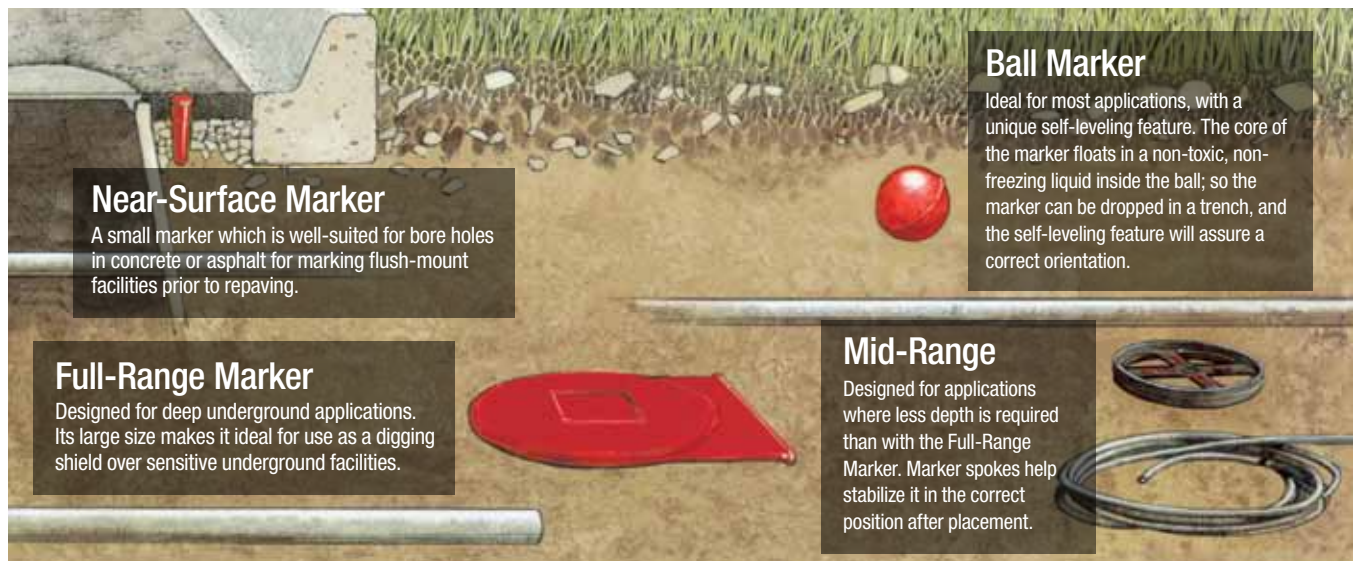


Recommendations for Marking Power Facilities Using 3M™ EMS Electronic Markers

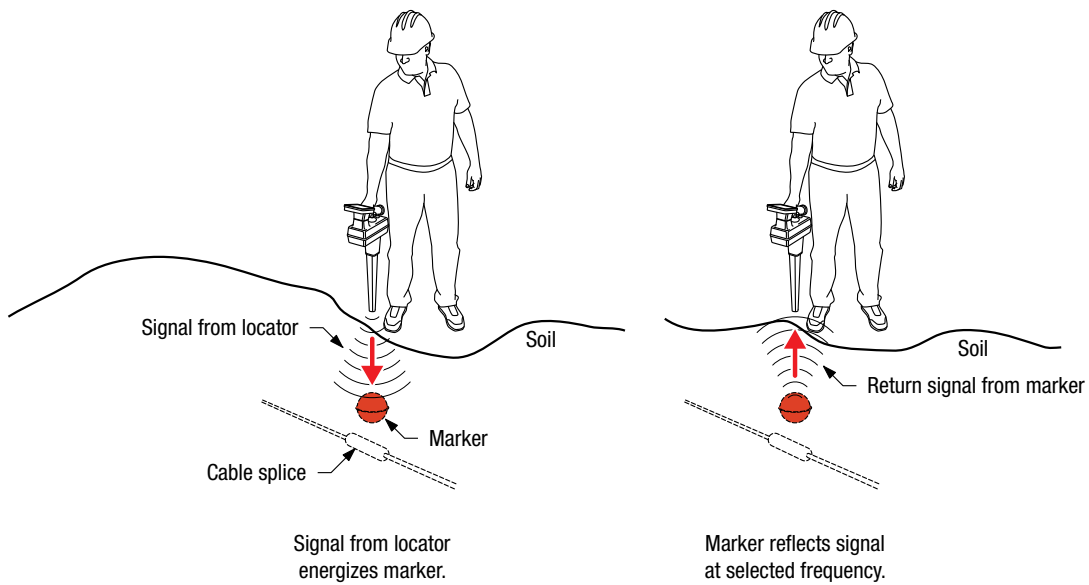


1.0 Overview

The 3M™ electronic marker system helps make the job of precisely locating underground facilities easier and faster. The basic component of the system is a durable electronic marker which is buried above key underground elements during construction or maintenance. A stand-alone 3M™ Dynatel™ marker locator model 1420-iD, an integrated 3M™ Dynatel™ cable/marker locator 2500-iD series, or an integrated 3M™ Dynatel™ 2200M-iD series provides fast and accurate location of a marker many years after its placement.

Depending on the resonant frequency and the color, electronic markers are used to mark a wide range of underground facilities such as cable television networks, telecommunication lines, power supply networks, water supply pipelines, wastewater pipelines, oil and gas pipelines, and so on.

The solid red colored markers are used for general power applications. These markers are tuned to 169.8 kHz and are available in five different form factors for varying applications: Near Surface Marker, Ball Marker, Mid-Range Marker, Full Range Marker and Disk Marker. The marker consists of a sealed shell containing a passive antenna: a low-frequency resonance circuit tuned to a certain frequency. The locator sends a signal to the marker, energizing it. The signal is then reflected back to the locator. Electronic markers are tolerant to congestion and extremely reliable. Electronic markers are typically installed during construction or repairs when the facility is visible to the eye, making them one of the most trusted methods for positive identification of buried facilities.



