming Card Pin Connections.....	145
4.3.7.2 Connector P2 Programming Card Pin Connections.....	145
4.4 Functions	146
4.4.1 MMU Power Failure	146
4.4.2 Minimum Flashing Indication	146
4.4.3 Conflict Monitoring	146
4.4.4 Red Monitoring.....	147
4.4.5 Minimum Yellow Change / Red Clearance Interval Monitoring	147
4.4.5.1 Yellow Plus Red Interval.....	147
4.4.5.2 Yellow Change Interval.....	147
4.4.6 Port 1 Timeout	148
4.4.7 Voltage Monitoring.....	148
4.4.7.1 Volt Direct Current Supply Monitor	148
4.4.7.2 Volt Monitor Inhibit Input.....	148
4.4.8 Controller Voltage/Fault Monitor Input.....	149
4.4.9 Reset	149
4.5 Diagnostics	149
4.5.1 Memory	149
4.5.2 Microprocessor Monitor	150

Section 5 TERMINALS AND FACILITIES

5.1 Definitions	151
5.1.1 Cabinet	151
5.1.2 Flash Bus	151
5.1.3 Earth Ground	151

5.1.4 Logic Ground	151
5.1.5 Primary Feed	151
5.1.6 Signal Bus	151
5.1.7 Terminal(s).....	151
5.2 Physical	151
5.2.1 Material	151
5.2.2 Terminal Identification.....	151
5.2.3 Component Identification	152
5.2.4 Printed Circuits.....	152
5.2.5 Wire	152
5.2.6 Wiring	152
5.2.7 Layout	153
5.2.8 Load Switch and Flasher Support.....	153
5.3 Interface	153
5.3.1 Type 1 Controller Interface	153
5.3.1.1 Load Switch and Flasher Positions	153
5.3.1.2 Input/Output Terminals	154
5.3.1.3 Power and Control Terminals	157
5.3.1.4 BIU Interface	157
5.3.2 Type 2 Controller Interface	163
5.3.2.1 Load Switch and Flash Transfer Positions	163
5.3.2.2 Interface Terminals	163
5.3.2.3 Input/Output Mode	163
5.3.3 Port 1 Communication Cables	163
5.3.4 Detector Rack	164
5.3.4.1 Dimensions	164
5.3.4.2 Design.....	165
5.3.4.3 Detector Rack BIU	165
5.3.4.4 Detector Loop Connections	167
5.3.4.5 Power Supply Connections	167
5.3.5 Power Supply	168
5.3.5.1 Dimensions	168
5.3.5.2 Environmental Requirements	168
5.3.5.3 Electrical Requirements	168
5.3.5.4 Power Supply Inputs	168
5.3.6 Field Terminals	169
5.3.6.1 General	169
5.3.6.2 Number and Size of Terminals	170
5.3.6.3 Field Terminal Nomenclature	170
5.3.7 Terminal Types and Practices	171
5.4 Electrical Requirements	171
5.4.1 AC Service	171
5.4.2 Power Distribution Within Cabinet	171
5.4.2.1 Grounding System	171
5.4.2.2 Disconnecting Means	173
5.4.2.3 Signal Bus.....	173
5.4.2.4 AC Service Transient Suppression.....	173
5.4.2.5 Radio Interference Suppression	173
5.4.2.6 Convenience Receptacle	173
5.4.2.7 Lighting Fixture	173
5.4.3 Communications Transient Suppression.....	174
5.5 Control Circuits	174
5.5.1 Auto/Flash Switch	174
5.5.2 Flash Transfer Control	174
5.5.3 Malfunction Management Unit	174

