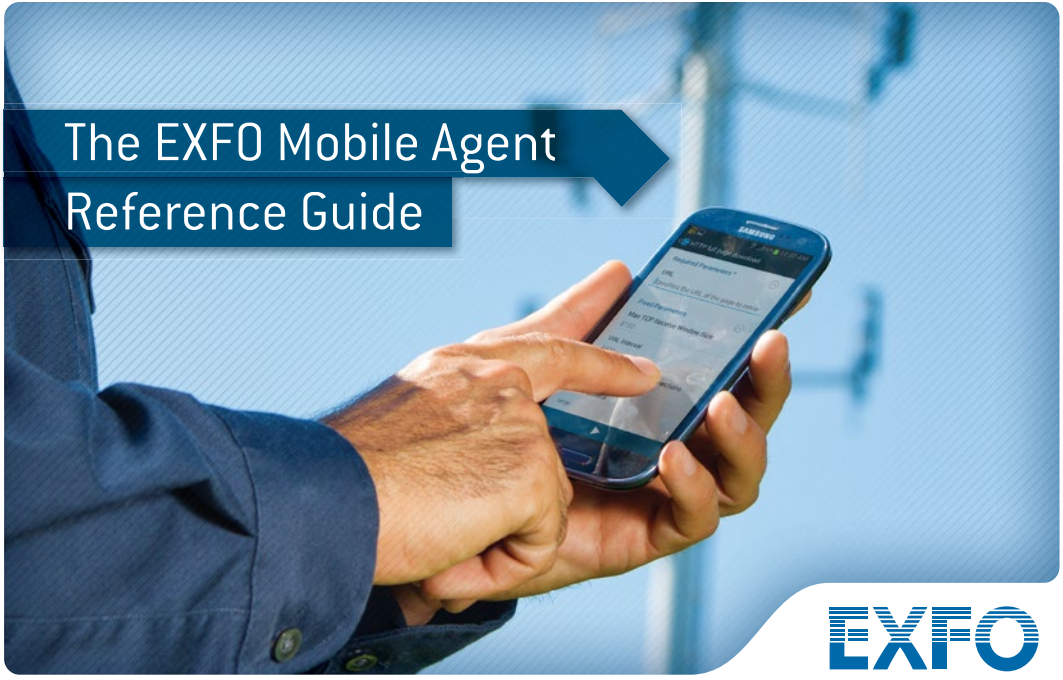
The EXFO Mobile Agent Reference Guide



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1. EXECUTIVE SUMMARY

Mobile service providers are always seeking to improve and enhance their end users' quality of experience (QoE) on their mobile devices. They are constantly developing new metrics and tools to probe, monitor, analyze and report real-time behavior in networks during normal operations. The objective is to be able to adapt to and quickly resolve issues that would otherwise have taken a long response time and led to end-user dissatisfaction.

Developed with the above philosophy in mind, the EXFO Mobile Agent (EMA) uses mobile devices to push the boundaries of service assurance.

2. OVERVIEW

This reference guide is an overview of how the EMA is able to deliver EXFO Verifier-like functionality on 3G and 4G/LTE mobile smartphones. It also provides the step-by-step process for setting up, testing and validating the EMA.

The active tests that run on the EMA can be configured as on-demand or SLA-driven tests from the EXFO Worx platform, and executed in Foreground or Remote Control mode on a smartphone.

All test results are uploaded to the EXFO Worx analytics engine for storage, aggregation, correlation and presentation. The active tests that run on the EMA are identical to those that run on the EXFO Verifiers. This approach means that the service quality measurements taken by EMA are directly comparable to verifier-based measurements taken in the mobile access, edge and core. The result is an integrated network of EMAs and EXFO Verifiers providing per-segment service quality views for fast drilldown to the root causes of performance degradation in mobile networks.

