Production Performance Monitoring (PPM) Application Guide

Production Performance Monitoring Application Guide Introduction

Increase process awareness and begin monitoring manufacturing throughput with a wireless Production Performance Monitoring (PPM) Kit from Banner Engineering. The PPM Kit is a modular self contained solution that can be used to monitor up to 47 lines or processes using battery-powered Q45 All-in-One Photoelectric Sensor Nodes or DC-powered Wireless TL70 Tower Light Nodes for use with already installed sensors. TL70 Tower Light Nodes can be equipped with lighted segments for local line speed indication without any additional configuration.

This application enables quicker responses from line operators to increase production speeds when throughput rates are low, and empowers process and automation engineers with real data for continuous improvement without the need to change any programming on their production process.

This application guide demonstrates how to bind the Wireless Q45 All-in-One Photoelectric Sensor Nodes and Wireless TL70 Tower Light Nodes to the DXM Controller and how to load the pre-configured XML and ScriptBasic files. Operators can quickly be up and running by entering line speed information directly into the DXM using the built-in screen and buttons. The system can be further customized for specific application requirements.

Guide Features and Benefits

Performance Calculations	Calculates line performance by comparing the actual line throughput to a user-defined ideal state
Part Counting	Use up to 47 battery-powered Q45 All-in-One Photoelectric Sensor Nodes or Wireless TL70 Tower Light Nodes for part counting up to 960 parts per minute
Track line speeds	Calculates the parts per minute rates for each sensor and gives the instantaneous rate and a daily averaged rate
Monitors Machine Status	Determines line status (running, slow, or stopped) based on user-defined throughput rates; tracks changes of event and monitors length of events
Status Alerting	User-configured alert settings for extended slow or stopped conditions
Remote Monitoring	Pushes data to Banner's Cloud Data Services for remote viewing, generating automatic dashboards, generating alerts, and logging data

Equipment

Users can order a Production Performance Monitoring Kit that includes the base hardware for the solution and can expand it by adding additional Q45 All-in-One Photoelectric Sensor Nodes and/or Wireless TL70 Tower Light Nodes. The pre-configured PPM Kit comes with a single DXM1200 and one Q45 Sensor Node and/or TL70 Node. Users can also build their own kit and manually configure the solution.

Table 1: Pre-configured kit models and components

Model	Frequency	Sensing Mode	Kit Components
PPM-DKIT-9	900 MHz ISM Band	Diffuse	DXM1200-B1R1-812310 Wireless Controller DX80N9Q45DD All-in-One D Cell Sensor Node PSW-24-1 Power Supply, LMB30LP bracket, and a 90-day trial for Banner CDS
PPM-DKIT-2	2.4 GHz ISM Band		DXM1200-B1R3-812311 Wireless Controller DX80N2Q45DD All-in-One D Cell Sensor Node PSW-24-1 Power Supply, LMB30LP bracket, and a 90-day trial for Banner CDS
PPM-LPKIT-9	900 MHz ISM Band	Retroreflective	DXM1200-B1R1-812310 Wireless Controller DX80N9Q45LPD All-in-One D Cell Sensor Node PSW-24-1 Power Supply, LMB30LP bracket, BRT-2X2 reflector, and a 90-day trial for Banner CDS
PPM-LPKIT-2	2.4 GHz ISM Band		DXM1200-B1R3-812311 Wireless Controller DX80N2Q45LPD All-in-One D Cell Sensor Node PSW-24-1 Power Supply, LMB30LP bracket, BRT-2X2 reflector, and a 90-day trial for Banner CDS
PPM-TLKIT-9	900 MHz ISM Band	Wireless Node only - requires a PNP sensor	DXM1200-B1R1-812310 Wireless Controller B-TL70DXN9-Q5 Wireless Base Module PSW-24-1 Power Supply (qty 2), S15A-F1235X-M123X4-Q adapter, CSB-M1250M1250-T splitter, LMB30LP bracket and a 90-day trial for Banner CDS
PPM-TLKIT-2	2.4 GHz ISM Band		DXM1200-B1R3-812311 Wireless Controller B-TL70DXN2-Q5 Wireless Base Module PSW-24-1 Power Supply (qty 2), S15A-F1235X-M123X4-Q adapter, CSB-M1250M1250-T splitter, LMB30LP bracket and a 90-day trial for Banner CDS

Build your own Kit— Users can build their own kit and customize individual component choices.