Section 6 AUXILIARY DEVICES

6.1 Definitions	177
6.2 Three-Circuit Solid State Load Switches	177
6.2.1 Physical Characteristics.....	177
6.2.2 General Electrical Characteristics.....	178
6.2.3 Input Electrical Characteristics	179
6.2.4 Output Electrical Characteristics.....	179
6.3 Solid State Flashers.....	180
6.3.1 Type of Flasher	180
6.3.2 Physical Characteristics.....	180
6.3.3 General Electrical Characteristics.....	181
6.4 Flash Transfer Relays.....	182
6.4.1 Environmental Requirements	182
6.4.1.1 Temperature and Humidity	183
6.4.1.2 Vibration and Shock.....	183
6.4.1.3 Transients	183
6.4.2 Mechanical Requirements	182
6.4.2.1 Enclosure	183
6.4.2.2 Contacts and Connector	183
6.4.2.3 Dimensions	183
6.4.3 Electrical Requirements.....	182
6.4.3.1 Contact Rating	183
6.4.3.2 Contact Material.....	183
6.4.3.3 Coil Rating	184
6.4.3.4 Insulation	184
6.5 Inductive Loop Detector Units.....	184
6.5.1 Loop Detector Unit Definitions.....	184
6.5.1.1 Channel	185
6.5.1.2 Crosstalk	185
6.5.1.3 Detector Mode	185
6.5.1.4 Lead-In Cable	185
6.5.1.5 Loop Detector System	185
6.5.1.6 Loop Detector Unit.....	185
6.5.1.7 Reset Channel.....	185
6.5.1.8 Reset Unit	185
6.5.1.9 Sensor Loop	185
6.5.1.10 Vehicle Detector System	186
6.5.1.11 Zone of Detection	186
6.5.2 Functional Standards	185
6.5.2.1 Operation	186
6.5.2.2 Configurations and Dimensions.....	186
6.5.2.3 Accessibility	188
6.5.2.4 Material and Construction of Rigid Printed Circuit Assemblies	188
6.5.2.5 Power Inputs.....	188
6.5.2.6 Logic Ground	188
6.5.2.7 Earth Ground	188
6.5.2.8 DC Control Inputs	188
6.5.2.9 Data Receive (RX) Input.....	189
6.5.2.10 Loop Inputs	189
6.5.2.11 Loop/Lead in Electrical Properties.....	190
6.5.2.12 Test Loop Configurations	190
6.5.2.13 Test Vehicle Definition	190
6.5.2.14 Sensitivity.....	191
6.5.2.15 Sensitivity Control	191

6.5.2.16 Approach Speed	191
6.5.2.17 Modes of Operation	192
6.5.2.18 Recovery from Sustained Occupancy	192
6.5.2.19 Response Time.....	192
6.5.2.20 Tuning.....	192
6.5.2.21 Self-Tracking.....	193
6.5.2.22 Recovery From Reset.....	193
6.5.2.23 Crosstalk Avoidance	193
6.5.2.24 Delay/Extension.....	193
6.5.2.25 Controls and Indicators.....	194
6.5.2.26 Outputs	195
6.5.2.27 Communication Port Functional Requirements	197
6.5.2.28 Electrical Connections	198

Section 7 CABINETS

7.1 Definitions	199
7.2 Materials	199
7.2.1 Cabinets of Ferrous Material	199
7.2.2 Cabinets of Aluminum Alloy.....	199
7.2.2.1 Cabinets of Aluminum Alloy	200
7.2.2.2 Cast Aluminum	200
7.3 Cabinet Dimensions.....	200
7.4 Top Surface Construction	200
7.5 Doors	200
7.5.1 Main Cabinet Door	200
7.5.2 Hinges	200
7.5.3 Door Stop	200
7.5.4 Latches and Locking Mechanism	200
7.5.4.1 Latching	201
7.5.4.2 Rotation of Handle.....	201
7.5.4.3 Locks	202
7.5.4.4 Provisions for Padlock	202
7.5.5 Door Opening.....	201
7.5.6 Gasketing	201
7.5.7 Police Compartment	201
7.5.7.1 Door	202
7.5.7.2 Locks	202
7.5.7.3 Compartment Size.....	202
7.6 Shelves	201
7.6.1 Positioning	201
7.7 Finish and Surface Preparation	202
7.7.1 Steel Cabinets.....	202
7.7.1.1 Preparation	203
7.7.1.2 Prime Coat.....	203
7.7.1.3 Interior Surfaces	203
7.7.1.4 Exterior Surfaces	203
7.7.2 Aluminum Cabinets.....	202
7.7.2.1 Preparation: Painted Cabinets	203
7.7.2.2 Prime Coat	203
7.7.2.3 Interior Surfaces	203
7.7.2.4 Exterior Surfaces	203
7.7.3 Unpainted Aluminum Cabinets	202
7.8 Cabinet Mounting	202
7.8.1 Pole-Mounted Cabinets	202
7.8.2 Pedestal-Mounted Cabinets	202

7.8.3 Base-Mounted Cabinets	203
7.8.3.1 Sizes 3, 4, and 5	204
7.8.3.2 Sizes 6 and 7	204
7.8.4 Anchor Bolts.....	203
7.9 Cabinet Ventilation.....	204
7.9.1 Fan or Cooling System Design	204
7.9.2 Fan or Cooling System Operation	204
7.9.2.1 Operating Conditions	205
7.9.2.2 Fan or Cooling System Controls.....	205
7.9.2.3 Filter	205