3. AUDIENCE

The EMA is designed to perform tests that continuously monitor, report and evaluate the health of mobile networks. The target audience for this EMA reference guide is field operations as well as technicians and engineers who must continuously monitor and validate mobile networks for normal mobile service. In conjunction with the application note, specification sheet and user guide, this reference guide provides an overview of all the EMA's features. If you are new to EXFO Worx technology, we highly recommend that you visit the EXFO website at **www.exfo.com**, where you can download the EXFO Worx specification sheet and application note for reference purposes.

4. USE CASES

The EMA currently supports the following:

1. Validating mobile services after new installations, upgrades and repairs to cell sites.
2. Performing continuous service quality monitoring at cell sites and during major public events.
3. Carrying out roaming-partner service quality monitoring.
4. Performing remote cell-site and subscriber-focused troubleshooting.
5. Performing indoor and outdoor, end-user QoE service validations.

5. DEFINITIONS AND ACRONYMS

EMA	*EXFO Mobile Agent (application for smartphones)*
Active tests	*Tests that are downloaded into active verifiers for service monitoring purposes.*
EXFO Worx network	*A collection of verifiers that are all managed by the same EXFO Worx server system.*
Verifier	*Device that is installed either off a switch port or in line with the main traffic flow of the network.*
IP	*Internet protocol*
VoLTE	*Voice-over-LTE*
LTE	*Long-term evolution*
GSM	*Global systems for mobile communication*
UMTS	*Universal mobile telecommunications system*
3G/4G	*Third-/fourth generation mobile devices*
CDMA	*Code division multiple access*
HSPA	*High-speed packet access*
GUI	*Graphical user interface*
SLA	*Service level agreement*
FTP	*File transfer protocol*
HTTP	*Hypertext transfer protocol*
UDP	*User-datagram protocol*
TCP	*Transmission control protocol*
DNS	*Domain name service*
SIP	*Session initiation protocol*
RTP	*Real-time protocol*
IMS	*IP multimedia subsystem*
CoS	*Class of service*
QoE	*Quality of experience*
ICMP	*Internet control message protocol*
VoIP	*Voice-over-Internet protocol*

6. THE EXFO MOBILE AGENT

The EMA application runs on mobile smartphone. It is comprised of active tests that support a rich set of basic, intermediate and advanced service quality measurements tagged by class-of-service (CoS) identifiers. These tests can be run locally on smartphones in either the on-demand or SLA-driven mode, and are identical to those that run on traditional EXFO Verifiers.

6.1 CELL-SITE SERVICE VALIDATION

Field technicians and engineers who repair mobile cell sites or turn up new cell-site capacity need a fast way to validate whether or not complete service coverage has been restored before they leave the job site. The EMA achieves this by providing an easy-to-use menu of service-validation tests, predefined in EXFO Worx and preloaded in the EMA.

Before running service validation tests, technicians and engineers have the ability to lock radio resources on the cell sites that have undergone recent repairs. They can then execute one of the predefined test suites (e.g., IP services). Once complete, each test run provides a clear pass/warn/fail indication based on the preset test-result thresholds.

When service validation tests fail, the technician is immediately provided with a rich set of supporting measurements to troubleshoot the root cause(s). All test results are logged with associated radio metrics for easy review and comparison when needed. The test results are also stored in EXFO Worx, thus ensuring long-term records of cell-site repair actions or birth certificates for new service installations.

6.2 CONTINUOUS MOBILE SERVICE MONITORING

The EMA can also be used as a smartphone-based verifier that operates under remote EXFO Worx control, in the same way as a traditional EXFO Verifier. In this mode, active tests are run periodically and continuously by EXFO SLA configurations. The same SLA-driven tests can also be run from EXFO Worx on-demand test templates to support remote troubleshooting actions by operations personnel.

In this mode, the continuous monitoring of cell-site performance is done from the viewpoint of an actual subscriber. Continuous service monitoring may be focused on specific radio resources, or on a selection of radio resources, thereby simulating an actual subscriber's smartphone. By continuously tracking cell-site service performance, patterns such as busy-period overload events are easily discovered and characterized.