2.0 General Recommendations for Electronic Marker Placement

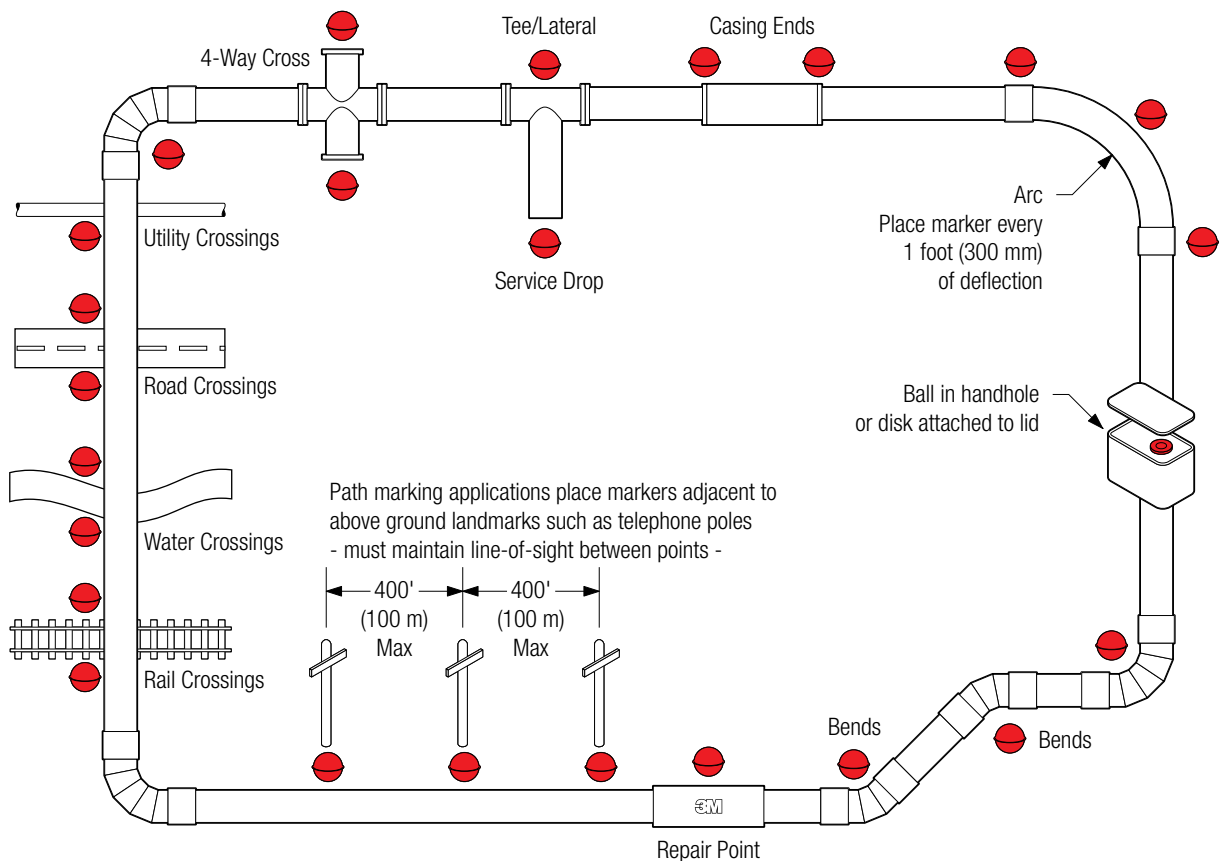
2.1 Recommended Placement

- All 'Items of Plant' (facility items) that are assigned unique reference numbers on facility maps and records.
- Handholes
- Buried splices of all types
- Repair points
- Buried service drops: Service stubs
- Slack loops
- Depth changes
- Laterals
- Bends: changes of direction, arcs
- Depth changes: lateral deflection
- Fiber optic facilities with no metallic conductor
- Conduit stubs

- Encasement ends: conduit ends of horizontally directional drilled facilities
- Manhole covers
- Water crossings
- Major road crossings
- Rail crossings
- Utility crossings: locations where the cable crosses over or under other utilities.
- Non-metallic facilities
- Other items of value or interest

2.2 Additional Marker Placement Information

Using the GPS interface on the 3M™ Dynatel™ Locator model 1420 -iD, 2500 Series and 2200M-iD series also helps provide positive verification of marker placement during construction and direct data import capability to leading industry standard GIS systems for electronic map updating.



Various Recommended Marker Locations

3.0 Recommended Ball Marker Spacing and Depth

Note: See Section 4 for recommended depths of other marker form factors.)

3.1 Recommended Depth for Ball Markers

Maximum distance from ground surface to ball marker:

3M™ Ball Marker model	Read/Detection Range
1422-XR/iD (iD version marker)	5 feet (1.5 m) (using U.S. 3M marker locator)
	40 inches (1.0 m) (using CE-approved 3M marker locator)
1402-XR (Non-iD (passive) version marker)	5 feet (1.5 m)

- To increase the detection area at ground level, it is recommended to place the marker at half of its rated depth. This will produce a detection area of approximately 6 feet (2 meters) in diameter.
- If fill to finish grade is anticipated, place marker at a 2 foot (0.5 m) depth. This may vary depending on the amount of fill required.
- If a cut to finish grade is anticipated, place marker at its maximum rated distance.
- If it is anticipated that there will be a need to rewrite an iD marker's information after it has been buried, place marker at a maximum depth of 1 foot (0.3 m).