Section 8 BUS INTERFACE UNIT

8.1 General	205
8.2 Physical	205
8.2.1 Material	205
8.2.2 Printed Circuits.....	205
8.2.3 Dimensions	205
8.3 Configurations	205
8.4 Environmental Requirements	205
8.5 Power Requirements	206
8.5.1 Initialization	206
8.6 Indicators	207
8.6.1 Power on Indicator	207
8.6.2 Port 1 Indicator.....	207
8.6.3 Rack TX Indicator (BIU2 Only)	207
8.7 BIU-to-Rack Communication Port Functional Requirements (BIU2 Only)	207
8.7.1 Communication Port Electrical Requirements	207
8.7.2 Baud Rate	207
8.8 Interface Requirements.....	207
8.8.1 Port 1 Communications	207
8.8.2 Port 1 Connector.....	207
8.8.2.1 Port 1 Connector Pin Assignments.....	209
8.8.3 Card Rack Connector	208
8.8.3.1 Connector Pin Assignments for BIU Type BIU	209
8.8.3.2 Connector Pin Assignments for BIU Type BIU2	209
8.8.4 Outputs	209
8.8.4.1 Data Transmit Output (TX) for BIU Type BIU2	211
8.8.5 Inputs	210
8.8.5.1 Opto Common	211
8.8.5.2 Opto Inputs	211
8.8.5.3 Line Frequency Reference	212
8.8.5.4 24 Volt Signal Inputs.....	212
8.8.5.5 Data Receive Input (RX) for BIU Type BIU2	213
8.8.5.6 +24 VDC Input	213
8.8.5.7 Earth Ground	213
8.8.5.8 Logic Ground	213

Tables

Table 2-1 WET-BULB DRY-BULB RELATIVE HUMIDITY AT BAROMETRIC PRESSURE OF 29.92 In. Hg.	14
Table 3-1 COMMAND FRAMES.....	42
Table 3-2 RESPONSE FRAMES.....	43

Table 3-3 COMMAND FRAMES AND FREQUENCY OF TRANSMISSION.....	72
Table 3-4 SERVICE, RESPONSE, AND COMMAND VALUES (MILLISECONDS)	74
Table 3-5 OBJECT RANGE VALUES FOR ACTUATED SIGNAL CONTROLLERS.....	83
Table 3-6 TIMING PLAN.....	90
Table 3-7 OFFSET.....	91
Table 3-8 SIGNAL PLAN	91
Table 3-9 I/O MODE BITS (3 PER UNIT).....	92
Table 3-10 CODED STATUS BITS (3 PER UNIT)	94
Table 3-11 CODED STATUS BITS (3 PER RING)	110
Table 3-12 ALTERNATE SEQUENCE	112
Table 3-13 I/O MODE BITS (3 PER UNIT).....	115
Table 3-14 TIMING PLAN.....	121
Table 3-15 OFFSET.....	122
Table 5-1 AMPACITY	152
Table 5-2 TYPE 1 CONFIGURATIONS.....	154
Table 5-3 INPUT / OUTPUT TERMINALS	154
Table 5-4 BIU ADDRESS ASSIGNMENT	158
Table 5-5 BIU 1 SIGNAL ASSIGNMENT.....	158
Table 5-6 BIU 2 SIGNAL ASSIGNMENT.....	159
Table 5-7 BIU 3 SIGNAL ASSIGNMENT.....	161
Table 5-8 BIU 4 SIGNAL ASSIGNMENT.....	162
Table 5-9 DETECTOR RACK CONFIGURATIONS	164
Table 5-10 DETECTOR MODULE COMMUNICATIONS ADDRESS	165
Table 5-11 DETECTOR RACK BIU ADDRESS ASSIGNMENT	166
Table 5-12 BIU 9 SIGNAL ASSIGNMENT.....	166
Table 5-13 FIELD TERMINALS.....	169
Table 5-14 MMU CHANNEL ASSIGNMENTS.....	175
Table 6-1 DETECTOR UNIT TYPES.....	185
Table 6-2 CONNECTOR TERMINATIONS	198
Table 7-1 OUTLINE DIMENSIONS	200
Table 8-1 BIU TYPES	205

Figures

Figure 2-1 TEST PROFILE.....	19
Figure 2-2 SHOCK TEST FIXTURE	24
Figure 2-3 PIV AND DV/DT TEST CIRCUIT (SOLID STATE LOAD SWITCH OR FLASHER)	30
Figure 2-4 TEST CONFIGURATIONS.....	32