Thanks to the portability and cost-effectiveness of the EMA smartphone platform, previously impractical service-monitoring applications are now within reach. For example, dozens of EMAs can be installed on-site at major public venues such as conventions, concerts and sporting events. Service coverage can therefore be easily verified from a subscriber's viewpoint both before and during the event, with troubleshooting tools in place to rapidly manage any service degradations.

6.3 MOBILE ROAMING ASSURANCE

The EMA is a cost-effective solution for monitoring subscriber QoE when roaming because it can determine whether or not subscribers are obtaining the same QoE while roaming as they would at home. Low-cost smartphones are easily mailed or sent to remote locations, where they can be used by contract personnel to activate the EMA. As with continuous service monitoring, the EMA can be remotely configured using EXFO Worx to perform a predefined set of continuous service quality monitoring tests. All test results are uploaded to EXFO Worx for analysis, reporting, trending and, if necessary, remote troubleshooting.

6.4 REMOTE TROUBLESHOOTING

Mobile subscriber issues that cannot be easily resolved by customer care or tier-2 operations personnel require the advanced troubleshooting of the subscriber's handset. In this scenario, tier-3 operations personnel can ask a subscriber to download the EMA to his or her handset and then obtain the permissions needed to perform advanced troubleshooting.

The EMA can be quickly and easily downloaded from EXFO Worx upon request, and is as easy to uninstall as any other smartphone application. The predefined menus make it easy for subscribers to navigate, execute tests and view results. After each run, all test results and radio metrics are uploaded to EXFO Worx, providing operations personnel with the advanced measurements they need to troubleshoot the root cause. With the subscriber's authorization, the EMA can be switched to remote EXFO Worx operation, thus enabling operations personnel to remotely execute the required tests.

6.5 INDOOR AND OUTDOOR QoE VALIDATION

According to independent research, nearly 90% of worldwide mobile traffic is expected to originate indoors as opposed to outdoors by 2015. Mobile network operators (MNO) will therefore have to be able to monitor and evaluate end-user QoE based on whether the traffic is generated indoors or outdoors. The reason for this is that the QoE varies greatly between them. Fortunately, the EMA can help QoE service validations in both indoor and outdoor environments. Operations personnel can schedule SLA tests for any type of geography: outdoor areas such as highways, freeways or mass transportation; indoor areas such as homes, malls, buildings and offices. Results can then be analyzed for various metrics and key performance indicators (KPI) in EXFO Worx.