3.2 Recommended Spacing to Utility

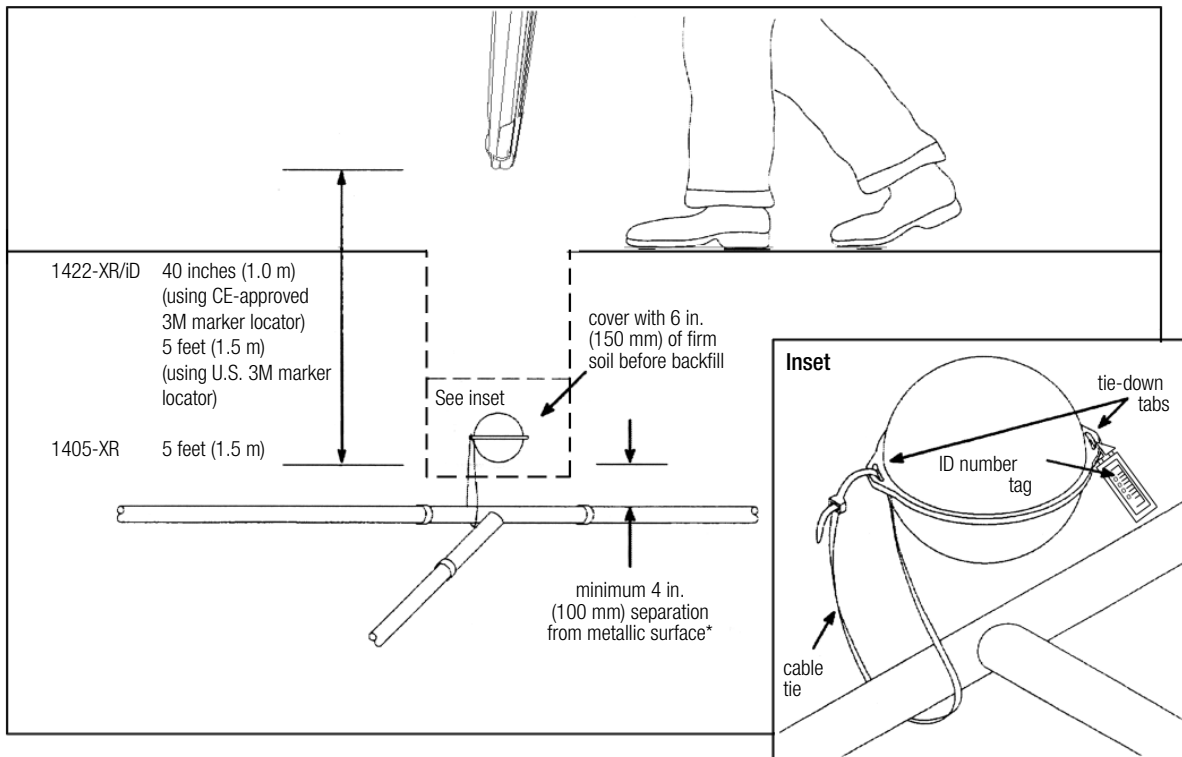
Place ball marker at least 4 inches (104 mm) from the facility.

3.3 Spacing Between Ball Markers

- The minimum distance between markers should be at least 3.5 feet (1.06 m) for clear identification
- In straight sections for path marking applications, it is recommended to place markers adjacent to existing above ground landmarks such as telephone or power poles to simplify future locating. Markers should be placed where there is direct line of sight to the next marker. Recommended 200 feet (61 m) maximum distance between markers with a preferred distance of 100 feet (31 m) between markers.
- In bends or lateral pipe deflections, it is recommended to place one marker for every 1 foot (300 mm) deflection (arc) to accurately indicate cable position.

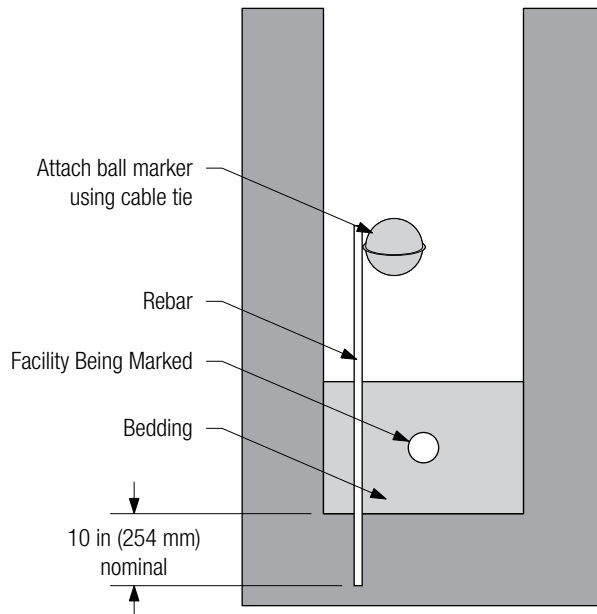
3.4 Standard Ball Marker Tie Down Procedure