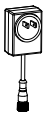
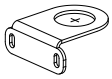
1. Select what radio frequency can be used:
   900 MHz
   2.4 GHz
2. Select a DXM Controller/gateway/Edge device:
   DXM700
   DXM1000
   DXM1200
3. Select how many lines are being monitored (Number of Nodes) and what sensor is suitable for monitoring. Any combination of the following devices is compatible with the PPM Kit:
   Diffuse
   Retroreflective
   Tower Light Node for use with any PNP sensor
4. Add optional accessories as needed

Refer to Table 2 on p. 2 for suggested models and to Optional Accessories on p. 2 for suggested brackets, power supplies, and cables.

Table 2: Solution components

Model		Description
900 MHz	2.4GHz	
DXM1200-B1R1	DXM1200-B1R3	DXM Series Wireless Controller, system compatible with DXM700, DXM1000, or DXM1200 Wireless Controllers
DX80N9Q45DD	DX80N2Q45DD	Wireless All-in-One D Cell Photoelectric Diffuse Sensor Node
DX80N9Q45LPD	DX80N2Q45LPD	Wireless All-in-One D Cell Photoelectric Retroreflective Sensor Node
B-TL70DXN9-Q5	B-TL70DXN2-Q5	TL70 Wireless base module for PNP sensors

Optional Accessories

Accessory	Model	Description
	SG-TL70-G	Green TL70 Wireless Base Segment for Status Indication
	SG-TL70-Y	Yellow TL70 Wireless Base Segment for Status Indication
	SG-TL70-R	Red TL70 Wireless Base Segment for Status Indication
	TL70DXN9GYRQ	TL70 Wireless Tower Light with counter input, 900 MHz
	TL70DXN2GYRQ	TL70 Wireless Tower Light with counter input, 2.4 GHz
	PSW-24-1	DC power supply with wall plug, 100-240 V AC 50/60 Hz input, 24 V DC 1 A output, UL Listed Class 2 (comes with kit, power supply for the DXM controller and TL70)
	S15A-F1235X-M123X4-Q	S15A In-Line Adapter for adapting sensor output (black wire/pin 4) to TL70 input wire (gray wire/pin 5)
	CSB-M1250M1250-T	M12 straight T splitter connector for use with TL70 and S15A In-Line Adapter
	LMB30LP	Low-profile mounting bracket for Q45s and TL70 Wireless Base Segment

Accessory	Model	Description
	**SMB30A**	Right-angle Mounting Bracket for Q45s and TL70 Wireless Base Segment
	**BRT-2X2**	Retroreflector, square 51 mm × 51 mm for use with Q45 Retroreflective All-in-One Sensor Node
	**BWA-BATT-011**	3.6 V Lithium D Cell Replacement Battery

Step 1: Set the DIP Switches

The Q45 All-in-One Photoelectric Sensor Nodes and WirelessTL70 Tower Light Node require specific DIP switch settings to operate correctly with the PPM Kit.

Table 3: DIP switch positions

Model	DIP Switch 1	DIP Switch 2	DIP Switch 3	DIP Switch 4
Q45DD and LPD All-in-One Nodes	OFF	OFF	ON	OFF
TL70 Tower Light Node	OFF	OFF	ON	OFF

For detailed instructions about how to access the DIP switches, refer to the Q45DD and LPD datasheet (p/n 223998) and the Wireless TL70 Tower Light Node datasheet (p/n 185469).

After making changes to the DIP switches, cycle power to the Q45s and/or the TL70. To cycle the power to any battery-powered radios, enter binding mode and then exit binding mode (with or without binding). For instructions on how to enter/exit binding mode, see Step 2: Bind the Q45 and Tower Light Nodes on p. 3.

Step 2: Bind the Q45 and Tower Light Nodes

The binding process establishes a secure radio connection between the Nodes and the DXM Controller. Follow these steps to bind the Q45 All-in-One Photoelectric Sensors and/or TL70 Nodes to your DXM Controller.

Before beginning the binding procedure, apply power to all the devices.

1. On the DXM: Enter binding mode by going to the Main menu and selecting **ISM Radio** > **Binding**.
2. Select the Node ID you would like to assign to the Q45 or TL70 Node.