6.6 EXFO WORX FAMILY SYNERGY

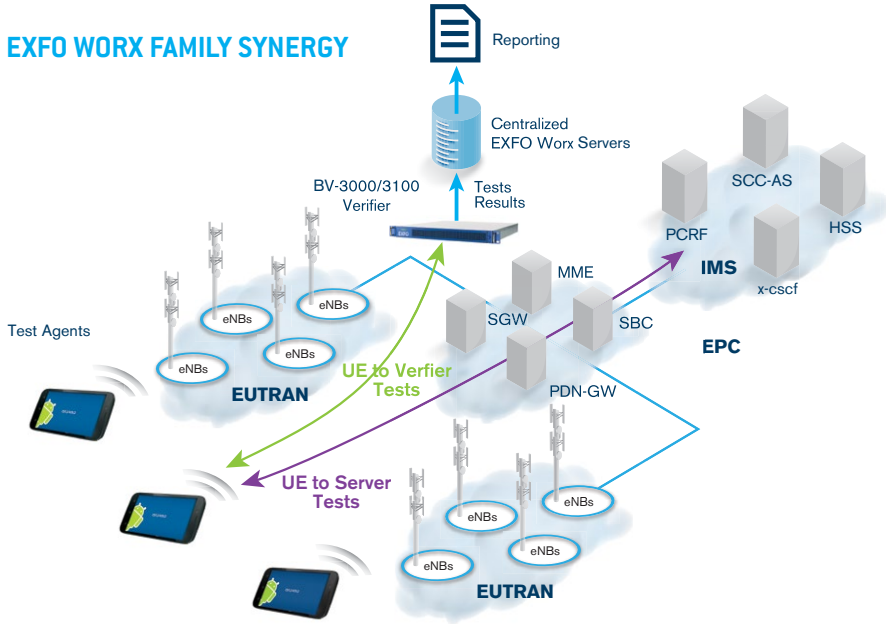


Figure 1. EMA end-to-end synergy

Active tests that run on the EMA are identical to those that run on EXFO Verifiers. This approach means that service quality measurements taken by the EMA are directly comparable to those taken by verifiers in the mobile access, edge and core networks. The result is an integrated network of EMAs and verifiers providing per-segment service quality views and metrics for fast root-cause analysis of service performance degradations.

The EMA's on-demand tests are managed as an extension to traditional verifier tests. These predefined tests are configured by the EXFO Worx administrator using the standard EXFO on-demand test template editor. The tests may specify any combination of hard-coded parameters, default parameters and/or other parameters that can be set at runtime. Once defined, these test templates are downloaded to the EMA and automatically appear as selectable menu items. These tests can also be scheduled from EXFO Worx when the EMA is operating in remote-control mode. When operating in this mode, the EMA runs standard active tests under SLA control, as per traditional verifiers. Status and health metrics for all active EMAs are tracked and reported to EXFO Worx administrators.

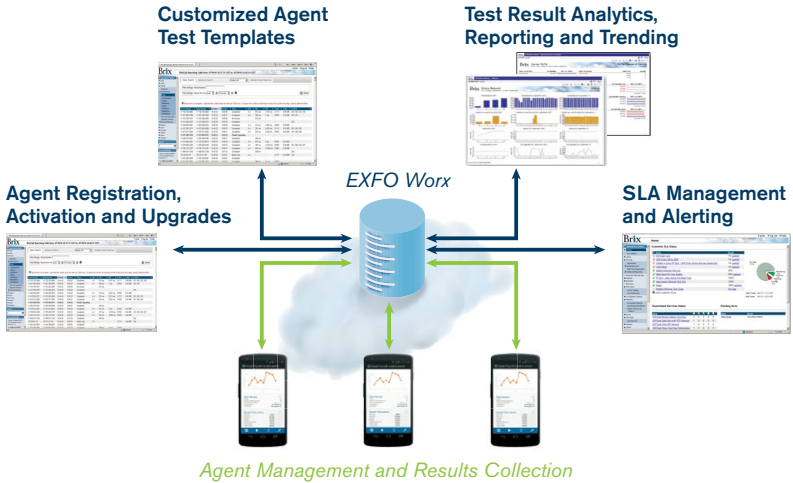


Figure 2. EMA interaction with EXFO Worx

EMA's synergy with EXFO Worx ensures that all hosted service assurance applications have access to a common set of essential functions (open application programming interfaces, or APIs) where KPIs and alerts can be easily integrated with third-party operations support systems (OSS). Users gain access to the service status, SLAs, problem detection and troubleshooting functions through the entirely web-based EXFO Worx Operation Center.

EMA licensing and upgrades are managed in EXFO Worx, as well as the ability to manage multiple EMA versions in the field population. Newly authorized EMA users are notified and provided with a link to download and activate the EMA on their smartphone, while users already familiar with EXFO Worx are granted general EXFO Worx privileges.