Figure 2-5 LOOP INPUT TERMINAL TRANSIENT TESTS	34
Figure 3-1 PORT 1 CONNECTIONS, TYPE 1 CONTROLLER ASSEMBLY	39
Figure 3-2 PORT 1 CONNECTIONS, TYPE 2 CONTROLLER ASSEMBLY	39
Figure 3-3 PORT 1 TIMING	40
Figure 3-4 PORT 1 FRAME FORMAT	40
Figure 3-5 COMMAND AND RESPONSE FRAME TIMING	73
Figure 3-6 DUAL RING CONTROLLER UNIT	96
Figure 3-7 SINGLE RING CONTROLLER UNIT	97
Figure 3-8 VARIABLE INITIAL TIMING	102
Figure 3-9 GAP REDUCTION	103
Figure 3-10 ACTIVATED PHASE OPERATING IN THE NONACTIVATED MODE.....	104
Figure 3-11 ACTIVATED PHASE OPERATING IN THE NONACTIVATED MODE.....	106
Figure 3-12 LOAD SWITCH DRIVERS, PEDESTRIAN	109
Figure 4-1 PROGRAMMING CARD	143
Figure 5-1 LOAD SWITCH OR FLASHER SUPPORT	155
Figure 5-2 FRONT VIEW—LOAD SWITCH SUPPORT DIMENSIONS.....	156
Figure 5-3 FRONT VIEW—FLASHER SUPPORT DIMENSIONS	157
Figure 5-4 CABINET POWER DISTRIBUTION SCHEMATIC	172
Figure 5-5 TERMINAL & FACILITIES WIRING	176
Figure 6-1 CONNECTOR PIN ASSIGNMENT	178
Figure 6-2 CONNECTOR PIN ASSIGNMENTS SOLID STATE FLASHER (VIEWED—CONNECTOR END).....	181
Figure 6-3 FLASH TRANSFER RELAY WIRING DIAGRAM	183
Figure 6-4 TWO CHANNEL CARD RACK UNIT	186
Figure 6-5 FOUR CHANNEL CARD RACK UNIT	186
Figure 6-6 TEST LOOP CONFIGURATIONS.....	190
Figure 6-7 DELAY OPERATION	193
Figure 6-8 EXTENSION OPERATION	193
Figure 7-1 FOUNDATION FOR SIZES 3, 4, AND 5 BASE-MOUNTED CABINETS.....	203
Figure 7-2 FOUNDATION FOR SIZE 6 AND 7 BASE-MOUNTED CABINETS	204
Figure 8-1 BUS INTERFACE UNIT	206

Foreword

This NEMA Standards Publication TS 2-2003, *Traffic Controller Assemblies with NTCIP Requirements*, has been developed as a design guide for traffic signaling equipment which can be safely installed and provide operational features not covered by the NEMA TS 1-1989, *Traffic Control Systems*. Within the standard, any reference to a specific manufacturer is made strictly for the purpose of defining interchangeability where there exists no nationally recognized standard covering all the requirements. The manufacturer references do not constitute a preference.

The TS 2 Standards Publication has been established to reduce hazards to persons and property when traffic signaling equipment is properly selected and installed in conformance with the requirements herein.

The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in connection therewith.

Comments and suggestions for the improvement of this document are encouraged. They should be sent to:

Senior Technical Director, Operations
National Electrical Manufacturers Association
1300 North 17th Street
Rosslyn, Virginia 22209

Scope

This Standards Publication covers traffic signaling equipment used to facilitate and expedite the safe movement of pedestrians and vehicular traffic.

Two approaches to expansion of traffic features of NEMA TS 1, *Traffic Control Systems*, are provided:

Type 1—

- Entirely new performance oriented standard.

Type 2—

- Use of the MSA, B, and C connectors in common use with NEMA TS 1 equipment.

The Type 1 approach embraces:

- Controller Unit
 - Display-alphanumeric Display—32 Characters, 2 Lines Minimum
 - Port 1 Connector
 - High speed full duplex data channel connecting controller unit, conflict monitor (malfunction management unit), rear panel (terminals and facilities) and detectors.
 - All data exchange with rear panel.
 - Controller unit and conflict monitor exchange information on a regular basis, performing redundant checks on each other. Controller unit has access to all conflict monitor internal information, making enhanced event logging, remote intersection monitoring, and remote diagnostics feasible.
 - All detector information, including detector diagnostics.
 - EIA-485 serial communications interface with noise immunity characteristics.
 - SDLC (synchronous data link) communication protocol with a bit rate of 153, 600 bits/second, utilizing sophisticated error checking.
 - Vast reduction in number of wires in the cabinet.
 - Port 2 Connector
 - Interface to personal computer.
 - Interface to printer.
 - Port 3 Connector
 - 1200 baud, FSK serial port for on-street communications.