1. Before placing the ball marker over the key point, decide if a tie down procedure is necessary to keep it in place. If so, secure the marker by inserting a cable tie through one or both tie-down tabs on the marker and attach to the key point.
2. If the key point is metallic, it is recommended that the ball marker be separated from it with a minimum of 4 inches (120 mm) of clean fill dirt.
3. If the key point is non-metallic, place the marker over the desired location.
4. Hand fill at least 6 inches (150 mm) of soil over the marker to prevent movement, or damage, during backfill.
5. Backfill the hole.



3.5 Alternate Ball Marker Tie Down Procedure for Deeper Facilities

1. Tie the ball marker to a section of steel rebar using a cable tie.



3.6 Additional Placement Recommendations for 3M™ Ball Marker 1422-XR/iD

Additional applications are possible with the XR/iD series of ball markers due to their ability to store specific facility information. Facility information that may be of value to write into the iD ball marker includes:

- Facility owner
- Utility type
- Description of facility point
- Item of plant identification number (IPID)
- Depth (to facility, or from marker to facility)
- Conductor size
 - # KCMIL
 - # MCM
 - # AWG
- Type of insulation and jacket
 - XLP - Cross linked polyethylene
 - EPR - Rubber
 - Paper/Lead
- Type of splice
 - Y splice
 - Straight splice
 - Transition splice
 - 1 way or 3 way splice
 - Paper to Poly splice (transition splice)
- Voltage
- Address: service drop

- Direction
- Distance or length
- Date of installation or repair
- Other description information that is of value

4.0 Form Factors

3M offers a complete line of electronic markers that provide solutions supporting a variety of power applications.

4.1 3M™ Ball Marker 1402-XR

The unique self-leveling design of the 3M ball marker horizontally orients the marker coil inside the ball regardless of how it is placed in the ground. The marker shell is made from high-strength plastic, which protects the device from mechanical and weather



damage. The marker contains an antenna molded inside a moisture-resistant plastic disk, which is free-floating on the surface of a non-freezing liquid. (The liquid is a mixture of propylene glycol and water which is approved for use in pharmaceuticals, cosmetics and as a food additive. The mixture is readily biodegradable and will not harm humans, wildlife or the environment in this application.) 3M™ Ball Markers 1402-XR are used to mark points of special interest that may need to be accessed in the future. In power applications where there is a need to mark non-metallic empty conduit, the 1402-XR ball marker can be used for path marking.

3M™ Ball Marker 1402-XR

Shell diameter	4 inches (104 mm)
Maximum installation/detection depth	5 feet (1.5 m)
Minimum horizontal and vertical distance from the facility being marked	4 inches (104 mm) from the ball center
Minimum distance between markers	3.5 feet (1.06 m)

4.2 3M™ Ball Marker 1422-XR/iD (iD Marker)

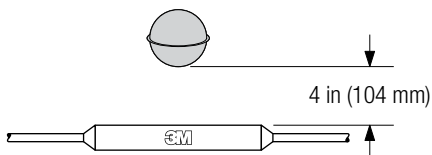
This marker is similar to the 1402-XR ball marker in size and form. Additionally, the 1422-XR/iD ball marker contains an RFID microchip, which allows introduction and storage of facility data. Each marker comes pre-programmed with a unique 10-digit identification number. This pre-programmed number is also attached to the marker on a removable bar-coded tag, which can be peeled off before installation and attached to facility maps. (Refer to section 2.6 for a listing of applications.) In general terms, 1422-XR/iD ball markers are ideal for marking underground facilities in urban areas with a high density of underground networks, in rural areas where there are few physical landmarks that can be referenced on maps, and for marking facilities that cannot be located using traditional electromagnetic cable locating devices. Additionally, 1422-XR/iD ball markers are ideal for marking high-value facilities, lifeline facilities, or other points of special interest where service outages would have a significant impact and cost or hardship.