   Assign each Node a unique Node ID. Node IDs 1 through 47 are the valid selections. Banner Engineering recommends binding Nodes in order (Node 1, Node 2, etc).
3. Press **Enter** to start the binding procedure.
4. Enter binding mode on a Q45 or TL70.
   - On the Q45 All-in-One Photoelectric Sensors: Access the binding button by unscrewing and lifting the plastic cover. Press the binding button three times.
   - On the TL70: Access the binding button by holding the base module and twisting the cover counter-clockwise and pulling the cover off. Press the binding button three times.

   The red and green LEDs flash alternately and the radio searches for a DXM in binding mode. After the device is bound, the LEDs stay solid momentarily (appears orange), then flash four times. The radio exits binding mode.
5. Label the Node's ID number with the supplied Device ID sticker.
6. On the DXM: Press **Back** to return to the **Bind to #** screen.
   If the Node is bound and synchronized with the DXM, the green status LED flashes.
7. Repeat these steps for as many Nodes as are needed for your network.
8. After binding all Nodes, exit binding mode on the DXM by pressing **Back** until you return to the **Main** menu.

Step 3: Conduct a Site Survey from the DXM

Conduct a Site Survey to verify the wireless communication between the radios within your wireless network. Conduct the site survey when the Nodes and DXM Controller are at the proposed installation sites to determine each radio's signal strength with the DXM.

1. On the DXM: Use the arrow buttons to select the **ISM Radio** menu and press **ENTER**.

2. Select the **Site Survey** menu and press **ENTER**.
3. Use the Up or Down arrows to select the device ID number and press **ENTER** to run the site survey with that radio.
   The site survey results display as green, yellow, red, and missed packets. Green indicates the highest signal strength, then yellow, and red. Missed packets were not received.
4. When you are finished running the Site Survey, press **Back** twice to return to the main menu and exit site survey mode.

If the Site Survey fails (100 missed packets), verify the radios are at least 10 feet from the DXM and/or rerun the binding procedure. If you find poor signal quality, common solutions include moving the DXM to a more central location relative to the Nodes or using higher-gain antennas on the DXM. Contact your local Banner Engineering representative for assistance.

Step 4: Upload the Configuration Files

There are two files loaded onto the DXM: the XML configuration file that defines the DXM's Local Register configuration and the ScriptBasic file that runs the main program. **Skip these instructions and to go Step 5: Configure the Application Settings on p. 4 if your DXM1200 is pre-loaded with the XML and ScriptBasic files. The DXM1200 that comes in the PPM Kits is pre-loaded with the files.**

Verify you have run the binding instructions on all Nodes, assigned Node IDs to all radios, installed the radios, and conducted a Site Survey to test the signal strength.

1. Download and install Banner's DXM Configuration Software (v4 or newer) onto the computer you will be using to configure your files.
2. Download the Production Performance Monitoring Kit configuration files (p/n b_51144830) from www.bannerengineering.com. The pre-configured files can also be found on the DXM Series Page or the Production Performance Monitoring application guide page.
3. Extract the ZIP files into a folder on your computer. Note the location where the files were saved.
4. Connect the DXM, using the USB Cable supplied or with an Ethernet cable, to a computer containing the DXM Configuration Software V4.
5. Launch the configuration software and connect to the DXM.
6. In the **Configuration Mode** drop-down list, select **Traditional Setup**.
7. Select the connection mode.
   - **Serial**—Select the COM port the USB cable is plugged into. If you are unsure which COM port to select and multiple ports are listed, disconnect the USB cable and press the refresh button to see which port disappears. Reconnect the USB cable and select the COM port that reappeared.
   - **TCP/IP**—Enter the IP address of the DXM, which can be found in the DXM LCD under **System Info** > **Ethernet** > **IP**. The default static IP is 192.168.0.1. Your computer must be on the same network as the DXM.
8. In the **Select DXM Model** drop-down list, select **DXM1200**.
9. Click **Connect**.
10. To load the configuration file, go to **File** > **Open** and choose the XML file **223065.xml**.
11. To load the ScriptBasic file, go to **Settings** > **Scripting** and click **Upload File**. Select the ScriptBasic file **223064.sb**.
12. On the menu bar, go to **DXM** > **Send Configuration to DXM**.
    The XML configuration file uploads to the DXM and runs the PPM program after the DXM is rebooted.
13. Cycle power to the DXM Controller.

Step 5: Configure the Application Settings

After uploading the configuration file to the DXM, users can modify application-specific settings directly from the DXM's menu system. Before making any changes, enable the Delay Mode via the DXM display. The PPM Kit is pre-configured to work without additional complex programming or software. For the most accurate performance metrics, we recommend that users modify the Number of Sensors, Ideal Run Rate, and Stopped Rate parameters to fit their specific production speeds.