7. SPECIFICATIONS

7.1 SUPPORTED TESTS

All EMA active tests are supported as technician-controlled, on-demand, service-validation tests or EXFO Worx-controlled, continuous-monitoring, service assurance tests. A list of currently supported tests is provided below:

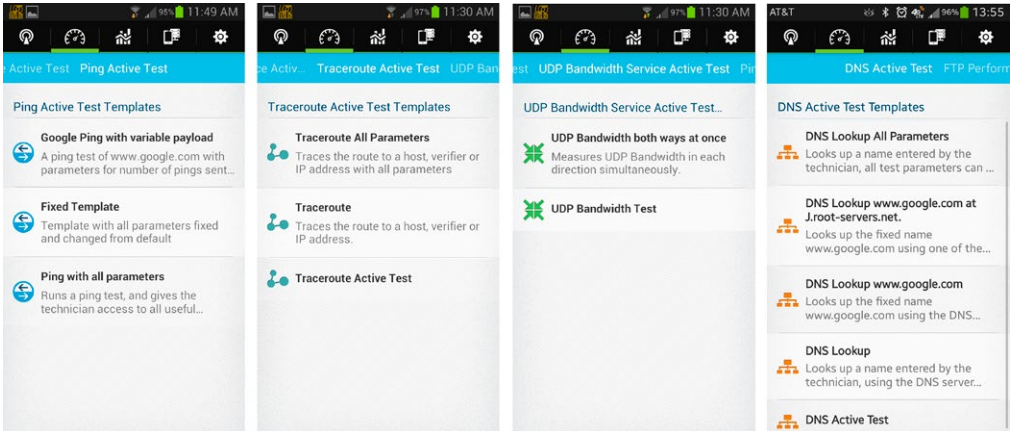
7.1.1 Ping and Traceroute

The ping active test measures IP network availability and performance using Internet-control-message-protocol (ICMP) echo requests to a target device or verifier. Closely related, the traceroute

active test determines the path taken through a network and the performance of router hops along that path. Typical KPIs include:

1) **IP Endpoint:** Endpoint availability, packet loss and round-trip latency

2) **IP Path**: Per-hop distance, IP path addresses and router response times



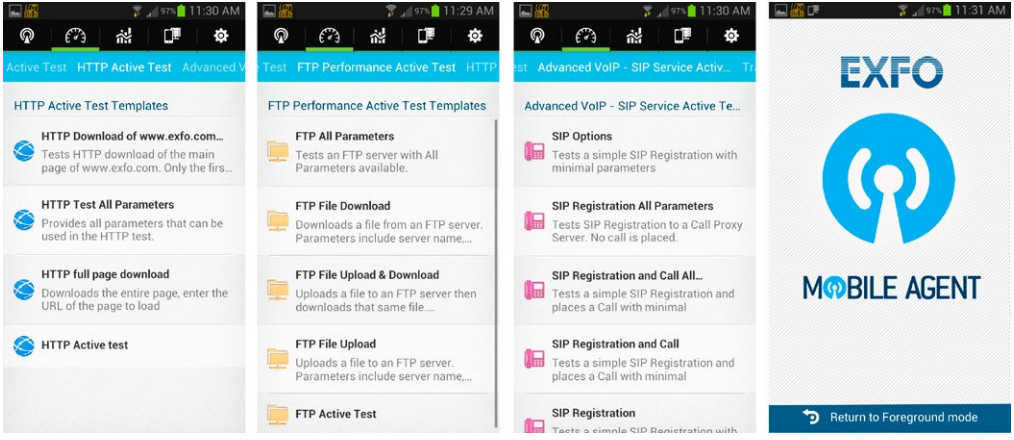


Figure 3. EMA-supported tests overview

7.1.2 UDP Bandwidth

The user datagram protocol (UDP) bandwidth test measures available UDP bandwidth between the EMA and the verifier test responder, or between two EMAs (i.e., M2M). Typical KPIs include:

1) **Uplink**: Initiator-to-responder bandwidth, packet loss, packets out of order and packet latency
2) **Downlink**: Responder-to-initiator bandwidth, packet loss, packets out of order and packet latency

7.1.3 DNS Performance

The DNS active test measures the availability and performance of a DNS service or server. Supported query types include A, AAAA, CNAME, ENUM and SRV record types. Typical KPIs include:

1) Server availability, query failure rate (by reason), resolved address(es) and query response time

7.1.4 HTTP/HTTPS Performance

The HTTP active test measures the availability and performance of an HTTP web server by downloading a complete web page from a web service or server, in addition to all embedded and redirected objects within the page. Typical KPIs include:

1) **Server**: Service availability, first-page download time, first-page response time, total download time, redirect time, network latency and metrics for all objects that are part of the page
2) **Transfer**: Throughput, transfer size

7.1.5 FTP/FTPS Performance

The FTP performance test measures the availability and performance of an RFC 959-compliant FTP service or server, including file-upload and file-download performance. Typical KPIs include:

1) **Server**: Service availability and connection response time
2) **Transfer**: Throughput, transfer size

7.1.6 VoIP and SIP Performance (SIP + RTP Media)

The voice-over-Internet protocol (VoIP) tests measure the availability and performance of VoIP calls from the EMA to the verifier test responder, voice-service endpoints and/or another EMA. These tests support RFC 3261-compliant SIP, RFC 3550-compliant real-time protocol (RTP) media, and RFC 3661-compliant RTCP-XR. Typical KPIs include:

1) **VoIP Call**: Call-service availability, success and failure rates (by reason), call setup time, post-dial delay and post-pickup delay
2) **RTP Media**: Voice quality (RFactor, MOS), degradation factors, packet loss, jitter, jitter buffer packet discard and latency

7.2 RESULTS

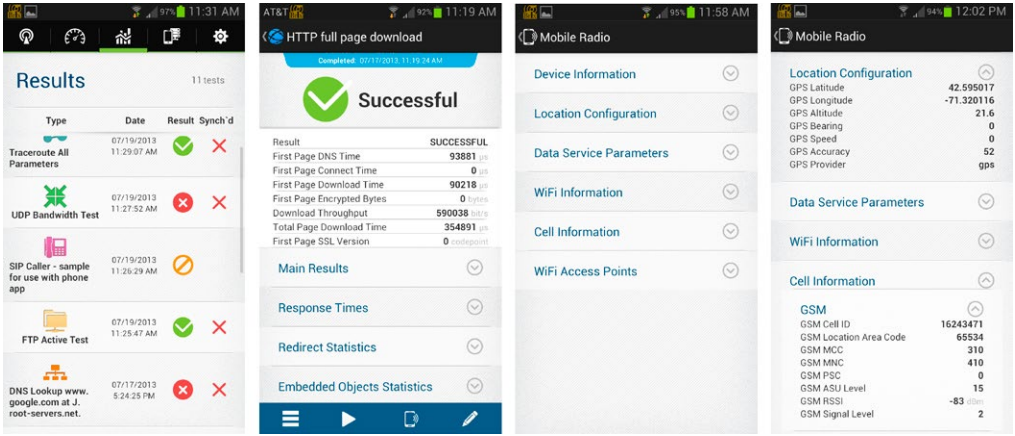


Figure 4. EMA results overview

The results for each test are displayed and saved on the mobile device. Test results are also available on the EXFO Worx server as soon as they have been successfully synchronized. The three types of test results, each of which is tagged by a set of CoS identifiers, are:

1) **Basic** test results provide at-a-glance views of acceptable or unacceptable performance levels
2) **Intermediate** test results provide top-level insight into problem areas
3) **Advanced** test results facilitate in-depth, root-cause troubleshooting

7.3 DEVICE, RADIO AND TRANSPORT METRICS

In addition to on-demand and SLA-driven test metrics, the EMA reports standard mobile device and radio-network health metrics. These radio metrics are illustrated in the screenshot above, and can be summarized as follows:

1. **Device Information:**
   a. **Configuration details:** Model, OS type, kernel, build information
   b. **Identifier details:** IMEI, IMSI, ICCID and MSISDN
   c. **Status details:** Call, data, connection, network, radio, operator, roaming and PLMN
   d. **Battery information:** Status, health and charge level

2. **Location Information:** Latitude, longitude, altitude, bearing, speed, accuracy and provider
3. **Data Service Parameters:** IP address, DNS, DHCP, Gateway, and netmask details
4. **Wi-Fi Information:** State, network ID, BSSID, SSID, signal strength and link speed
5. **Cell Information:** GSM, CDMA and LTE cell and network details, LAC and signal strength details
6. **Wi-Fi Access Points:** SSID, BSSID and signal level for all available access points

Other radio metrics in the works.