3M™ Ball Marker 1422-XR/iD

Shell diameter	4 inches (104 mm)
Maximum installation/detection depth	5 feet (1.5 m) (using U.S. 3M marker locator)
	40 inches (1.0 m) (using CE-approved 3M marker locator)
Minimum horizontal and vertical distance from the facility	4 inches (104 mm) from the ball center
Minimum distance between markers	3.5 feet (1.06 m)

Spacing of ball markers to the buried facility:



4.3 3M™ Disk Markers (Do Not Direct Bury) 1412-XR and 1412-XR/iD

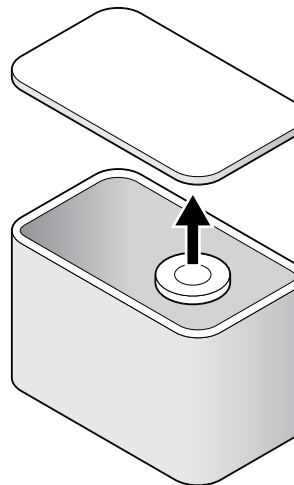
3M™ Disk Markers 1412-XR (non-iD (passive) version marker) and 1412-XR/iD (iD version marker) are used in hand hole applications where they are attached mechanically to the top cover of the hand hole. 1412-XR disk markers are identical in performance to the 1402-XR ball markers. (See note.) 1412-XR/iD disk markers contain an RFID microchip and are identical in performance to the 1422-XR/iD ball markers.



Note: 3M disk markers are not intended for direct bury applications or applications where they would be attached to solid metal manhole covers.

3M™ Disk Markers 1412-XR and 1412-XR/iD

Shell diameter	4 inches (104 mm)
Shell height	0.7 inches (18 mm)
Maximum installation/detection depth (1412-XR, non-iD version)	5 feet (1.5 m)
Maximum installation/detection depth (1412-XR/iD, iD version)	5 feet (1.5 m) (using U.S. 3M marker locator)
	40 inches (1.0 m) (using CE-approved 3M marker locator)
Minimum distance between markers	3.5 feet (1.06 m)



Attach disk marker mechanically to top cover in handhole

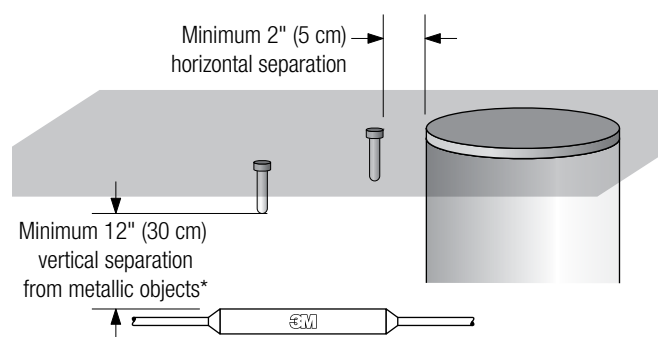
4.4 3M™ Near Surface Markers 1433 and 1433-XR/iD

3M™ Near Surface Markers 1433 Non-iD (passive) version marker and 1433-XR/iD (iD version marker) are recommended for urban applications. Near-surface markers allow for convenient marking of facilities under asphalt or concrete or for marking facilities after construction has completed. The marker is installed vertically at a shallow depth in a hole drilled or gouged in soil or in street pavement. Near-surface markers are also ideal for path of facilities installed using trenchless (HDD) technology and for marking existing facilities. In recent years, near-surface markers have become increasingly popular for marking existing or legacy facilities due to their ease of installation.