1. On the DXM, use the arrow keys to select the **Registers** menu and press **ENTER**.
2. Scroll down to **Delay Mode** and press **ENTER**.
3. Using the arrow keys, change the value to 1 and press **ENTER** three times.
   The **Delay Mode** setting should now display **ON**.
4. Use the arrow keys to modify any parameters based on the application/user requirements. See the Parameters table for parameters that are configuration using the display.
   a) Set the **Number of Sensors** to the number of Q45 or TL70 devices in the system. For increased processing speed and reduced data pushed to the cloud, do not set this value higher than the actual number of devices in the network.
   b) Set the **Ideal Run Rate** to the ideal line speed in parts per minute (PPM). The sensor will be in an ideal run state when the PPM is above this parameter. When the PPM value is below this parameter, the sensor is in a slow running condition. This parameter applies to all connected sensors. For individual Ideal Cycle Time parameters, set this value to 0 and modify registers 7051 and greater (not configurable with the display).
   c) Set the **Stopped Rate** to the line speed in parts per minute (PPM) at which the process is considered stopped. The sensor will be in a stop condition when the PPM value is less than this parameter. This parameter applies to all connected sensors. For individual Stop Cycle Time parameters, set this value to 0 and modify registers 7101 and greater (not configurable with the display).

5. After all the application settings changes are entered, disable **Delay Mode** by setting the **Delay Mode** value to **0**.
6. Cycle power to the DXM to apply your changes.

Table 4: Parameters

DXM Registers	Name	Description	Default Value	Cloud
851	Report Time	Global setting for Sensor report time in seconds, for Battery powered applications, it is not recommended to report faster than 1/minute, longer report times increase battery life. Set to 0 to use individual line report times. See register 7001	60	At boot/write
852	Number of Sensors	Indicates the number of Sensors in the system. The system cannot exceed 47 Sensors and can be a combination of Q45s or TL70s	47	At boot/write
853	Ideal Run Rate	Global setting for an ideal run rate in parts per minute (PPM). Set to 0 to use individual line Ideal Run Rates. See register 7051	15	At boot/write
854	Stopped Rate	Global setting for a stop condition in parts per minute (PPM). Set to 0 to use individual stopped line rates. See register 7101	3	At boot/write
855	Slow Alarm Time	Global setting, in seconds, for initiating a slow state alarm	300	At boot/write
856	Stop Alarm Time	Global setting, in seconds, for initiating a stop state alarm	150	At boot/write
857	Stop Count	Successive reports below stopped rate to trigger a stopped scenario. For example, a stop count of three (3) with a report time of 60 seconds means a line will not enter a stop state until it has been below the Stopped Rate for three consecutive reports or 3 minutes	3	At boot/write
858	Delay Mode	Enables script delay that adds a two second wait time before starting another loop in the program, the system operates normally with this exception. This is helpful for troubleshooting the system and should be disabled during normal operation. 1 = Enabled, 0 = Disabled	0	
859	Push Rate	Global setting, in seconds, for initiating a push rate to Banner CDS.	300	1/day
860	Push Enable	Enables the controller to push data to Banner CDS. Set to a value of 0 to disable cloud pushing	1	
861	Low Performance	Global setting for a Low Performance Alert. Set to a value of 0 to use individual Low Performance Alerts. See register 7151	85	At boot/write
862	Critical Performance	Global setting for a Critical Performance Alert. Set to a value of 0 to use individual Critical Performance Alerts. See register 7201	50	At boot/write

Step 6: Push Information to BannerCDS

The DXM Wireless Controller can connect to the Web via Ethernet or an internal cell module. The controller pushes data from the DXM to be stored and displayed on a website.

The Banner website for storing and monitoring the system's data is https://bannercds.com. The Banner Cloud Data Services website automatically generates dashboard icons and graphs for the application that is populated onto the Dashboard. Email alerts can be configured using the Alarms screen.

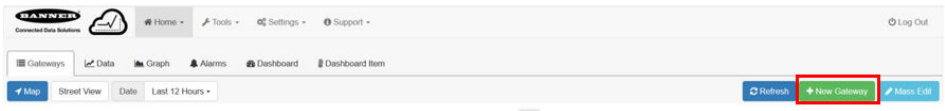
Create a New Gateway

After you log into the Banner CDS website, the **Gateway** screen displays. Follow these steps to create a new monitoring site.