7.4 MOBILE PLATFORM AND DEVICE SUPPORT

1. The EMA currently supports Android versions 4.0.4 (Ice Cream Sandwich) and Android 4.1 (Jelly Bean).
2. The EMA is currently validated on mobile devices such as the Samsung Galaxy SIII and the Samsung Galaxy S4.
3. Support for other certified Android mobile devices and non-Android mobile devices is underway.

8. CONCLUSION

The EMA is a unique application in the mobile service assurance market. As previously outlined in this reference guide, there is a tremendous advantage to ensuring that SLA tests tie into the subscriber's experience. Having the flexibility to perform tests on mobile devices such as EXFO Worx Verifiers provides customers with a unique view of the day-to-day operations of their mobile networks.

EXFO Service Assurance is a world leader in telecom service assurance products. For more information or details about getting started with the EMA solution, please contact our sales representatives, or visit **www.exfo.com/products**.

Acknowledgements

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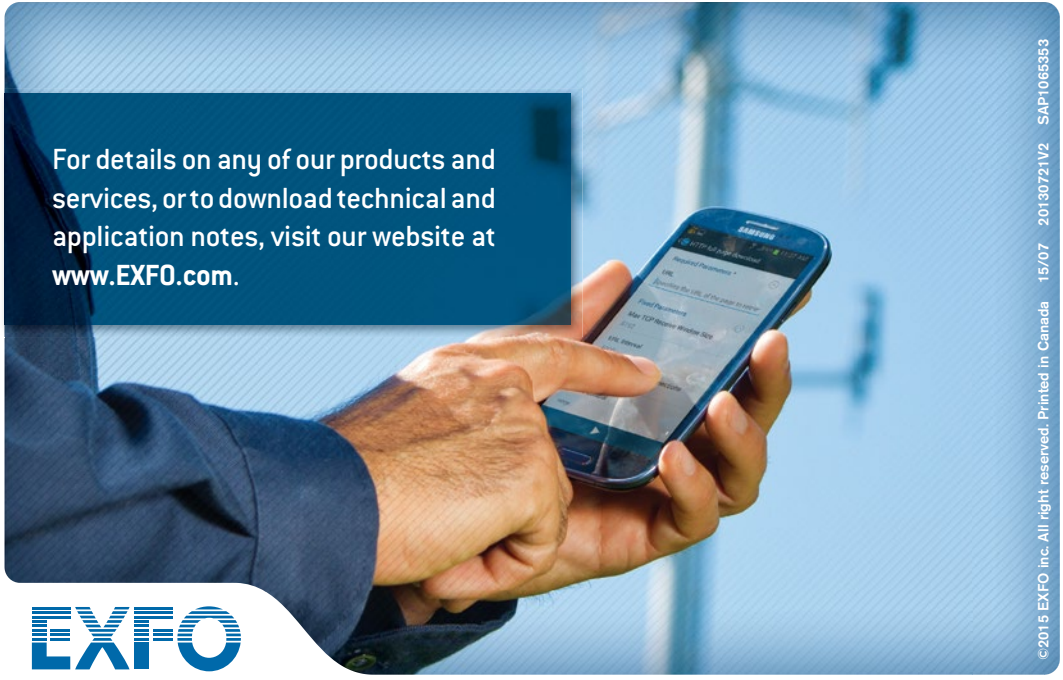
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