3M™ Near Surface Markers 1433 and 1433-XR/iD	
Case diameter	0.8 inches (20 mm)
Case length	3 inches (76 mm)
Maximum installation/detection depth (1433, non-iD version)	2 feet (610 mm)
Maximum installation/detection depth (1433-XR/iD, iD version)	3 feet (915 mm) (using U.S. 3M marker locator) 2 feet (610 mm) (using CE-approved 3M marker locator)
Minimum vertical distance from facility	12 inches (300 mm)
Minimum horizontal distance from facility	2 inches (50 mm)
Minimum distance between markers	3.5 feet (1.06 m)

Spacing of near-surface markers to the buried facility:



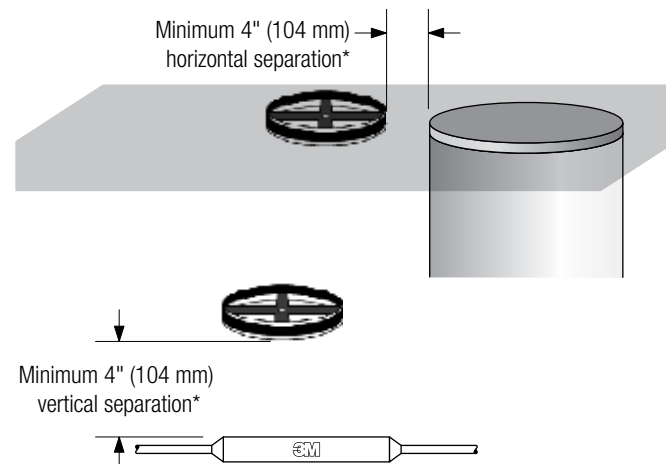
4.5 3M™ Mid-Range Marker 1256

Note: Mid-Range Markers are only available as Non-iD (passive) markers.

3M™ Mid-Range Marker 1256 is used in areas with low-density underground facilities as point markers for items of special interest such as splices, repair points, slack loops, service stubs and as guides for marking linear segments of the paths of long cables that are deeper than can be accommodated with ball markers. The 1256 mid-range marker is often used in larger ‘point’ excavations but not typically used in narrow trench applications due to its larger diameter.



3M™ Mid-Range Marker 1256	
Case diameter	8.4 inches (210 mm)
Case height	1.2 inches (30 mm)
Maximum installation/detection depth	6 feet (1.8 m)
Minimum vertical distance from facility	4 inches (104 mm)
Minimum horizontal distance from facility	4 inches (104 mm)
Minimum distance between markers	3.5 feet (1.06 m)



4.6 3M™ Full-Range Markers 1251 and 1251-XR/iD

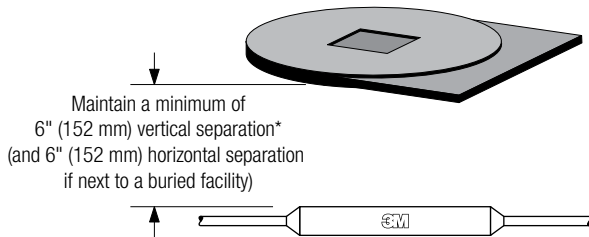
The full-range marker is designed for marking deep underground facilities. Its large diameter is also valued by facility owners as a ‘dig shield’ that can help protect the facility from damage by being cut or damaged by a shovel during excavation. When placed above the facility, the full-range marker serves as a cover which warns of encroachment to the underground facility.



3M™ Full-Range Markers 1251 and 1251-XR/iD

Case diameter	15 inches (380 mm) 3M Marker
Case height	0.7 inches (17 mm)
Maximum installation/detection depth (1251, non-iD version)	8 feet (2.4 m)
Maximum installation/detection depth (1251-XR/iD, iD version)	8 feet (2.4 m) (using U.S. 3M Marker locator) 6.5 feet (2.0 m) (using CE-approved 3M Marker locator)
Minimum vertical distance from facility	6 inches (152 mm)
Minimum horizontal distance from facility	6 inches (152 mm)
Minimum distance between markers	3.5 feet (1.06 m)

Spacing of full-range markers to the buried facility:



5.0 3M™ Dynatel™ Electronic Marker Locators

3M™ Dynatel™ Electronic Marker Locators are recommended for locating 3M™ Electronic Markers. 3M offers stand-alone electronic marker locators: 3M™ Dynatel™ 1420-iD (US) and 1420E-iD (CE approved for export). Additionally 3M offers integrated cable locators with electronic marker locating capabilities: the 3M™ Dynatel™ 2200M-iD series and 2500-iD series. These locators provide a single integrated platform for what has previously been two separate test sets. This can reduce the initial capital expenditure, the number of pieces of

equipment that need to be maintained, space requirements in the vehicle, and number of test sets that must be carried by a technician into the field to perform a locate. The 2500-iD series and 2200M-iD series locators can communicate with selected GPS devices which can help enhance efficiencies in documenting as-built facilities and reduce the need for inspection.