1. Click on **+New Gateway**.

   Create a new Gateway/site for each device that will be sending data to the web server.

   Figure 1. Create a New Gateway/Site

   A **Create New Gateway** prompt appears.
2. Verify **Traditional** is selected for the **Configuration**.
3. Enter a site name.
4. Under **XML Config**, select **Choose File** and upload the PPM configuration XML file: **223065.xml**.
5. When prompted to generate a unique gateway ID, click **Yes** and then click **Get XML** when prompted to download the file. This generates a unique ID that needs to be loaded back into the DXM. Save this file for the next step.

6. Click **Create**.
   The Gateway/Site appears in the listing of devices on the **Gateways** screen and lists a status of **Waiting for device to connect**. After the DXM begins pushing data, the status changes to a green timestamp after a successful push.

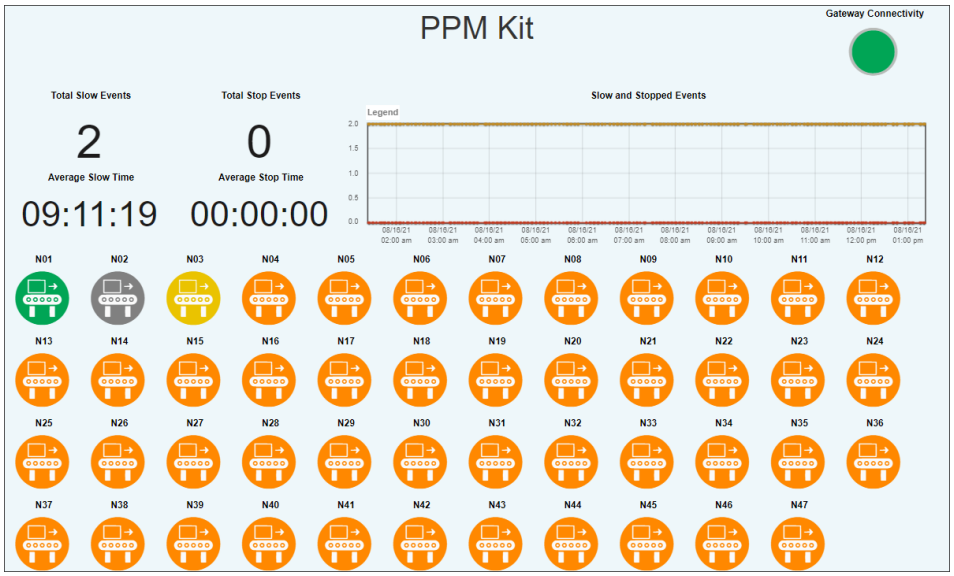
Update the DXM with the Banner CDS Configuration

The DXM is automatically configured to push data to Banner CDS at 5 minute intervals. No additional configuration changes are required after downloading the modified XML that was created for this application.

1. Within the DXM Configuration Software, connect to the DXM and go to the **File** > **Open** menu. Open the XML configuration file downloaded from Banner CDS for this application.
2. Send the updated XML to the DXM Controller using the **DXM** > **Send XML Configuration to DXM** menu.

Completing these steps creates continuity between the site created on the website with the DXM used in the field. The DXM pushes data to the website, which can be viewed at any time.

Figure 2. Main dashboard screen

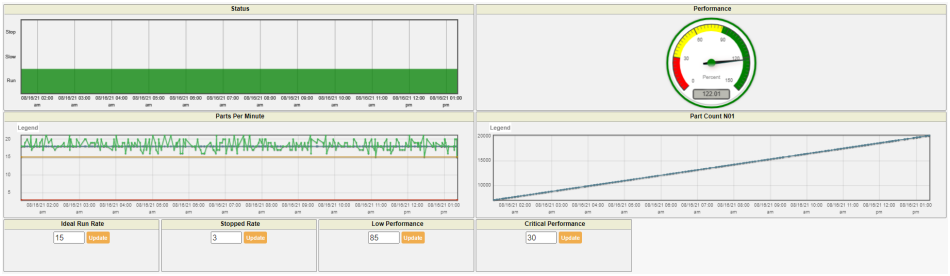


Refer to the Banner Cloud Data Services Instruction Manual to review all the features available for monitoring, comparing data, and establishing warnings/alarms on the website. To access a demo version of the website please contact your local Banner distributor and follow the instructions in the technical note: Connecting to the Banner Cloud Data Services Demo Site for modified instructions on how to send data to the demo site.

Dashboard View

The PPM Kit automatically creates two dashboards for performance monitoring. The main dashboard gives users a high level view of the system, showing the total slow and stop events and average length of events across the entire system of sensors. Individual item view dashboards give users access to view individual sensor performance, part counts, status, average ppm, and the ability to configure individual sensor settings such as run rates, stop rates, and performance thresholds.

Figure 3. Item View dashboard screen for the PPM kit



Optional Configuration Steps

Clear the Sensor Data from the DXM

The Sensor Data, State, and Timer registers in the system have a reset register that can be accessed using the DXM's display, Modbus Registers, or Banner CDS. Set register 822 to a value of 1 to reset all the counters and data registers.

Follow these steps to clear the sensor data using the DXM display.

1. On the DXM: Use the arrows to select **Registers**.
2. Select the **Clear Sensors** register.
3. Press **Enter**.
4. Change the value to 1 then press **Enter** three times.
   The reset register automatically returns to zero after the data is reset.

Clear the Sensor Data from Banner CDS

Follow these steps to clear the sensor data using the Banner Cloud Data Services website.

1. Go to the **Dashboard** > **Sites** screen.
2. Select the **Dashboard** name where the Call for Parts Kit exists.
3. Toggle the **Clear Sensors** button.
4. A pop-up window asks if you would like to trigger an update. Click **Yes**.
   An update to reset the data registers is sent to the DXM the next time the DXM pushes data to Banner CDS.

Clear the Sensor Data from the Scheduler Tool

The Sensor Data can be cleared using the DXM Configuration Software's Scheduler tool.

Synchronize the DXM's on-board clock with your PC for accurate scheduled resets. To sync the PC time with the DXM, go to **Settings** > **System** and click **Sync PC time with device**.

1. In the DXM Configuration Software: Load the PPM configuration XML file (223065.xml).
2. Go to **Tools** > **Scheduler** > **Weekly Events** and click **Add Weekly Event**.
3. Name the event and set the **Register** to 822. Register 822 is the Clear Sensors register.
4. Select the days that the reset will be conducted, the abbreviations will be highlighted yellow when selected.
5. Set the **Schedule Definition** parameters.
   a) Set the **Start Value** to 1.
   b) In the **Start at** drop-down list, select **Specific Time**.
   c) Set the desired reset time using 24-hour format.

   This can be repeated multiple times for automatic shift resets. An **End Value** is not required for this functionality.
6. Go to **File** > **Save** to save the changes to your configuration file.
7. Go to **DXM** > **Send Configuration to DXM** to upload the new configuration file to the DXM.

Set Individual Report Rates

Sensor report rates can be customized to have individual reporting (such as some sensors reporting once every minute and others every 5 minutes). For this advanced setting, the DXM must be accessed using the DXM Configuration Software, Banner CDS, or Industrial protocols (Modbus TCP/Ethernet IP).

1. On the DXM: Use the arrows to select **Registers**.
2. Select the **Report Time** register and press **Enter**.
3. Change the value to 0 then press **Enter** three times.
4. Access the Individual Report Time registers (7001 through 7050).
   a) When you are connected through the DXM Configuration Software, go to **Tools** > **Register View** > **Writer Registers**. Set the Starting Register to 7001. Enter a value, in seconds, and click **Write registers**. The individual **Report Time** registers can be updated one by one or in batches.
   b) When you are connected through Banner CDS, go to the **Data** screen and find register 7001, Report Time N#. Click the update icon on the left, enter the time in seconds, and click **Save**. The parameter will update on the next push to Banner CDS.
   c) When you are using industrial protocols, update the DXM's Local Registers 7001–7050 to reflect the individual **Report Time** desired for each sensor.
5. After the **Report Time** parameter is updated, cycle the power to the DXM or set the Initialize command to 1 to update the parameters on each sensor.

Configure the Kit for a Cellular Push Interface

By default, the DXM in the Production Performance Monitoring kit is configured for an Ethernet push interface to push information to Banner CDS. To configure the system for a cellular push interface, configure the default configuration file (223065.xml) for cell capabilities. Cellular cloud connectivity requires an appropriate cellular modem and cell plan for the DXM1200.

1. In the DXM Configuration Software: Load the PPM configuration XML file (223065.xml).
2. Go to the **Settings** > **Cloud Services** screen and select **Cell** in the **Push Interface** drop-down list. If you are changing the configuring from **Cell** to **Ethernet**, select Ethernet and go to step 4.