3M Dynatel offers the following electronic marker and multipurpose locators:

3M™ Dynatel™ Marker Locator 1420-iD and 1420E-iD



3M™ Dynatel™ Cable/ Pipe and Marker Locator 2250M-iD



3M™ Dynatel™ Cable/ Pipe/Fault and Marker Locator 2273M-iD



3M™ Dynatel™ Cable/ Pipe and Marker Locator 2550-iD



3M™ Dynatel™ Cable/ Pipe/Fault and Marker Locator 2573-iD



Additional information about 3M™ Dynatel™ cable and electronic marker locating products for power applications is available at www.3M.com/dynatel or from your local 3M sales professional.

6.0 3M™ Dynatel™ Electronic Marker Information

6.1 3M™ Electronic Markers For Power Facilities Part Numbers & Descriptions

Marker Type	Marker Color	Non-iD (Passive) Marker Part #	Id Marker Part #
Ball Markers	Red	1402-XR	1422-XR/iD
Disk Markers (Do Not Direct Bury)	Red	1412-XR	1412-XR/iD
Near-Surface Markers	Red	1433	1433-XR/iD
Mid-Range Markers	Black w/Red Printing	1256	—
Full-Range Markers	Red	1251	1251-XR-iD

6.2 3M™ Electronic Marker Write & Read/Detection Ranges

U.S. Model Marker Locators

3M iD Markers	Maximum Writing Range	Maximum Reading/Detection Range
Near-Surface iD Markers	6 inches (15 cm)	3 feet (0.9 m)
Ball iD Markers	12 inches (30 cm)	5 feet (1.5 m)
Disk iD Markers (Do Not Direct Bury)	12 inches (30 cm)	5 feet (1.5 m)
Full-Range iD Markers	24 inches (61 cm)	8 feet (2.4 m)

3M Non-iD (Passive) Markers

Near-Surface Non-iD Markers	—	2 feet (0.6 m)
Ball Non-iD Markers	—	5 feet (1.5 m)
Disk Non-iD Markers (Do Not Direct Bury)	—	5 feet (1.5 m)
Mid-Range Non-iD Markers	—	6 feet (1.8 m)
Full-Range Non-iD Markers	—	8 feet (2.4 m)

CE Approved (Export) Model Marker Locators

3M iD Markers	Maximum Writing Range	Maximum Reading/Detection Range
Near-Surface iD Markers	15 cm (6 inches)	61 cm (24 inches)
Ball iD Markers	30 cm (12 inches)	1.0 m (40 inches)
Disk iD Markers (Do Not Direct Bury)	30 cm (12 inches)	1.0 m (40 inches)
Full-Range iD Markers	61 cm (24 inches)	2.0 m (78 inches)

3M Non-iD (Passive) Markers

Near-Surface Non-iD Markers	—	0.6 m (2 feet)
Ball Non-iD Markers	—	1.5 m (5 feet)
Disk Non-iD Markers (Do Not Direct Bury)	—	1.5 m (5 feet)
Mid-Range Non-iD Markers	—	1.8 m (6 feet)
Full-Range Non-iD Markers	—	2.4 m (8 feet)

6.3 3M™ Electronic Marker Environmental Specifications

Environmental Specifications	
Operating Temperature	-4°F to 122°F (-20°C to 50°C)
Storage Temperature	-40°F to 158°F (-40°C to 70°C)

* Target size and material dependent. Depth estimation may be adversely affected when placing the marker above a large metallic object, such as a manhole cover. To improve depth estimation accuracy, increase the vertical separation from the metallic object to at least 12 inches (30 cm) or perform a field test for accuracy.

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