   Setting the cloud push interval is not required; the PPM ScriptBasic file controls the cloud push rate.
3. In the **Settings** > **Cellular** screen, select the appropriate Cell Module that is connected to your DXM from the drop-down list.
4. Go to **File** > **Save** to save the changes to your configuration file.
5. Go to **DXM** > **Send Configuration to DXM** to upload the new configuration file to the DXM.

Interpreting the Status Registers

The Q45 All-in-one Photoelectric Sensor Nodes and Wireless TL70 Tower Light Nodes contain virtual status registers. These registers can be used to determine what state each line is in and to calculate advanced metrics.

Registers 5951 through 6000 contain the status registers. The register's value determines what state the line is in. Users can map this information to a PLC, HMI, or SCADA system for advanced analytics such as monitoring average slow/stop rates or monitoring stop events.

Table 5: Sensor state and timers

DXM Registers	Name	Register Value	Status	Description	Cloud
5951–6000	Sensor State N#	100	Off	Sensor/Node is powered on but has not begun counting	R/W
		200	Run	Sensor is in a run state condition, line speed is greater than Ideal Run Rate setting	
		300	Slow	Sensor is in a slow state condition, line speed is less than Ideal Run Rate	
		400	Stop	Sensor is in a stop state condition, line speed is less than or equal to the Stopped Rate	

Local Registers

Table 6: Supervisory data

DXM Registers	Name	Description	Cloud
801	Global Run State	At least one line is in a Run state, OR'd value of all sensors. 1 = true	R/W
802	Global Slow State	At least one line is in a Slow state, OR'd value of all sensors. 1 = true	R/W
803	Global Stop State	At least one line is in a Stop state, OR'd value of all sensors. 1 = true	R/W
804	Total Slow Events	Sum of all Slow Counters for all sensors	R/W
805	Total Stop Events	Sum of al Stop Counters for all sensors	R/W
806	Average Slow Time	Average time of all slow events (minutes) for all sensors, total slow time divided by total slow events	R/W
807	Average Stop Time	Average time of all stop events (minutes) for all sensors, total stop time divided by total slow events	R/W
808	Total Slow Time	Sum of all slow times for all sensors	R/W
809	Total Stopped Time	Sum of all stopped times for all sensors	R/W
810	Global Low Performance	At least one Sensor has a Low Performance Alert, OR'd value of all sensors. 1 = true	R/W
811	Global Critical Performance	At least one Sensor has a Critical Performance Alert, OR'd value of all sensors. 1 = true	R/W

Table 7: Commands

DXM Registers	Name	Description	Default Value	Cloud
821	Initialize	Reads all parameter settings, generates node IDs and clears counters. Set to 1 to initiate. Initializing should be executed when the Report Time or Number of Sensors Parameter is Changed	0	At boot/write
822	Clear Sensors	Clears all Sensor Data registers and Sensor States and Timers	0	At boot/write
823	Sync Sensors	Synchronizes Sensors to network (use when Sensor is powered ON but status is not 128). This is generally used at startup/when initializing the system	0	

Table 8: Parameters

DXM Registers	Name	Description	Default Value	Cloud
851	Report Time	Global setting for Sensor report time in seconds, for Battery powered applications, it is not recommended to report faster than 1/minute, longer report times increase battery life. Set to 0 to use individual line report times. See register 7001	60	At boot/write
852	Number of Sensors	Indicates the number of Sensors in the system. The system cannot exceed 47 Sensors and can be a combination of Q45s or TL70s	47	At boot/write
853	Ideal Run Rate	Global setting for an ideal run rate in parts per minute (PPM). Set to 0 to use individual line Ideal Run Rates. See register 7051	15	At boot/write
854	Stopped Rate	Global setting for a stop condition in parts per minute (PPM). Set to 0 to use individual stopped line rates. See register 7101	3	At boot/write
855	Slow Alarm Time	Global setting, in seconds, for initiating a slow state alarm	300	At boot/write
856	Stop Alarm Time	Global setting, in seconds, for initiating a stop state alarm	150	At boot/write
857	Stop Count	Successive reports below stopped rate to trigger a stopped scenario. For example, a stop count of three (3) with a report time of 60 seconds means a line will not enter a stop state until it has been below the Stopped Rate for three consecutive reports or 3 minutes	3	At boot/write
858	Delay Mode	Enables script delay that adds a two second wait time before starting another loop in the program, the system operates normally with this exception. This is helpful for troubleshooting the system and should be disabled during normal operation. 1 = Enabled, 0 = Disabled	0	
859	Push Rate	Global setting, in seconds, for initiating a push rate to Banner CDS.	300	1/day
860	Push Enable	Enables the controller to push data to Banner CDS. Set to a value of 0 to disable cloud pushing	1	
861	Low Performance	Global setting for a Low Performance Alert. Set to a value of 0 to use individual Low Performance Alerts. See register 7151	85	At boot/write
862	Critical Performance	Global setting for a Critical Performance Alert. Set to a value of 0 to use individual Critical Performance Alerts. See register 7201	50	At boot/write

Table 9: Sensor data

DXM Registers	Name	Description	Cloud
5001–5050	Part Count N#	Part Count for each sensor	R/W
5051–5100	Parts Per Minute (PPM) N#	Current line speed for each sensor. Calculated as the difference between the current count and last count averaged over 1 minute	R/W
5101–5150	Average PPM N#	Averages PPM values since last reset/count clear	R/W
5151–5200	Ideal Run Rate Deviation N#	Percent offset of Ideal Run Rate using Average PPM. Reported as a signed 32 bit value	R/W
5201–5250	Last Count N#	Last reported count value, non-cumulative	R/W

Table 10: Sensor state and timers

DXM Registers	Name	Description	Cloud
5501–5550	Sync Status N#	Alarm for Sensor out of sync condition. Value of 0 = Out of sync, Value of 128 = sensor in sync	R/W

DXM Registers	Name	Description	Cloud
5551–5600	Total Ideal Run Time N#	Total Time (Seconds) that the Sensor is in a Run State condition.	R/W
5601–5650	Total Slow Time N#	Total Time (Seconds) that the Sensor is in a Slowed State condition.	R/W
5651–5700	Total Stop Time N#	Total Time (Seconds) that the Sensor is in a Stopped State condition.	R/W
5701–5750	Total ON Time N#	Total Time (Seconds) that the Sensor is ON, sum of Ideal Run Time, Slow Time, and Stop Time	R/W
5751–5800	Average Slow Time N#	Average Time (Seconds) that the Sensor is in Slow State conditions	R/W
5801–5850	Average Stop Time N#	Average Time (Seconds) that the Sensor is in Stop State conditions	R/W
5851–5900	Slow Event Count N#	Number of Slow State events	R/W
5901–5950	Stop Event Count N#	Number of Stop State events	R/W
5951–6000	Sensor State N#	Current Status of the Sensor, 100 = OFF, 200 = Run, 300 = Slow, 400 = Stop	R/W
6001–6050	Sensor Running N#	Sensor is in a run state condition. Value of 1 = Run	
6051–6100	Sensor Slowed N#	Sensor is in a slow state condition. Value of 1 = Slow	
6101–6150	Sensor Stopped N#	Sensor is in a stop state condition. Value of 1 = Stopped	
6151–6200	Availability N#	Sensor Availability calculated as (Ideal Run Rate Time + Slow Time) / Total ON Time	R/W
6201–6250	Performance N#	Sensor Performance calculated as (Part Count/Total ON Time)/Ideal Run Rate	R/W
6251–6300	Low Performance Alert N#	Individual Sensor Low Performance Alert. 1 = Alert Active	
6301–6350	Critical Performance Alert N#	Individual Sensor Critical Performance Alert. 1 = Alert Active	
6901–6950	Clear Count N#	Clears the Sensor States and Counter information for the designated node ID	At Boot/Write

Table 11: Individual parameters

DXM Registers	Name	Description	Cloud
7001–7050	Report Time N#	Individual Sensor report Times (seconds), only enabled if register 851 = 0	At Boot/Write
7051–7100	Ideal Run Rate N#	Individual Sensor Ideal Run Rate (PPM), only enabled if register 855 = 0	At Boot/Write
7101–7150	Stopped Rate N#	Individual Sensor Stopped Rate (PPM), only enabled if register 856 = 0	At Boot/Write
7151–7200	Performance Low N#	Individual Sensor Low Performance Setting (Percent), will only be enabled if register " " = 0. Valid settings are between 0 and 100.	At Boot/Write
7201–7250	Performance Critical N#	Individual Sensor Critical Performance Setting (Percent), will only be enabled if register " " = 0. Valid settings are between 0 and 100.	At Boot/Write